



JOINT EUROPEAN COMMISSION / EPOSS EXPERT WORKSHOP 2008

BEYOND RFID – THE INTERNET OF THINGS

11-12 FEBRUARY 2008

EXPERT WORKSHOP ON THE TOPICS

I - PEOPLE

II - ITEMS AND TECHNOLOGY

III - PROCESSES

IV - VISION



FRAMEWORK DOCUMENT

Vision 2020 (General introduction)

How could the internet of things be pictured in the mid- to long-term future?

The power of information technology doubles every 18 months, the price of every given piece of silicon can be expected to drop by half every 18 months, the amount of computer memory we can get for one euro is doubling every 15 months, and the size of the Internet is doubling every 12 months – change is taking place exponentially. Knowledge tends to double every year compared to every six years 30 years ago.

Today RFID technology is already entering the market on a broad scale; however, the smartness of the “tags” is still low. At the same time the size of sensors, actuators, logic and storage components is shrinking dramatically, and novel functionalities are added. Through advanced integration these tags will become active and “smart” systems which will be able to act and react according to the environment they are in.

By 2020 smart tags or systems, some incorporating the computing power of today’s desktop computers will be attached, embedded or seamlessly integrated everywhere, in our walls, tables, desks, garments, watches, and in the human body environment. They will operate autonomously, make efficient use of energy sources, and be networked by all means, potentially to each of the 1,000 to 5,000 “things” which surround human beings every day. Thanks to the ubiquity of networks, ordinary things will be capable of computing and communicating, connecting or being connected to each other, and acting rationally with some intelligence.

The next generation of Internet applications will be able to instantaneously identify any kind of “thing”. The “Internet of things” will be capable of encoding the 50 to 100,000 billion “things” that exist on Earth, following their movement, and utilizing the information they are carrying.

The autonomous interaction of objects, devices and infrastructure without the need for active control by human beings will result in completely new applications, scenarios and services. The environment will become active and reactive with potentially an enormous increase in convenience, safety and health, competing with various challenges in terms of privacy and social life.

Technically, an enormous amount of information of the annotated (tagged) environment will be available on a number of different levels (basic object information e.g. name, description, status; system information e.g. network status; physical parameters e.g. temperature, humidity, etc.). This massive flood of additional information will need a coherent architecture, inherent logic and sound structuring concepts in order to match information requests (by either humans or infrastructure entities) and information provided by the environment.

Given the significance of the domains RFID, smart systems, and networked communication for both the advancement of information society, and the competitiveness of the European industry, an in-depth mid- and long-term assessment of opportunities and challenges related to the “Internet of Things” is required. It has to be done from various perspectives, including the ones of the human being, the technology, the economy, and from the perspective of future ICT in general. Strengths and weaknesses have to be identified in order to create a joint strategy.

Rational

This expert workshop “Beyond RFID – The Internet of Things” is intended to provide a platform for discussing the mid- and long- term aspects of the increasingly “smart” and “connected” environment that we are facing in the future.

The outcome of this workshop shall serve three purposes:

- First, it will create or extend a common basis for future public discussion of the topic “The Internet of Things”.
- Secondly, the topics and research needs, the roadblocks and barriers identified and the scenarios established should contribute to the formulation of future calls in FP7.
- Thirdly, the results of the workshop will shape and contribute to the strategic research agenda of EPoSS.

A final report will be compiled by selected rapporteurs and then disseminated to the public.

This framework paper is intended to serve as starting point for discussions during the workshop. It does not claim to completely cover all aspects of the topic but rather lists some of the crucial factors that might be addressed.

This document has been jointly written by the European Commission, DG Infso, Unit D5 and Unit G2 and the EPoSS working group on RFID.

Further information can be accessed at:

<http://www.smart-systems-integration.org/public/internet-of-things>

Login: expert_rfid Password: eposs4u

SUB-WORKSHOP I - “PEOPLE”

The workshop I on “People” shall deal with topics where people (humans) come in contact with the “internet of things”, “beyond-RFID-technology” and the connected applications or services. The complementary topics, where no humans are involved, will be discussed in workshop III.

Outline of topics to be discussed during the workshop:

The workshop will aim to demonstrate that any use of RFID and other technologies deemed catalytic in the emergence of the Internet of Things, in particular where personal data may be involved, must have gone through a comprehensive risk and impact assessment prior to actual implementation. A constant dialogue involving all stakeholders must take place to appraise and determine the utility and the necessity of the use of these technologies. It cannot be a top-down process where businesses do not engage with the consumers and citizens and present it as a *fait accompli*.

To convince the general public of the many benefits of IoT technologies, applications of true social and societal interest must be identified, researched and trialled in real scale settings on a European level. The workshop will bring together some of the most internationally recognised experts in the field to clarify the issues, requirements and research options to realise the potential of IoT technologies for the benefit of society.

The identified topics will serve as basis for future calls of FP7 and future policy initiatives of the European Commission

Scenario 2020 - I: A Day in the Life of Adam

How will the IoT look like?

Adam has just finished a long working day. His Personal Universal Device (PUD) is telling him he should go shopping, as the milk in his Intelligent Fridge (i-fridge) is going off. He gets into the car, and the PUD drives him, showing him the quickest path, considering traffic congestions and road works, to his favourite supermarket. There, he can go around with his trolley, while his i-fridge is sending him messages of what to buy and what not to buy, as the RFID of the different products reach his device, and send availability messages to the i-fridge.

If he puts something different into his trolley, he gets warned that he will gain weight, his cholesterol level will raise 1.5%, the last time he bought the same product he threw away half of it, he should get more fruit and vegetables because an heat wave is forecasted for the next few days, and if he buys that other stuff he will not sleep well.

He also has to remember to opt-out all the products at the cashier – last time he forgot, and some other supermarket company started sending him tons of advertising about products X and Y, and why they are better than product Z, the one he bought.

After getting home, he starts preparing his dinner – and the smart pan is telling him he’s putting too much oil, the temperature is too high, while the i-fridge tells him to cook the product W instead of X because it’s closer to the expiry date.

If Adam is somewhere near normal, we believe that he will be very close to a nervous breakdown, and start crying his miseries of having not one but two mothers in law to bare, before destroying all the technological devices he can find in a 100 meters radius.

Note: This scenario was deliberately formulated very controversial to spark the discussion in this area!

Social benefits

What kind of concrete societal benefits could be imagined? (A few examples)

Health

- Safe medication and treatment
- Hospital environments, monitoring of patients
- Prevention of counterfeited drugs

Food traceability

- Origin of products, freshness, full list of ingredients (allergies, etc.)

Elderly and Disabled people

- RFID communicators indicate to handicapped or visually impaired persons road-blocks or best way to proceed around a town, building, etc.
 - e.g., RFID location tags at airports and tags embedded in sidewalks in cities to guide blind people, and special computers for physically challenged people
- Ambient Assisted Living making homes more “intelligent” through RFID to help the ageing population with daily tasks (intelligent fridge, energy consumption, etc.)

Anti counterfeit/Fraud

- Ticketing, official documents ensuring that the document is genuine and not a replica (increased certainty for individuals, avoidance of ticket fraud, etc.)
- Prevention of counterfeited goods which endanger people (e.g. drugs, liquids, spare parts, lighters, fun articles)

Mass transit/Transport systems/Government

- Location information provided to users of personal-navigation systems
- Quick and easy access to metro and other mass transit systems
- Unique and secure digital identity

Assisted living and social networking

- Monitoring and control of ambient environment (air conditioning, heating lighting)
- Parents may equip their children with RFID bracelets so that they can be tracked when away from home for their own safety
- Facilitation and new features for social networking and interaction

SWOT Analysis

Overview of the sub-workshop topic summarising most important issues

	<i>Positive</i>	<i>Negative / challenging</i>
<i>European</i>	<p>Strengths</p> <ul style="list-style-type: none"> ▪ Several research centres of world class ▪ Big RFID suppliers, incl. many dynamic SMEs ▪ High market potential for consumer/personal applications ▪ Pro-active role of the European Commission towards a common policy framework ▪ Unique legislative framework for Data Protection and ePrivacy ▪ High attention given to European social/cultural values (privacy, human rights, inclusion, etc.) 	<p>Weaknesses</p> <ul style="list-style-type: none"> ▪ Many EU countries still with only marginal attention for RFID / Internet of things ▪ No level playing field for RFID/IoT across countries ▪ No harmonised frequency policy in the EU (although it is in progress) ▪ Trust issue ▪ Lack of pan-European pilot projects to draw lessons from actual large-scale trials and experiments
<i>General</i>	<p>Opportunities</p> <ul style="list-style-type: none"> ▪ Creation of new services, new workplaces ▪ Spur for economic development ▪ Increased convenience in citizens' everyday life 	<p>Threats</p> <ul style="list-style-type: none"> ▪ High initial costs ▪ Rapid technological evolution may displace a technology before it is widely adopted ▪ High hidden costs (education and training...) ▪ Potential threats to privacy and security (function creep, surveillance capacity)

Technological Challenges

- Miniaturisation, low power sources, wireless, biosensors, scalability
- Privacy and security-by-design / encryption
- Management of digital identities
- Interlinking of dynamically configurable communication networks (personal area network, vehicle network, home network, office network, etc.)
- Speech and voice interaction with smart wearable devices using natural language recognition

Non-technological Challenges

- Respect of human nature, dignity, and physical integrity.
- Human right to welfare (quality of life, long-term health and safety issues).
- Balanced and equitable R&D Internet of Things investment in society – the investments must be done in such a way that the benefits and secondary consequences are properly distributed in society, including for opportunities for education and training.
- Sustainable development of technology, energy supply, and transportation, including life-cycle analysis of products, materials flow analysis, etc.
- Economic, legal, ethical, moral and other social aspects to anticipate and address socio-economic changes caused by the Internet of Things – the new knowledge should be developed through research, creation of databases, and awareness-raising activities and dissemination, including two-way interaction with the public and interested organisations.

Questions (possibly to be answered during the discussion)

General:

1. Prioritisation of the technologies and applications?
2. Which fields/ technological approaches are important to Europe? Economically and for society?
3. Which are the most prominent roadblocks / barriers hindering technology adoption?
4. Which technological challenges should be approached first?
5. Which stakeholders are responsible/ have to be included into the process?

Specific questions:

6. Which kind of information has to be exchanged? Different objects may provide and require different information.
7. Information has to be filtered on different levels to the needs of the respective user (a user can be an object, a device or a human being, etc...)

Workshop Agenda

How will the workshop be organised?

The workshop essentially will provide an opportunity for brainstorming and give room for the discussion of technological aspects of the “internet of things”.

Day 1

- A) Introduction by the moderator
- B) Self introduction by participants
- C) Brainstorming on technology and non-technological fields
- D) Brainstorming on specific application fields of general / public interest
- E) Prioritization of future policy issues and research topics

Day 2

- F) Wrap up of topics discussed on the previous day.
- G) Comments to the rapporteurs' notes.

SUB-WORKSHOP II - "ITEMS AND TECHNOLOGY"

Workshop II shall address technology related aspects that become important on the way towards the "internet of things". Her technological aspects, e.g. roadblocks that have been identified, breakthroughs that are shall be discussed

Outline of topics to be discussed during the workshop:

The technology/ items related sub-workshop is dedicated to identifying technological strengths and weaknesses, opportunities and threats on the way towards the internet of things from a European perspective.

It shall address mid-term technological issues related to components and devices, ICT architecture and infrastructure.

Especially the technical needs shall be identified. This includes the listing of technologies that will be enablers for future applications and services in the fields of society and business.

The identified technological topics will serve as basis for input towards FP7 and the formulation of future calls.

For the reality is that RFID is still very much a work in progress, RFID products remain expensive, passive RFID tags don't work overly well with certain items (read percentages have been often in the 50 to 70 range), physics interfere, as radio frequency doesn't pass through metal or liquid easily, two standards organizations, EPC Global and the International Standards Organization, are adding additional complexity, rather than making things easier.

On short term, manufacturers could easily find themselves hosting a number of RFID applications to support customer/retailer mandates, regulatory compliance, and/or ROI-driven applications. While some of these applications will continue to be served by differing technologies, e.g., LF or HF vs. UHF, there is tremendous opportunity to leverage emerging RFID standards and achieve commonality across applications. So from the technology point of view the very first step should be that manufacturers similarly prepare themselves by specifying scalable, upgradeable systems that can expand with further application and penetration of the technology. Meanwhile according research can pave the way after.

Scenario 2020 - II: A Day in the Life of Barbara

How will the IoT look like?

Now, what does the Internet of Things mean in a practical sense for a citizen of the future? Let us imagine for a moment a day in the life of Barbara, a 23-year-old student from Spain, in the year 2020. Barbara has just quarreled with her boyfriend and needs a little time to herself. She decides to drive secretly to the French Alps in her smart Toyota to spend a weekend at a ski resort. But it seems she must first stop at a garage – her car's RFID sensor system (required by law) has alerted her of possible tire failure.

As she passes through the entrance to her favorite garage, a diagnostic tool using sensors and radio technology conducts a comprehensive check of her car and asks her to proceed

to a specialized maintenance terminal. The terminal is equipped with fully automated robotic arms and Barbara confidently leaves her beloved car behind in order to get some coffee. The “Orange Wall” beverage machine knows all about Barbara’s love of iced coffee and pours it for her after Barbara waves her internet watch for secure payment. When she gets back, a brand new pair of rear tires has already been installed with integrated RFID tags for monitoring pressure, temperature and deformation. The robotic guide then prompts Barbara on the privacy-related options associated with the new tires. The information stored in her car’s control system is intended for maintenance purposes but can be read at different points of the car journey where RFID readers are available. However, since Barbara does not want anyone to know (especially her boyfriend) where she is heading, such information is too sensitive to be left unprotected. She therefore chooses to have the privacy option turned on to prevent unauthorized tracking. Finally, Barbara can do some shopping and drives to the nearest mall.

She wants to buy that new snowboard jacket with embedded media player and weather-adjusting features. The resort she is heading towards uses a network of wireless sensors to monitor the possibilities of avalanches so she feels both healthy and safe. At the French-Spanish border, there is no need to stop, as

Barbara’s car contains information on her driver’s licence and passport which is automatically transmitted to the minimal border control installations. Suddenly, Barbara gets a video-call on her sunglasses. She pulls over and sees her boyfriend who begs to be forgiven and asks if she wants to spend the weekend together. Her spirits rise and on impulse she gives a speech command to the navigation system to disable the privacy protection, so that her boyfriend’s car might find her location and aim directly for it. Even in a world full of smart interconnected things, human feelings continue to rule.

Source : “ITU Internet Reports 2005: The Internet of Things, November 2005”

Benefits

What kind of societal benefits could be imagined?

- Information on the environment a person is moving in is ubiquitously available.
- If necessary the environment can take over protective or monitoring functions.
- Completely new applications services will emerge.
- Simplification/ cost saving in business applications.
- ...

Challenges

Which are the most imminent or crucial challenges?

- Technology :
 - integration of sensors ,
 - energy supply, energy harvesting
 - integration of antennas
 - integration into existing networks,

- integration into materials / packaging / paper/...etc ,
- Common standards and the compatibility of systems is crucial. “Things” have to speak the same language!
- Nanotechnology: can “smart dust” still be based on silicon?
- Where are the limits?
- Security at all levels
- Social acceptance
- Data-oriented integration of very large numbers of data sources

Questions

A collection of questions that might be discussed during the workshop

General:

1. Prioritization of technologies and applications?
2. Which fields/ technological approaches are important to Europe? Economically and for society?
3. Which are the most prominent roadblocks/barriers hindering technology adoption?
4. Which challenges should be approached first?
5. Which stakeholders are responsible/ have to be included into the process?

Specific question:

6. Which kind of information has to be exchanged? Different objects may provide and require different information.
7. A common language for the information exchange might be necessary (similar to XML)
8. Information has to be filtered on different levels to the needs of the respective user (a user can be an object, a device or a human being, etc...)
9. what needs to be done to come to less, more unified standards

Workshop Agenda

How will the workshop be organised?

The workshop essentially will provide an opportunity for brainstorming and give room for the discussion of technological aspects of the “internet of things”.

The principal structure will be as follows:

Day 1

- A) Introduction by the moderator / (Intro presentation)
- B) Self introduction of the participants/ experts

- C) Brainstorming on technology fields / technology roadblocks
- D) Brainstorming on application fields
- E) Prioritization of future policy issues and research topics

Day 2

- F) Wrap up of topics discussed on the previous day.
- G) Comments to the rapporteurs' notes.

SWOT Analysis

Overview of the sub-workshop topic summarising most important issues

	<i>Positive</i>	<i>negative / challenging</i>
<i>European</i>	<p>Strengths:</p> <ul style="list-style-type: none"> ▪ Large number of applicable technologies available ▪ NFC : the first platform to connect RFID via the mobile phone with the internet and services ▪ Near Field Communication Interface and Protocol (NFCIP-1) is be able to use the secure means of communication between various devices without exerting much intellectual effort in configuring their “network”. In order to make two devices communicate, bring them together or make them touch ▪ RFID chips can be made thinner than paper and therefore integrated into it ▪ Printing technology progress drives cost down (antennae) ▪ Polymer-technology cannot yet replace silicon for RFID, but a lot of positive results are already available (strong research community) ▪ 	<p>Weaknesses:</p> <ul style="list-style-type: none"> ▪ Manufacturing challenges (roll-to-roll manufacturing, self assembly, etc.) ▪ Printing and Polymer technology as means to reduce costs ▪ Integration aspects → Demand for smaller antennae, compact readers – in particular the integration in substances like metal, wood, plastic etc. open up new challenges ▪ Integration into mobile devices → new application scenarios (problem is not to get a reader in a mobile phone, but combine all existing standards : GSM, UMTS, bluetooth, ...NFC etc.) ▪ Plug and play of RFID technology, adaptation to the environment ▪ Compatibility to existing networks (network-technology) ▪ Low cost security (e.g. against product piracy) ▪ Integrated Sensors (various applications) ▪ Effect of disposable technology on environment (environmental protection) ▪ Smart Integration aspects: multi-material, design aspects, form follows function ▪ Different Frequencies, different standards (HF vs. UHF) ▪ Higher data rates will be needed (multitag reading) and better algorithms ▪ Optimizing power management (energy scavenging, polymer batteries, ...) ▪ Privacy enhancing technologies
<i>General</i>	Opportunities:	Threats

<ul style="list-style-type: none"> ▪ New technologies/ devices lead to new applications and services ▪ Socio-Economic Impact: (assisted living, reduced costs for social systems) ▪ Solve the counterfeiting problem ▪ Establish real pedigree not just for pharmaceuticals but also for all cold chain products ▪ Much progress has been made in some European countries (specifically Germany) to lead the way in e-government and e-administration applications. ▪ Long before many North American companies had heard of RFID, European companies were using high- and low-frequency RFID technologies. Car immobilizers were developed in Europe. European ski lift operators were pioneers in using RFID for ticketing applications. And Europeans have embraced RFID, or contactless, smart cards. Now things have to be put into perspective, getting from trials to real use to keep the lead 	<ul style="list-style-type: none"> ▪ Strong competition worldwide (e.g. China/Taiwan have started to support heavily university research) ▪ The Asian region generally leads its North American and European counterparts in ubiquitous computing. Projects like (city-of-the-future projects in Tokyo's famed Ginza shopping district (10,000 RFID tags, wireless beacons embedded in public fixtures like walls and street lamps) demonstrate that in many respects Japan and Korea are world leaders in the <u>realization</u> of the "Internet of Things" . Ironically a manifestation of the concept like the one in Ginza might well be rejected by the North American and European public, who are generally seen as more sensitive to the protection of personal privacy and anonymity than the Asian public. ▪ Unlike in the U.S. and Europe, Asian RFID adoption is not retailer mandate-driven. Instead, initiatives are often headed by government and the suppliers themselves, which leads to faster implementation ▪ Many mostly small companies – specifically in the US focus on IP creation. As long as this IP is not commonly available and free, it can hamper further innovation, cost down and slow down market growth
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SUB-WORKSHOP III - “PROCESS”

Workshop III “Process” shall be seen as complementary to workshop I. Focus shall be set on the non human related issues of the “internet of things”. This includes topics such as mid- to long-term RFID research related to business and service application areas like e.g. logistics, manufacturing, and retail that have no or very tiny links to identifiable persons¹.

Outline of topics to be discussed during the workshop:

The long term vision within these application fields is a system providing necessary real-time information on production processes and the whole supply chain. RFID is the key technology to gather real-time information on the location, contents and conditions of individually identified products, transport units, or shipments in a controlled manner. The collected data can be combined with the planning information and processed into appropriate information to be used at different stages of the process. Product history will become available via B2B networks. The information can be distributed effectively and in real time to the stakeholders. In the retail area this information can be used for after-sales processes and warranty issues.

RFID systems provide item and product visibility within the supply chain. This visibility can further be translated into actionable data and predictive changes with additional information attained through sensors. RFID transponders with sensor functionalities will be developed, which will further enhance their usability and applications. As an example, they will allow the automated monitoring of conditions during production processes and through the supply chain. Intelligent sensors can combine sensing, computation and communication into a single, small device. The future vision for RFID technology consists of completely automated sensing networks that can react to external changes in real time. For the field of logistics a scenario in which pallets, packages and products will independently find their way through the logistics chain with the aid of intelligent RFID chips combined with a global logistics network.

Furthermore, the product life cycle might change profoundly in the “internet of things” / “internet of objects” era. Customisation, efficiency and accuracy of the product life cycle will reach new levels of perfection. Cars, furniture, buildings, and many other products will be customisable by the buyer on line using advanced 3 D tools, virtual reality and simulators. The manufacturing process flow, and the full supporting chain of tier 1, 2, ..n suppliers will be managed by the information available on the 'Internet of Things' about the object (or maybe embedded in the smart-tag of the object itself). Distribution routing throughout the supply chain will be managed by the object without need for large central systems. Each object will have a unique identifier and this will enhance many post sale processes such as maintenance, configuration management of complex products such as trains, airplanes. Easy authentication will ensure that mission critical components are original, that a consumer can verify the origin of food items, that drugs are not counterfeited, etc. Maintenance and reverse logistics can be automated to a large extent. The product engineering team will get much more information on the live behaviour of each

¹ A detailed description of these RFID application fields can be found at the CE RFID project website: www.rfid-in-action.eu/public/rfid-reference-model

product, the way customers use it, and able to enhance the product design, manufacturing process or used materials almost in real time. Individualized product recalls are possible.

Scenario 2020 - III: A Day in the Life of Carla

How will the IoT look like?

After having breakfast and completing the virtual shopping tour for dinner Carla goes to work. She works as process manager for an internationally operating car production company. One of her big achievements was to set up a system providing necessary real-time information on their production processes and the whole supply chain. It was very difficult and time-consuming to integrate all suppliers, but Carla finally convinced them when presenting a secure data-sharing model. RFID is the key technology to gather this real-time information on the location and condition of individually identified products or transport units in Carla's company.

The data is also very valuable for forecasting and planning processes. However, also planning processes are automated and missing components are ordered without any people being involved. And also the production processes are automated. The cars they produce actually build themselves autonomously. All components are equipped with transponders and intelligent sensors, combining sensing, computation and communication functionalities. Carla is very impressed whenever she steps into the production halls, because it seems that invisible people would do the work. All pallets, packages and products find their way independently and production processes run automatically.

On her way home she stops at the local distribution node for a "shopping tour". She uses the opportunity to fit some clothes from the new collection. The computer projects on real scale a video how she would look in the selected clothes. Once her choice has been made the full business supply chain behind it is automated. Smart Dressing Rooms and Smart Shelve applications have been installed in almost all local distribution nodes as a special service for the customers. They identify clothes via RFID and supply useful information such as the price, size and material of the article via an integrated display. This way RFID helps to enhance the efficiency of business processes and reduces costs. But not only services such as high on-shelve availability and efficient delivering services convince Carla, she can also use the information on the transponder for after-sales processes and warranty issues. It gives her a feeling of security knowing that all product history is accessible at any time when reading the EPC of a product.

Benefits (examples)

- Gathering real-time data allowing to improve analysis and forecasting
- Improvement of monitoring and controlling of processes
- automated sensor networks that react to changes
- fully automated order administration and processing along the whole supply chain
- Efficiency of processes increases with possibility of cost reduction

Challenges (examples)

- Technological development (tags, readers, sensor networks, reliability, etc.)
- Improvement of technological interoperability

- Especially in the retail area: improvement of cooperation between actors within very heterogeneous supply chains
- Development of secure and reliable data-sharing models for different actors within supply chains

Questions (possibly to be answered during the discussion)

1. What are the most relevant application fields?
2. What are the main future use cases in these fields?
3. What are the main challenges?
4. Prioritisation of these challenges?
5. How could these challenges be overcome?
6. How could data-sharing models look like?
7. What is the time frame for different challenges?
8. Who are the addresses for these challenges (e.g. research institutions, business organisations, standardisation bodies, etc.) => who should contribute to the different topics?

Workshop Agenda

Day 1

- A) Introduction by the moderator
- B) Self introduction by participants
- C) Brainstorming on technology and non-technological fields
- D) Brainstorming on specific application fields of general / public interest
- E) Prioritization of future policy issues and research topics

Day 2

- F) Wrap up of topics discussed on the previous day.
- G) Comments to the rapporteurs' notes.

Annexe: RFID Reference Model for RFID applications

Subcategories	RFID Application Field	
	Mainly Object Tagging	Tagging with Reference or Potential Reference to Individuals
AA. - Inhouse Logistics AB. - Closed Loop Logistics AC. - Open Logistics AD. - Postal Applications AE. - Dangerous Goods Logistics AF. - Manufacturing Logistics	A. Logistical Tracking & Tracing	D. Access Control and Tracing & Tracing of Individuals
BA. - Archive Systems BB. - Asset Management (incl. Environmental Monitoring) BC. - Facility Management BD. - Vehicles BE. - Airplanes BF. - Automation / Process Control BG. - Food and Consumer Goods	B. Production, Monitoring and Maintenance	
CA. - Fast Moving Consumer Goods CB. - Electronic Goods CC. - Textile Goods CD. - Fresh/Perishable Foods CE. - Pharmaceutical CF. - Customer Information Systems	C. Product Safety, Quality and Information	
DA. - Ticketing DB. - Access Control Systems DC. - Animal Tracking DD. - Personal Tracking	E. Loyalty, Membership and Payment	
EA. - Loyalty Cards EB. - Membership Cards EC. - Contactless Banking Cards ED. - Payment and Advertising via mobile phones	F. eHealth Care	
FA. - Assistance for the Disabled FB. - Hospital Management FC. - Implants FD. - Medical Monitoring FE. - Smart Implants	G. Sports, Leisure and Household	
GA. - Sports Applications GB. - Rental Systems GC. - Smart Games GD. - Smart Home	H. Public Services	
HA. - Public Service Maintenance HB. - Road Tolling Systems HC. - Banknotes HD. - ID Cards and Passports HE. - Health Insurance Cards		

SUB-WORKSHOP IV - “VISIONS”

Workshop IV “Visions” should be seen to provide a forum for open thoughts. Here new, “visionary” concepts could and should be discussed. The focus of addressed research and applications will be rather long-term.

Outline of topics to be discussed during the workshop:

Topics that will be addressed by the experts might be:

- Connection between the virtual world (Second Life,...) and the physical world, facilitated by the internet of things?
- (Semi-)autonomous vehicles for transportation (public, goods)
- Highly automated factories
- Near real-time customer services
- Automated environment management
- Intelligent/autonomous building management
- Individuals carrying sensors inside human body
- Intelligent clothes and garments
- High individual protection

Scenario 2030 - IV: A Day in the Life of David

How will the IoT look like?

It is a normal weekday morning. David wakes up and plans his day. He wants to leave for work in half an hour and asks the Ubiquitous Network Environment (UNE), by means of a voice command, to find a vehicle to share with somebody on his route to work. UNE starts searching the trip database and, after checking the agreement of the driver, finds someone that will pass by in 30 minutes. From that moment on, David and his driver are in permanent contact if wanted – both wear their personal area networks (PAN) allowing seamless and intuitive contacts.

While taking his breakfast coffee, David lists his shopping since he has been informed by UNE that he would soon become short of food and beverages. He would like also to cook a cake for his companion and the e-i-fridge flashes the recipe. It highlights the ingredients that are missing: milk, eggs and flour. He completes the shopping on the e-i-fridge screen and asks for it to be delivered to the closest distribution point in the neighbourhood. All goods are tagged, so that David can check the progress of her virtual shopping expedition, from any enabled device at home, the office or from her smart watch when she is on the move.

David goes downstairs onto the street, as his driver arrives. When David gets into the car, the vehicle area network (VAN) registers his and by doing that the in-vehicle payment systems start counting. A micro-payment system will automatically transfer the amount into the e-purse of the driver when he gets out of the car.

At noon David's wireless monitoring system that keeps track of vital signs notifies him on the screen of her RFID wrist watch that it's time to take insulin to regulate his insulin-dependent diabetes.

At 5:45pm, after work, David arrives at the local distribution node (actually his neighbourhood corner shop) to pick up the goods he has ordered in the morning. By getting them out, the system registers payment and deletes the items from David's shopping list. At home, his smart i-fridge screen will be blank.

Coming home, UNE welcomes David and suggests to telework the next day as due to the heat the atmosphere will be unhealthy and David might suffer from allergies to certain types of pollutants.

Social benefits

Better utilisation of resources

- Less waste, more resources for everyone
- Saving money
- Saving environment
- Saving time

Challenges

- Will the "things" in the Internet of things behave in an autonomic way?
- Will they be intelligent and non-deterministic?
- Will there be a hierarchy of objects?

PEST Analysis

Political Factors.

Although political directions can fluctuate significantly in the next 15 years, it seems clear that the development of these technologies is a key aspect of the future society. Political instability can, though significantly enhance or slow down their adoption.

Similarly, trade agreements can determine the speed of adoption, and drive, although marginally, the development and cost of the technology.

Economic Factors.

While Economic factors are fundamental for the development of any kind of technology, and a stable growth is probably the best scenario for fast advances on research on the internet of things, we believe that the rise of this technology will occur in any economic scenario. Even a case of strong recession might push its development, as a mean to save resources and money.

Sociocultural Factors.

Socio Economical factors can determine the adoption or rejection of the IoT. These technologies can be seen as a “big brother” creation, limiting the privacy and giving the possibility of a total control of our lives. The attitude of consumers is already very strong, and can kill this technology, simply by refusing to adopt it. It is therefore fundamental to prove that privacy is not violated, and all the benefits that can be obtained, in terms of economic savings, increased personal leisure, and security.

Technological Factors.

The technological development can get to a halt if appropriate communication standards are not in place, and if privacy and security issues are not convincingly solved. There is no doubt that the IoT will provide innovative services and may radically change long-established business models.

Workshop Agenda

Day 1

- A) Introduction by the moderator
- B) Self introduction by participants
- C) Brainstorming on technology and non-technological fields
- D) Brainstorming on specific application fields of general / public interest
- E) Prioritization of future policy issues and research topics

Day 2

- F) Wrap up of topics discussed on the previous day.
- G) Comments to the rapporteurs' notes.