Internet of Things Architecture

IoT-A

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Editor(s):	Alain Pastor	
List of contributors:	Alexander Salinas Segura, Ralf Kernchen, Sonja Meyer, Johannes Riedl, Fernando Lopez Aguilar, Alessandro Bassi	
Reviewers:	Alessandro Bassi	
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	Dissemination Level	
PU	Public	
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Executive Summary

This report outlines the results of the First IoT-A Stakeholders Workshop (SW1). The report points out the stakeholder opinions regarding IoT-A and IoT in general in a well structured and comprehensive summary.

The members of the stakeholder group were representative of a wide range of business domains with an interest on Internet of Things: Health, City, Law, Logistics to name a few of them. Participants of the stakeholder group got a unique opportunity to take part in the development of the IoT-Architecture. The stakeholder's contributions are of particular importance for the project's outcome since they will be collected and combined with the project activities to conduct a technical, business and socio-economic validation.

The report was written based on the questionnaire sent upstream to the workshop, the general presentation of each participants and the open discussions about use cases, as depicted in the following picture.

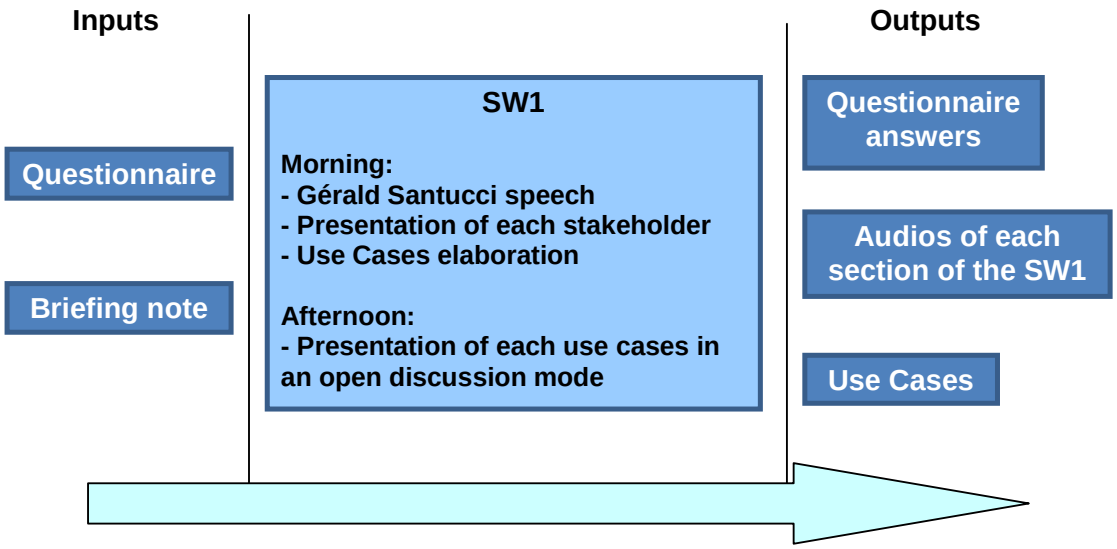


Table of Content

1. A reference architecture for the Internet of Things

The IoT-A Reference Architecture will provide the technological foundations that will allow a new wave of applications and Business Models to be realized in the Internet of Things domain. IoT-A will facilitate the development of a new set of services based on the IoT technologies that the society is currently demanding, like Smart Grids, Smart Cities, e-Health or Logistics. It will also provide an open framework where multiple actors can participate in an open ecosystem. Furthermore, it will promote the development of new Business Models by allowing the share of infrastructure among different and heterogeneous actors and user domains. IoT-A will provide the bases for breaking the vertical silos that are driving us towards an "Intranet of Things" view to a real "Internet of Things".

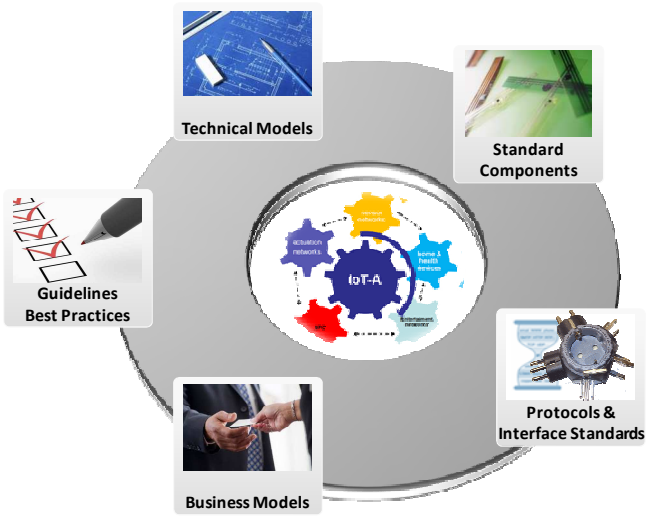


Figure 1: High level view on achievements of the IoT-A Reference Architecture

IoT-A is not aiming at the creation of yet another IoT architecture, but a reference architecture and its initial set of key building blocks, which are crucial for the grow of a future Internet of Things. This way of working will allow settling the bases so current developments can converge into a common view while enforcing a flexible evolution allowing the easy addition of future functionalities. Main achievements coming from IoT-A as depicted in Figure 1 can be summarized in the following:

- Architectural reference model for the interoperability of Internet of Things systems, outlining guidelines and best practices for the technical design of its protocols, interfaces and algorithms
- Corresponding mechanisms for its efficient integration into the service layer of the Future Internet
- Novel resolution infrastructure, allowing scalable look-up and discovery of IoT resources, entities of the real world and their associations
- Novel platform components that are based on solid technical models to become standard in IoT systems
- Implementation of real-life use cases demonstrating the benefits of the developed

architecture

The purpose of IoT-A is to define a reference architecture process based on existing architectures and solutions. The resulting vision has to be relevant for the stakeholder business scenarios identified in WP6. In order to use a common terminology across stakeholders coming from totally different business areas the development of an IoT Domain Model is needed. The architecture is described through several models, such as functional structure view or information model, that are targeted to precise stakeholders.

As architecture qualities are an important factor for the acceptance of an IoT system, we plan to identify them through non-functional requirements. As mentioned earlier the IoT-A Reference Architecture will provide guidelines and best practices to the interested stakeholder organisation to define and implement their own compliant IoT architecture. This is summarised in Figure 2.

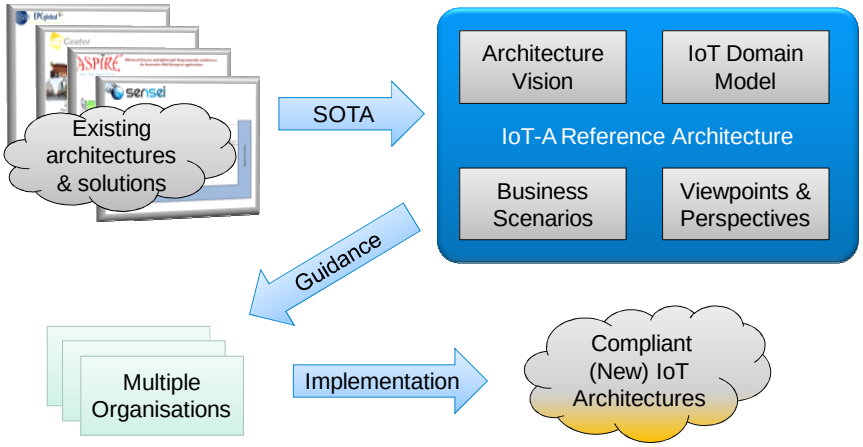


Figure 2: IoT-A Reference Architecture building process

2. Gérald Santucci opinion

The following chapter reports the speech made by Mr. Gérald Santucci - Head of Unit "Enterprise Networking and RFID" at European Commission and chairman of the High Level Expert Group on the Internet of Things, created by Commission Decision of August 10, 2010 - at the open session of the First IoT-A Stakeholders Workshop held in Paris November 28, 2010.

The views reported in the following chapter are those of the author and do not necessarily represent the views of the European Commission.

Good morning,

Thanks, Alex, for organizing this meeting which is important because it is the first one with a stakeholders group. As stakeholder, you will have a very important role to play in the success of the project. My message to you is that the project IoT-A[1] is an essential one; it is not the only one: we have for the time being eight projects[2] dealing with the Internet of Thing which are founded by the European Commission (FP7 Call5). IoT-A is the biggest one, simply because it is an Integrated Project (IP) and therefore it is a flagship.

The success of IoT-A will have an impact on the success of the entire cluster, IERC-European

[1] http://www.iot-a.eu/public
[2] http://www.internet-of-things-research.eu/partners.htm

Research Cluster on the Internet of Things[3]. Eight projects which in fact are more than eight because there are many ongoing projects, from the RFID Era, in Information Society and Media Directorate-General of the European Commission which are also part of the so called Internet of Things European Research Cluster. But again, IoT-A has a special role and therefore a special responsibility to play in there.

Context

IoT-A is the first big project in Europe and perhaps even in the world on the Internet of Things. It does not mean that Internet of Things is a new concept; it is a new phrase and even not so much because it was invented more than ten years ago in 1999 by a European, Kavin Ashton. The concept itself "to have a computer everywhere" - including in objects in order to provide new useful services to people - is much older probably we can go back to 1984 with the concept of TRON in Japan, invented by Prof. Ken Sakamura. Four years later, in the US, Mark Weiser coined the phrase "Pervasing Computing" which is exactly the same thing but you have different names. When Kavin Ashton coined the "Internet of Things" at a big RFID meeting in 1999, on the same year Philips adopt a commission to use a word about the same concept that is "Ambient intelligence". The term itself has fall down now, I would say.

Internet of Things is there now. It has been there for some time but you know like every time somebody has a vision, the vision would travel around for some years and suddenly it comes to the knowledge of many people who start to understand how that vision can be transformed into something more concrete and more useful. And we are at that critical stage when the Internet of Things has started to convince majority of stakeholders that it will have an impact on the productivity and the efficiency of organizations but also on the quality of life of the people. IoT-A comes at that time, as a flagship and there will be many aspects of work in IoT-A, some I do not even know but for what I know I would say there are several different points I would like to stress:

A reference architecture for the IoT and the importance of the Stakeholders

The first one which is perhaps the most important and the most special in the point of view of IoT-A is the definition of architecture approaches and modules. This is key, because we do not have in the world today a reference model for an IoT Architecture. For that it will be the main development goal of IoT-A and this is why you "stakeholders" – to keep it simple – you have an enormous responsibility because you will be those who will have to help IoT-A to identify what the requirements are and you will be those who will at the end do the validation of the reference model. So this is an immense responsibility and I hope, like I feel it, for each and all of you a matter of pride to be the little group in Europe and perhaps even in the world who will have to design and validate a reference model for an architecture of the IoT that will eventually launch the next wave of R&D actions that we will need at the end of FP7 and certainly in FP8. The result of your actions will play a major role in the definition of the R&D priorities that will be set for FP8. So there is no way other than success.

Naming and addressing issues

The second point I would like to mention will be the decision-making role for IoT-A in the questions of naming and addressing. We need some new schemes on that; there are many and there are competitive. It is difficult to assess how they operate, how they meet the requirements, how they can be interoperable. IoT-A will play a role in terms of providing a kind of novel resolution infrastructure. We need to understand how best IoT could be served by scheme regarding the naming of objects, the addressing and assigning problems.

[3] http://www.internet-of-things-research.eu/index.html

The governance of the IoT

I come to the third point which is the overall issue of the governance of the IoT. Some people would say “we do not need the governance, let the market do”; let me be clear with you, we do not believe on that. Some others would say “it is so important that the public sector should do the governance”; let me be clear with you, this is not also what we think. We believe that the governance architecture of the future IoT should eventually, preferably, based on a multiple stakeholders group that looks after the governance of the IoT. The IoT will not be one unique infrastructure; there will be many: this is not THE Internet. There are some cases where the application of the IoT will be small, limited to some applications or some sectors for which we do not need to have a global governance, even not a European one. But, IoT can also refer to a very large application across sectors with natural concerns for security, confidentiality, anonymity and etc. Yes indeed, there is a public concern. For this type of large infrastructure, we believe that we need to establish a governance: it will not be only a European governance, it should be multilateral, transparent and democratic, with the full involvement of governments, private sectors, international organizations and the civil society. The Expert Group, which we have just set up few months ago, works on that topic in order to define the principles, the values that would drive a global governance. We are also talking to people in Japan, in China, in the US, in Brazil and very soon in India on this subject. It will be highly debated into the Expert Group “why would we need a governance?” and if we need one – as I believe it, but the debate will take on – “what it should look like?”. What are the principles on which it should be based? The work of IoT-A on resolution infrastructure will allow to provide some principles, some elements that will be useful to define that IoT governance.

Service openness and Interoperability issues

The next point I would like to stress is the interoperability issues and the need for service openness. Probably we do not want to develop an IoT if it were only a set of “Intranet of Things” or even more “Intranet of Goods”. This is good for Carrefour, for Metro or Tesco. But the economy is not limited to distribution; it is much more. So if we want to have not silos but real cross-sectors IoT; what is “things”? First, it is not only goods. Second, it is not only artifacts, machines or even products in the sense that it would be manufactured in a massive way as all that we know in our everyday life. But it can also be these new trends towards objects that have virtual-reality today. The “blogjects” or “gizmos” as named by Bruce Sterling in his book tilted “*Shaping Things*”. The notion of object is one that is changing in front of our eyes even if on a day to day base we do not see the change. But the notion of object is something which will change and our relationship to these objects will also change. Because it will change, it will also change the way we apprehend our life, work and entertainment, everything we do and even the meaning of life. So this is very, very important. And what IoT-A will do will have an impact on this. Technically, I believe that IoT-A will do a lot to clarify for IoT the notion of semantic interoperability.

Privacy and Security issues

The fifth point I would like to mention to you is the role of IoT-A to guide stakeholders, the Commission and the government on the issues related to privacy and security.

Security, why? Simply because the IoT - I am sure you will demonstrate it - is a kind of critical information infrastructure which means that if ever for whatever reason there is a failure somewhere on the IoT the impact will be so high that it would be a social loss, like if we do not have more electricity. So, we need to establish the technical ways to ensure security and resilience.

On Privacy, of course, we need to look how privacy should be ensured, could be ensured in the

IoT. Not so easy, because some people would tell you “well, no, today we have the social network; we have many things that tell us that privacy is no longer an issue, even if we really need it let go two, three or five years and it will not be an issue anymore”. Many people think that the privacy issue is something for the politicians but that the reality of the ground make that it has no value or it will not have it anymore in a few years. Of course, we do not believe this should be true, because we have too much respect for the will of people to preserve their confidentiality. How to do privacy? There are several ways: technology is one answer – and we need to work on that side – regulation or legislation is a different way – we are doing that, we are aware of concepts like “privacy by design” which can have a technology called component but also a regulatory one. For instance, when we talk on establishing privacy impact and assessment it is a way to do “privacy by design”. So, we are working hard on that and IoT-A will have a role to play to say “what are the options and requirements for privacy and security in the IoT”. You will find in the revision of the law, which is on going on the European Directive on data protection, that there will be the concept of “the right to be forgotten” (“le droit à l’oubli” in French). This will be probably embedded into the new law. The proposal is going to be put on the table in the next few days. There will be a long debate in the council and in the European parliament on that. It will take at least two years but probably that will stay there. There is something more beyond “the right to be forgotten”; this is “the right to the silence of the chips”, where IoT-A can play a role to define better what it would look like, which is more or less to say that “we should have the technology means to provide function in the devices we used such as a mobile phone or whatever to disconnect when we want from the network environment and also to reconnect when we want”. It is not to say “I want it anymore”, it is to say “At that stage for whatever reason I want to be out; but may be in one hour, or in one day, I want to be in – on/off”. That is something which we could put in legislation. But if we would do that now it would be meaningless, because the problem is not to put it in a text, the problem is to make it happen. And first this is an R&D work. So, IoT-A probably will provide its part of the answer to this.

A framework for developing applications based on IoT

My sixth point – I will go very quickly on that – is about the definition of application scenarios, health care and so on. IoT-A will not work on applications, but you might be able to provide the framework that will set the technological requirements and options to further develop applications based on IoT. And if you do that my friend (Alex) you will have done your job, you and all of you. Because this is what we need and doing that, at the gain, the issue of interoperability will be covered. But the applications of IoT will be a lot, more and more. So the problem is to provide a framework, a set of scenarios where these applications could be developed in harmony, in an interoperable way and in a way that responses to the real needs of organization and people.

Standardization

And the last point I would like to stress is the need to start in IoT-A a pre-normative work. We can not wait that the pre-competitive R&D works have been done, we need to set the stage for what kind of standard should we need for biking the IoT a reality that is not only useful from an economical and social point of view but also would be industrially correct. No, it is not easy. And let me make a provocative statement there: there will be perhaps a meeting on “do we need standards at all for IoT?”. Yes, we need. But we have to say not only “we need standards”, we have to say “which kind of standards?”. I am provocative because I contemplate the time when communication between objects will take place no longer with human intervention, as it is the case today. You can foresee that this communications will be between objects. The objects being endorsed with the capability to decide themselves. They will be able to pre-empt what we need and when we need. And this autonomy of the objects will make that there will be an impossibility to standardize in the sense that you would like to lock the way the IoT would operate. Because there will be too many interferences, exceptions, volatility in the way it will work. The human being

if he is not at the source of the decision will not be able to standardize much. And that debate, at some stage, I would like we have it at IoT-A. We will need to standardize many things: the naming, addressing… lot of things. But again, help us identify what is essential for pre-standardization work and lets also have that debate "what will be the place and the role of standardization at large in a world where human intervention will not be anymore the source of decision?".

Conclusion

IoT-A is not alone. It is very important that IoT-A gains a leading role within the IERC. They are about thirty projects in the cluster today and there will be more very soon because we are now on the Call7 and there will be probably ten to twelve more R&D actions in the next few months. The point there is that you need to see your leading role in IERC as one to forester the minimization of overlaps and the maximization of synergies. Now, never forget, IoT-A, as the all, will have some expectation for us to tell us "How IoT can be a contribution to the overall scheme of the Future Internet?". Future Internet can be the extension of the Internet Architecture as we know it today – you can add to it IPv6, if you want. It could be also what Princeton, an Amercian University, called the *Clean-Slate* approach[4] where a totally new architecture is designed. This is not your role and we do not know today what it will look like. But, it is important always to keep in mind that IoT, as you will make it important, will have to be align to any notion of "How the Internet will evolve?". The second important issue is to make sure that you will make a contribution to the work on IoT related policy. It is important that you are aware of what are the policy issues which the Expert Group wants to tackle and be aware how technology speaking you can bring some feedback or some inputs to the policy debate.

So, that is what I wanted to tell you at this stage. Again, the main point being that: your focus will be to develop the first ever IoT Architecture. And, for doing it, the role of stakeholder is immense. This is a matter of pride because it will be the first time that it will take place.

Thank you.

3. Stakeholder opinions

3.1 Logistics

Lufthansa Cargo, represented by Markus Witte, is one of the leading cargo carriers in the world with a focus on airport-to-airport business. Besides its core business it also develops new industry and transport solutions in cooperation with customers including radio and localisation technologies. Thus, there is a common interest concerning IoT technologies in order to improve not only material flow systems or eProduction, but also global positioning, wireless communication and auto identification in the air freight logistics. As well as business issues there are also environmental aspects which lead to the light construction field to reduce the carbon emission. Regarding the material and information flow, for instance, there exist some media disruptions in the case of import or export air freight in certain areas in the world since custom officers often use paper to process orders. Manually written status information often leads to inconsistent real time status information. Hence, to cope with such problems there is a strong need to bridge those gaps and to have a continuous process synchronizing the information and material flow, in other words the vision is seamless real-time tracking and tracing of objects. Therefore several technologies are involved such as energy autarkic sensors, actuators, passive RFID and GPS/GSM in order to build a global communication network as a backbone.

[4] http://www.cs.princeton.edu/~jrex/papers/cacm10.pdf

Lufthansa Cargo currently works on other projects, such as a smart intelligent container, which are closely related to the IoT. These containers know their load they have inside and their location due to built-in RFID readers and GSM modules. Based on incorporated energy management a container gives information when it is moved or there is a request and it switches the GSM module into a sleep mode to avoid electromagnetic interference during a flight in an aircraft. The first smart containers will be introduced in 2011 and they will be called “cool” container as they address to the pharmaceutical industry because of its strong demand. An important property of these containers will be the temperature measurement as it has to be kept a certain temperature range during the shipment.

Input on the Questionnaire:

From Lufthansa Cargo's point of view in the IoT all products are connected to others and items communicate and navigate on their own. Moreover the objects are smart, act autonomous and traceable. One future vision encompasses consistent and real-time tracking and tracing of objects (e.g. unit load device) by means of a combination of passive RFID and GPS/GSM. For this purpose needed technologies are energy autarkic sensors and actors in order to reach the goal to increase energy efficiency and decrease energy consumption. Apart from the logistics market Lufthansa Cargo thinks the IoT will impact first the society due to more mobile devices in the future and new services against the background of ageing society and urbanisation. Regarding the impact on the business Lufthansa Cargo consider the IoT as a part of the business model rather than a disruptive change; however, it will bring significant changes (e.g. automated processes, substantial changes in the IT infrastructure). Advantages for its business area value chain will have an impact on the warehouse management and the ramp handling processes for a period of the next five years. Thus, lean processes will emerge and will lead to higher quality and lower costs in terms of higher throughput and speed. For a period of the next ten years these effects will considerably improved and stronger. In consequence of a pervasive IoT infrastructure the major social impacts will be a loss of jobs for blue-collar workers due to self-organising smart objects and the problem of interaction and adoption of technology into society. In respect of technical aspects (sensors, actuators, RFID) the most important technology characteristic is powerfulness because it will increase efficiency and cut costs. Concerning the distributed or central control Lufthansa Cargo thinks both are eligible as some departments prefer central steering, while others prefer greater flexibility.

3.2 Health Care

Christoph Thuemmler is currently member of the Institute of Applied eHealth at Edinburgh Napier University, in Edinburgh UK. He studied Medicine, Political Science and Educational Science at Heidelberg University where he earned his doctoral degree in Neurology. Among his interests are cloud computing, RFID and the Internet of Things in the context of eHealth. He has been involved in extensive knowledge transfer activities, especially in promoting the integration of life sciences, clinical practice and computing.

The Institute is working since ten years on workflows and ergonomics at hospitals which also refers to connectivity by linking things or people and to improve work processes in hospitals. One kind of media disruption in health care illustrates the fact that many activities are still done with pen and paper without any support of IT. Similarly, as often there are no digital records of medication as there is no logged information and hospital employees have to check cupboards to know the state. These problems directly lead to huge efficiency problems that can be easily improved with a set-up of an eHealth cloud, where tagged things can be linked to each other. There is an absolute necessity to develop a new digitalised model as the current one is clearly not able to keep up with current society changes. Moreover the hospital-centred model is completely

changing, since the point of care is moving to the home. Then, the problem of how to exchange information or locate objects between the hospital and people's home is fundamental.

Input on the Questionnaire:

The IoT characterizes a technology enabler to catalyze the interaction of objects and the integration of their meanings leading to a quantum leap in displaying realities and real world events. On the one hand the IoT is closely related to the IoS (Internet of Services) because of the clear overlap between these two fields based on cloud and peer-to-peer architectures within the scope of general network technologies. On the other hand it has to be clearly separated from virtualisation and the virtual world as the IoT displays in the first instance real world events and environments. Future services or applications in the eHealth field require a specific and standardised European eHealth cloud which covers all kinds of health related processes and interlinks the objects on the basis of an integration platform with an ontology establishing the context. For instance the next generation patient records need a trustworthy cloud infrastructure, federated identity and reliable digital libraries. Smart medical devices such as tagged insulin pumps, pacemakers and artificial joints could report changes in their status or enable monitoring materials and pharmaceuticals which in turn facilitate an integrated financial hospital controlling. Thus leads to more application accuracy and as a result to cost-saving opportunities. Since drug counterfeiting has become a huge problem for the pharmaceutical industry this issue could be addressed by using an IoT specific platform which immediately identifies if drugs appear in areas where they are not supposed to show up. This also refers to malicious drug interactions as tagged drugs would automatically report if, for instance, they are carried close together and, thus noting a prescription error might have been occurred. Smart drugs could also be able to indicate an inappropriate storage to correct the mistake and in the end avoid a failed cure effect. The IoT might also help demented people as they could be better monitored in terms of drug application and dangerous overdoses such as Digoxin which occur frequently the elderly and could be avoided. To serve the same purpose ambient assisted living (AAL) devices in smart homes could be interrogated automatically to flag up changes in behavioural pattern observing the need for support at an early stage and to prevent hereby irreversible conditions. Regarding the future business model in eHealth the IoT will be a part of it as the point of care is shifting towards the point of need. Prospectively care will be delivered in the patient's home rather than in hospitals and the IoT will contribute to the safety and to the reliability of care with less or without direct professional supervision. Besides the eHealth sector the IoT will also impact the mobile sector (mobile phones and communication), retail industry and food industry. For the next five to ten year period significant advantages due to IoT-related technologies will impact on the eHealth value chain such as patient monitoring and health records, personalised medication or infection control. The pervasive IoT infrastructure will have the major social impact of providing a safer health care system for patients and especially for elderly people who will be able to enjoy more independence as conditions will be diagnosed earlier and in the end the quality of life will improve. Moreover the European citizen will benefit from an increased mobility as health care information will float seamless across national borders and language frontiers. Regarding the technologies used in the IoT area they have to be more powerful and thus more reliable since there are still problems with range or over-range and physical limitations when used in fluids or on metals. Additionally ways have to be found to overcome the distance problem with passive RFID tags without violating the current guidance on maximum energy levels. For the IoT related application in the eHealth sector greater flexibility rather than central control is preferred as the former supports ideas and novel solutions.

3.3 Technology Integrator

Siemens IT Solutions represented by Thomas Jell presented the current situation and the major

issues in the healthcare arena from a technology integrator viewpoint. The healthcare model has been changing quite significantly since the 1990s. The point of care, for instance, has been moving away from hospital centric to more periphery centric systems, which is still an ongoing process. This of course requires suitably adapted ICT solutions fulfilling the specific requirements of such decentralized systems. For example, objects such as medicines or movable medical equipment need to be located and information about them needs to be made available for the respective caretakers. It is clear that IoT-related technologies and solutions will play a major role in that context.

The major IoT-related issue to be addressed from the healthcare area's viewpoint is that still most of documentation is done by handwriting. This means that quite often examination and care data are not easily available from any peripheral location when needed. Very little information is coming from sensors, medical machines or other objects. Quite useful and important information could be collected automatically and logged for later usage for a suitable medication or optimization of the healthcare processes.

Tagging things and enabling things to communicate with each other is an important step to overcome the above mentioned issues. Linking things amongst each other as well as with the people handling them will be the basis for better and faster workflows within hospitals and between hospitals and the periphery. Especially the dialogue between diagnostics and health delivery could be organized in a much more efficient way with suitable IoT technologies.

The main challenges in the "IoT for healthcare" application field are on the one hand side technical ones to provide standardized solutions for the problem spaces mentioned before and on the other hand side to overcome acceptance issues by intensive exchange with the medical community on such technical solutions. Regulation will also be necessary to enforce the application of the above mentioned standards to the whole value chain of healthcare objects.

Input on the Questionnaire:

From a technology integrator viewpoint in the healthcare arena, the IoT should be seen as the interconnection of objects via a communication network which allows for advanced applications based on the information provided by these objects. To become part of such an IoT communication community these objects could be equipped with RFID tags.

Even the IoT as such does not make any restrictions concerning the considered objects, the project might want to focus on a specific class of objects, which could e.g. be the one which are needed to cover the hospital's workflows. The most important services to look at in this area are the identification of patients as well as the availability of patient data via a secure cloud-like environment, such that these data can be accessed through any media and device by the authorized personal. Special emphasis should be put on the accessibility of such data and advanced services via an IPv6 environment.

Beside the healthcare arena, IoT technologies will penetrate the automotive (In-Car ICT and Car2X) and factory/process automation market and generate major value-add there.

3.4 Retail

The stakeholder Groupe Casino represented by Jean Prevost is one of the world's leading food retailers, which are active in multiple retail formats. Its' operating performance, which has grown steadily over the past several years exceeds the industry average, is the result of the stakeholders' unique position in the market and its ability to anticipate changing lifestyles and

consumer practices. Groupe Casino, which was founded in 1898 benefits from a 112 years retail history being the oldest retailing company in France. Today, in average Groupe Casino opens one shop per day in more than 14 countries in the world which includes in particular countries such as Brazil, Thailand and Vietnam.

Input on the Audio:

In general Groupe Casino is interested in using different IoT-technologies and IoT-aware application scenarios. This covers topics such as RFID supply and enabling the customer to pay in store with the mobile phone or performing a USB payment or using a NFC card. As the RFID technology currently is mainly profitable for upscale products, a large interest of the stakeholder focuses on the market development of the RFID technology as well as the application of alternative IoT-aware communication technologies. Currently, with respect to lower the costs of RFID tags the stakeholder is cooperating with many European retailers.

A main future aspect for the Groupe Casino is to understand the city of tomorrow and to discover the key contribution possibilities from retail perspective. This includes understanding the consumer of tomorrow, which will change its shopping habits in the totally new use of the tomorrow's city. The role of the mobile phone will be even more important as it was already in the past. At the moment a lot of different IoT-technologies are available, but the sector still suffers of a lack of example processes highlighting how the retail sector could make use of the IoT-technologies. The stakeholder expects particularly that the integration of IoT- technologies will enable the support of limited people such as visually handicapped, blind or allergic persons.

In particular, the stakeholder is working together with the Régie autonome des transports Parisiens (RATP) on the store in the train station of tomorrow in order to invent the future shopping environment of the consumers in detailed stories. In an overall view the stakeholder expects from the project IoT-A to work on a systematic approach, which includes to lead the future users and to convince even individual. Groupe Casino assumes that the inventor consortium should overtake a central position and not the consumer itself to define the requirements.

3.5 Automotive

Centro Ricerche Fiat (C.R.F.) represented by Julien Mascolo is an applied research centre, which was founded in 1978 as a common development center for innovation for the companies Fiat Group, Fiat Group Automobiles, Ferrari, Maserati, Iveco, CNH, Fiat Powertrain Technologies and Magneti Marelli. Now C.R.F. is an internationally recognized centre of excellence that enhances the Fiat products through the development and transfer of innovative technologies. Quite logically, the principal objective of C.R.F. is the development and application of innovative technologies improving powertrain performance, cutting engine and vehicle emissions and improving fuel economy. Further activities include the research and development of technologies for engines and components, green mobility, research for safe mobility, optics, telematics, new materials and micro-and production technology. C.R.F employs more than 850 highly qualified engineers. The headquarters are located in Orbassano (Turin) and further locations are Bari, Trento and Foggia, and Udine. Since its foundation C.R.F has in its portfolio more than 2300 patents and more than 50 projects contributed to the European Seventh Framework Programme.

Input on the Questionnaire:

Out of the stakeholders view the IoT can be considered as a dynamic global network infrastructure of physical and virtual entities that exist and move in time and space and capable of being identified. In this IoT-world things become active participants, which cover skills like sensing,

communicating, acting, reacting, interacting and changing their state. If IoT-technologies were ready today, C.R.F would be mainly interested in technologies that enable applications to improve the mobility with the help of vehicle diagnostics as well as lifecycle services. A third main important application group is the safety and mobility for electric vehicles. A part from the automotive market C.R.F assumes that the sector retail and logistics will be first impacted by the IoT technology. The stakeholder is convinced that IoT- technologies will contribute to change the old business model in the automotive business area and become a part of the stakeholders' future business model. The future business model will be probably influenced by the IoT-based vehicle diagnostics and the IoT lifecycle services. C.R.F expects that the IoT-related technologies for the energy availability for electric vehicles will bring a significant advantage in the coming 5-10 years to the automotive areas value chain. According to the stakeholder, the major social impact and its consequences by maintaining a pervasive IoT-infrastructure will be the contribution to reduce energy consumption and the use of liquid or gas hydrocarbons. Furthermore, the contribution to sustain renewable energy use in the mobility will be an important aspect. By selecting one of the most important characteristics out of more powerful, cheaper and smaller for the stakeholders' business area, C.R.F. decides to have the cheapest technology. This is caused by the fact that the automotive industry focuses on reducing costs because new vehicle-embedded things would be only affordable if they substitute existing objects. If the project stakeholder C.R.F would have to choose between focusing on a central control or allow greater flexibility in the business area, he thinks that both options would be adaptable. The traditional way for an Original Equipment Manufacturer in the automotive business area is centralized, but the business models of the electric vehicles imply different value chains. The integration of smart homes and the integration of smart personal devices to the automotive field could bring novel applications to the current stakeholders' business area.

3.6 Service Integrator

Alcatel-Lucent Services Group represented by Philippe Bereski focuses its business on Strategic Industries (IS). Strategic Industries cover everything that is not underlying to the telecommunication operators, such as Energy, Transportation or Public Safety. The services include consult, design, network and system integration and managed services for complex projects involving Alcatel-Lucent's portfolio as well products and services from 3rd parties.

One observation in the area of Smart Communities is the proliferation of equipments in the city with a plethora of systems all built in silos: none of them can cooperate. The technical issue behind is that it is almost impossible to inject information caught by a closed-circuit television system directly into a car or traffic management system of the city, for instance.

Input on the Questionnaire:

According to the definition provided, IoT is any kind of end to end, direct communication between devices without human interaction. IoT is therefore characterized by the networking of very intelligent objects that can talk to each other by not only exchanging information through a physical channel but also semantics. Several services and applications are foreseen in a near future based on IoT: smart metering, personal devices to car inter-connexion as well as home devices inter-connexion and home remote control. The number of IP address required by IoT implies the move to IPv6. IoT could be characterised by the combination of IPv6, NAT removal and security regarding access control and bad code prevention in the perspective of a common network layer. Internet today is the connection of users to users, most of the time through a 3rd party server. IPv4 NAT impedes true E2E communications and no operator is willing to open this door to end users. IoT will be the connection of devices to devices. From a business point of view, operators and content providers will try to promote the advantage of using 3rd party servers to

capture the traffic and the income of IoT. New kind of service or content providers will arrive (car manufacturer/repair, energy provider, retailers) on top of the network operators. The loss of privacy is considered as the major social impact brought by the advent of the IoT: at least people will be unaware of a big relaxation of their privacy rights, just as they recklessly open so much of them in social networks. Regarding the technological aspects around sensors, actuators and RFID, the most preeminent need is to gain more power in term of communication range (transmit over bigger distances-meters instead of cm) in order to minimize the points of collect of the information. The service integrator business area requires a central control for the IoT related application. The rational is, as energy or transport applications look at optimizing resources from IoT data, central control looks most efficient or at least safer.

3.7 Telecom Operator

Telefónica I+D represents the innovation company of the Telefónica Group. Founded in 1988, it contributes to the Group's competitiveness and modernity through technological innovation with the purpose to translate the innovative ideas, concepts and practices in order to develop advanced products and services within the core business of the Operator. It is the largest private R+D centre in Spain as regards activity and resources, and is the most active company in Europe in terms of European research projects in the ICT sector.

Telefónica I+D and Telefónica have a special interest within the M2M business in the forthcoming years through the creation of a specific Global M2M unit with more than 100 professionals worldwide working in the M2M business. However it is necessary to resolve the technological barriers that prevent IoT to be an everyday reality. IoT-A represents for Telefónica an important step, from a technical point of view, in overcoming the current limited state of the art. IoT-A will create the bases for the currently envisioned M2M services and also the technology for the future next generation of IoT services. All the tangible outcomes of the project will fuel the activity of the new Telefónica Business Unit.

Input on the Questionnaire:

From a telecom operator viewpoint, the IoT should be seen as the interconnection of objects through the Operator Core Network and using the facilities provided by the operator which allow advanced applications based on the information provided by these objects. This definition drives us through the creation of new operator services specially related to smart metering and smart cities. But we should firstly try to resolve some issues, which are relevant from the operator point of view in order to have a usable IoT Architecture. The first one is that it is needed a unified and unique identification of the IoT Resources which allows the use of different devices (mobile equipment) and resolve the mobility from the operator point of view. This means that the current identification of mobile equipment (not only the device but also the user identification) have to be considerer as a main topics to take into consideration in the identification of the IoT Resources. Besides it, if we want to compound services and allow the Data Mining over the measurements provided by IoT Resources, it is necessary that we can access to the information that these Resources provide us and know what means this information both syntactically and semantically. Last but not least, it is necessary to consider the privacy of the information. The information, that IoT resources can provide, and the IoT resources themselves have to be considered in high-level security. People could know for example if you are in your house only accessing to the historical information of the power or gas consumption. It is needed to provide secure communications to resolve this problem, but it is also necessary to define access policies to the information stored in the IoT architecture in order to allow or deny the access to them by applications or users.

Regarding the IoT and the Telefónica business, it is clear that the introduction of the IoT

Architecture brings the possibility to introduce new actors and business model. The interest of the operator at this point can be seen like an opportunity to develop new services based on the measurements stored in the IoT architecture through data mining techniques. This means that IoT architecture gives the possibility to interconnect different IoT Resources between them and between applications. This information flow allows the processing through the operator platform. But this platform must be clearly open to third parties in order that they can provide alternative solutions using the telecommunications infrastructure. Also it is clear that the operator needs to provide a clear business value that incentive the objects interconnection and applications. Operators will acts as a "market place" model, where it offers the infrastructure that makes easy to other companies to make business. This is the reason why a standard solution has to be developed in order that other actors can easily access to the proposed IoT architecture and used it to increase the value chain. This standard solution is not only related to the adopted or selected architecture but also the mechanisms to define the IoT resources, IoT services and the communications between them. The success or unsuccess of an IoT architecture can be related directly with the adoption of an open source platform with standards component and communications or not.

Moreover, the major social impact, that the introduction of the IoT architecture could give us, is the open world where new services can be provided to individuals and companies. Internet has changed our lives quite a lot without noticing, and future internet will provide another step towards this change. People can manage more available information produced by IoT resources.

Regarding technical aspects, one of the keys for the business development of IoT Resources is the price, more than size or power. Of course, it depends on the specific scenario that we want to develop or implement, but in general it is crucial to be "cheap". This means low CAPEX (cheap IoT Resources and easy to install -plug and play-) and low OPEX (for example no need to change batteries in many time). Nevertheless, smaller sensors are interesting if we want to attach it into mobile phones.

Besides it, IoT architecture is preferable to being a "central control" from the operator point of view. The reason is that we tend to have centralized intelligence hosted in our networks, in our business as telecommunication operators due to it is easier to maintain, update and/or resolve problems of final customers.

Finally, a general increase of connected devices requires more communications infrastructures that have to be provided by operators and it implies new incomes for them. But thinking in novel applications is more difficult to answer. Examples:

- Sharing your current activity among your relatives/friends (controlled by you). E.g. I am driving to work, at the cinema, etc. In that way relatives can know when they can communicate with you.

- Looking for objects. Where are my keys? (On the door), my glasses? (On the table), my book? (It was taken by my brother), etc.

3.8 Law

The Interdisciplinary Centre for Law & ICT (ICRI), represented by Eleni Kosta, is a research centre at the Faculty of Law of Katoliek Universiteit Leuven dedicated to advance and promote legal knowledge about the information society through research and teaching of the highest quality. ICRI is committed to contribute to a better and more efficient regulatory and policy framework for information & communication technologies (ICTs). Its research is focused on the design of

innovative legal engineering techniques and is characterised by its intra- and interdisciplinary approach, constantly aspiring cross-fertilisation between legal, technical, economic and socio-cultural perspectives.

Input on the Questionnaire:

The European Commission recently published a Communication on the Internet of Things — an action plan for Europe [COM (2009) 278 final, Brussels, 18.6.2009]. It is interesting to note that the Communication does not contain any definition of what should be understood under the term Internet of Things (IoT), but rather chooses a descriptive approach. According to the Commission, there is a progressive evolution from a network of interconnected computers to a network of interconnected objects, from books to cars, from electrical appliances to food, which thus create an 'Internet of things' (IoT). IoT, especially as part of the European Research Agenda, can be seen as an evolution from the focus of the Commission on RFID, which was seen as an emerging technology, due to the fact that it enables a huge amount of innovative applications. Given that IoT-A is an EU funded project, we should have as starting point the approach of the European Commission to IoT, and aim at the clarification of the term IoT that could be beneficial for the whole European Research Area. According to the opinion of Eleni Kosta, the Internet of Things should be understood as a networked interconnection of objects, irrespective of the enabling technology used for the interconnection. One goal of the IoT-A project could be the definition of criteria, which need to be fulfilled for a networked system to qualify as IoT. For instance the existence of a unique IP address could be considered such a criterion (this is not a suggestion, just a provocative statement for discussion). An interesting point to be decided is whether closed networks that offer such interconnection can be considered as part of the IoT. The EC Communication differentiates between connections established in restricted areas ('Intranet of Things') or connections that are publicly accessible ('Internet of Things'). Are these two necessarily excluding each other? Can an Intranet become part of an IoT? This question is important to be answered, as it has an impact on the application of the regulatory framework on electronic communications.

Given her law background, Eleni Kosta cannot answer the question on which technologies would be needed for the deployment of IoT services and applications. Nevertheless she mentions that car-to-car and car-to-infrastructure services and applications are close to being deployed and are promoted by the Commission in the frame of the eSafety programme[5]. It seems that there is also a high degree of acceptance by the public, which can sometimes be the problem with IoT applications (see some smart home applications that haven't managed to convince the public, which still chose for traditional applications).

IoT has great chance to affect current business models, depending on the way it is deployed. The interconnection of a great number of objects will create new types of networks and will challenge the traditional interrelations between the respective operators and actors involved. It is highly possible that new actors will emerge taking advantage of the business opportunities that will be created.

The current European (as this is an EU research project) legal signals frameworks, mainly the ones on data protection, electronic communications and eCommerce, will definitely influence and be influenced by the development of IoT applications and services. The current European legal framework on electronic communications is based on the horizontal distinction between transmissions of signals on the one hand and content of the other. However, the distinction between services that qualify as electronic communications ones or as information society ones becomes more and more difficult. Moreover, there is already a tendency of services to

[5] http://ec.europa.eu/information_society/activities/esafety/index_en.htm

increasingly become a mixture of private and public ones, which will create difficulties in which legal framework should apply to them. In the field of data protection, the IoT will challenge the foundations of data protection, as it renders the collection, transmission and processing of personal data automatic and in most cases even unnoticed from the parties involved. There is an important question that should be answered, as to whether the development of IoT technologies should adjust to the existing European legal framework, or whether amendments to the existing laws are required for the better deployment and implementation of IoT technologies, applications and services.

A pervasive IoT infrastructure will create challenges to the fundamental right to privacy (including data protection), as it is safeguarded in *Art. 8 of the European Convention for Human Rights*, *Art. 7 and 8 of the EU Charter of Fundamental Rights*, as well as the Constitutions of many Member States. The pervasiveness of IoT and the link ability potential it offers threatens the right of the individuals to their informational self-determination, as proclaimed in the famous Population Census decision of the German Constitutional Court. It is essential that alternative methods, perhaps beyond the current legal and regulatory framework, should be discovered that will enhance the empowerment of the users relating to the control over the information about them processed in IoT.

Given the increased security and privacy threats relating to the provision of central control, I would prefer allowing greater flexibility in IoT related application, taking all the necessary legal, technical and organisational measures for the prevention of extensive link ability. Profiling issues should also be avoided, something that the exercise of central control would favour.

3.9 Standardisation

ETSI, represented by Patrick Guillemin, produces globally-applicable standards for ICT (Information and Communications Technologies) and is recognized by the European Union as a European Standards Organization. Furthermore ETSI is also active in areas directly related to standardisation such as interoperability or technologies for communication in machine to machine (M2M) activities and therefore currently involved in a M2M committee regarding the IoT. Patrick Guillemin is a member in the European Research Cluster on the Internet of Things and fills the position of Cluster Standardization Coordinator.

Input on the Questionnaire:

The IoT is characterised as an integrated part of Future Internet and could be defined as a dynamic global network infrastructure with self configuring capabilities based on standard and interoperable communication protocols. In this information network physical and virtual "things" are seamlessly integrated, have identities, physical attributes, virtual personalities and use intelligent interfaces. "Things" will not only become active participants in the IoT but also in business information and social processes where they are enabled to interact and communicate among themselves and with the environment. This happens by exchanging data and information "sensed" about the environment, while reacting autonomously to the "real/physical world" events and influencing it by running processes that trigger actions and create services with or without direct human intervention. To facilitate interactions with such "smart things" over the Internet, interfaces in the form of services are necessary to query and change their state and any information associated with them, always against the background of privacy issues. Regarding the future service applications and domains, it would be telecommunications, healthcare, retail and recycling among others. The most relevant areas IoT will impact are Mobile applications, entertainment, eHealth and all kinds of smart objects such as smart homes and smart grids. With respect to the social impact and its consequences provided by the IoT, concerns such as security, reliability,

performance, and especially privacy issues must be solved. Once these problems are solved, one could enter into the ambient intelligence world and perhaps then in a pervasive computing age. To allow a greater flexibility, autonomic systems are needed without any central management.

3.10 Veterinary

The Department of Veterinary Science and Technology for Food Safety of the University of Milan, represented by Francesco Tangorra, was established on 1 January 2001. It is part of the University's Faculty of Veterinary Medicine and is a teaching, research and consultancy institute concerned with veterinary science and technologies applied to food inspection, animal feeds, animal nutrition, veterinary toxicology and chemotherapy, domestic animal physiology, plant engineering for agriculture and livestock production, food chemistry, and other areas with the aim of ensuring the safety of food products of animal origin.

Input on the Questionnaire:

According to Francesco Tangorra's opinion, IoT cannot be reduced to a specific technology or application, but includes a number of different technology solutions (RFID, network sensors, actuators, TCP/IP, mobile technologies, software, etc.) that allow you to uniquely identify objects and collect, store, processing and transfer data not only in physical environments but also between physical and virtual worlds. RFID, Near Field Communication, Bluetooth and ZigBee are among the key technologies currently under IoT. It is difficult to express what does not belong to the IoT field as each object can potentially participate in this global network infrastructure. Perhaps, the problem is to define the extent to which objects can participate in this infrastructure to not break ethical and legal boundaries.

In the area of veterinary, several services and applications are foreseen in a near future based on IoT: traceability and certification in meat supply chains will benefit of the IoT technologies in the next 5 years.

- Increasing safety at work when operating with the animals and when using machinery and equipments in livestock farms (alarms activation when you get near equipment, a dangerous animal or area).
- Increasing visitor safety in the farm areas open to the public (educational farms, farm holidays, etc.).
- Improving management and logistics processes into the livestock farms (identifying the "objects" that require attention and alerting the operator about the actions that must be undertaken, e.g., control of the reproductive cycle during the animal heat).
- Ensuring the traceability in the food chain for food and health safety.
- Ensuring the traceability in the food chain for the certification of the products quality.
- Ensuring the bio security in farms and livestock by identifying all the objects that enter the farms in order to know their previous contacts and check their safety (e.g., trucks entering the feed companies, veterinarians, etc.).
- Ensuring the proper use of veterinary drugs by farmers.
- Automation of the operational monitoring in animal waste management.

- Automation of the crop monitoring.
- Automatic detection and mapping of crop disease symptoms.
- Environmental protection by preventing that certain pollutants end up in farm areas where they should not be used.
- Improving the management of plants, machinery, equipments, and animals through specific sensors (e.g., ruminal boluses in cattle to measure physiological parameters).

Nevertheless the market opportunities are many and transverse. Retail, logistics and pharmaceutical could be the sectors in which IoT will impact first. Other important applications may be those related to the improvement of life: intelligent transport systems, vehicle diagnostics, telemedicine, energy management, etc. The profit margins of the primary sector are very low. Consequently IoT technologies must have to be cheaper and turned to a centralised control as an excess of flexibility could be counterproductive in a sector such as agriculture, where the ICT level of the operators is clearly below the average. Elaborating and maintaining a pervasive IoT infrastructure will affect the social life in the sense of the establishment of better social relations with increased knowledge and greater comfort, even if the risk could be to have the feeling of living in a "Matrix" world.

3.11 Smart Cities

Mr. Joan Batlle Montserrat is the Head of Innovation and eGovernment International Cooperation Department at the CIO office of the Barcelona City Council.

Input on the Questionnaire:

Internet of things is the extension of the current Internet to include, thus connect, terminal devices, that is things that do not always need users operating them, in a manner that these devices can provide information to Internet, get information from Internet and be operated through internet. (for example, a door can be connected and inform whether it is open, closed or locked, can count how many times it is open, can be locked/unlocked remotely and can incorporate a sensor to count the number of people that is passing through). What is not Internet of things? Internet of Things is stressing much more the weaknesses of Internet. There are important concerns about security and data privacy that are beyond Internet of Things since are problems of the Internet itself that are gaining now relevance due to the huge use of Internet.

There are a lot of different things that can benefit of connecting to Internet and being manageable through internet. A first view bring us the world of sensors, small devices that provide information about the environment and keep people more informed about what is happening. These devices can be also actuators, allowing remotely change of its behaviour. This approach has direct application to city management, industrial management, process control and domotics. This improved management can be directed or focused in energy savings, environmental pollution reduction or efficiency gains. In particular, for a city, there are several fields in which it can be quickly applied providing immediate benefits: real time information of public transport can save time people waiting in the bus stops, waste collection can be optimized using sensors in waste containers, and public lighting can save energy including a network of sensors…

Home automation is an important field that can drive IoT deployment. This will impact not only in energy savings but also in achieving better levels of comfort while maintaining cost reasonable. Decentralized/Distributed Industrial processes management will be easier with IoT. That will bring

new industrial processes organization, new factories and define a new industrial economy. The “Intranets” of Things could be the starting point for big organizations to benefit from a better management of own resources with no need of long distance connection. Hospitals or big organizations can quickly benefit from this particular case of Internet of things.

IoT is part of our business model, is one of the strategic lines. Up to now cities have been working optimizing internal bureaucracy and processes related with citizen’s attention. Now, thanks to IoT cities can change city management processes to make them more efficient. It brings cities a new opportunity to externalize services without loosing quality and SLA control, thus opening the scene for new business models and the introduction of new actors. Urban services are the most affected by the irruption of IoT. Streets and public spaces cleaning, waste collection, traffic management, public transport, urban furniture, pollution, crowd management, urban incidents, security, disaster management and recovery… all of them will be able to suffer deep process re-engineering thanks to IoT. Quality of life and business innovation are at the focus. Citizens will gain with the irruption of myriads of convenient services that will make life easier, more comfortable and cheaper. Companies, innovators, entrepreneurs will gain on amounts of raw data to develop new services, to change internal processes, to include in their own decision making.

In urban services, the key is to have sensors with a low TCO, which means low price, long life and no maintenance. We are talking now about the use of sensors in urban services management because sensors are cheaper than before. But still need important maintenance mainly due to power supply needs. The use of IoT in the field of urban services requires the deployment of thousands of sensors. Solutions must scale without adding complexity or new problems to the current urban services management.

The first priority is to have a central control but it must allow delegating virtual control centres according different aspects or variables of the deployed sensors. But there are different aspects to be considered. The first is the physical layer: network and the sensors management, but there is also the business layer in which for instance, the experts in air pollutions work with the information provided by the sensors, store information and feed models to understand whether there is an abnormal situation or not…

Information coming from other sensors placed in other cities will provide and real time benchmarking of air quality, traffic, noise, crowds in different cities. Also it will improve emergency services to move and act across neighbour cities and big urban areas. And it will improve seamless view of the urban area today under different local administrations, the same will happens in trans-border areas. Access to private networks of sensors. A good example is the mobile phone information today stored in the logs of telecom operators. It’s a huge amount of information generated by the citizens that can be used to understand and improve mobility, to better manage crowds, emergency and natural disaster.

Appendix A – Acknowledgments

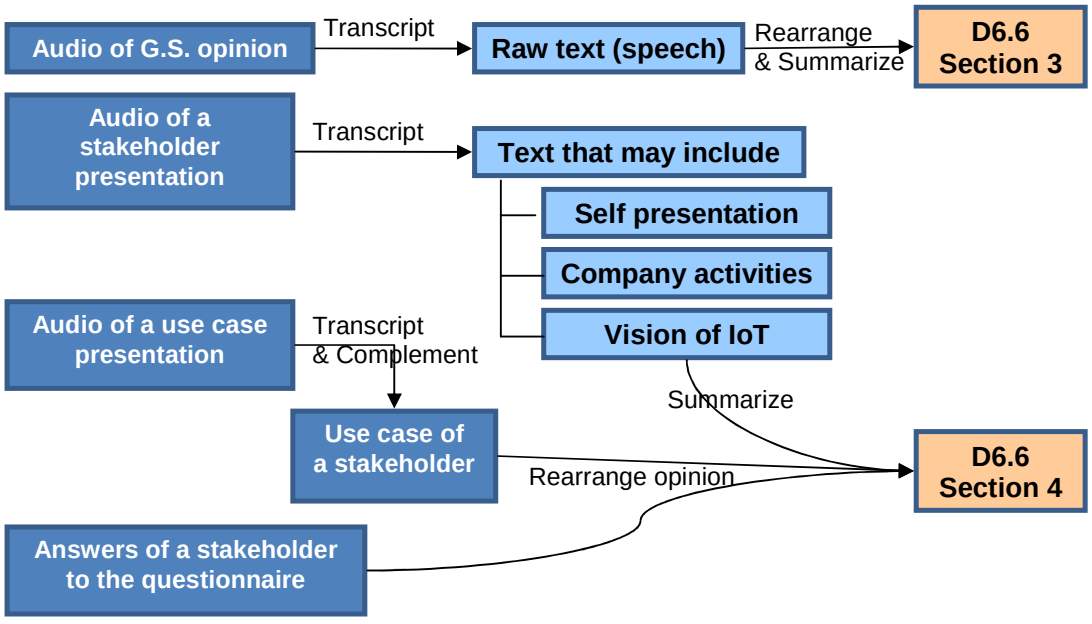
Workshop

This report is based on the outcome of the First IoT-A Stakeholder Workshop which took place on the 28th October 2010 in Paris. The workshop was initiated by Dr. Alessandro Bassi, technical leader of the IoT-A project, and organized by the work package 6: Requirements, Validation and Stakeholder Interaction, led by Alain Pastor, with the kind assistance of Laure Quintin.

A special thank to Gérald Santucci who was kind enough to share with project members and stakeholders, his expectations and wishes for the success of this workshop and the IoT-A project itself.

Report

The workshop report was written with the goal to point out the Stakeholder opinions regarding IoT-A and IoT in general in a well structured and comprehensive summary. The emergence of requirements that could result from this report is the subject of another deliverable, D6.1 Requirements List. The methodology followed to produce the report is showed in the picture below without further explanations at this stage:



Workshop participants

A particular recognition goes towards the workshop participants who dedicated their knowledge and time to this event. The following experts participated in the workshop with the privilege to be moderated by Rob van Kranenburg.

Name	Organisation	Domain
Alessandro Bassi	Hitachi Europe	IoT-A
Philippe Bereski	Alcatel-Lucent Services	Service Integrator
Nicola Bui	CFR	IoT-A
Patrick Guillemin	ETSI	Standardisation
Niko Hossain	Fraunhofer IML	IoT-A
Edward Ho	University St. Gallen	IoT-A
Amine Mohamed Houyou	Siemens AG	Technology Integrator
Thomas Jell	Siemens IT Solutions	Technology integrator
Ralf Kernchen	University of Surrey	IoT-A
Günter Külzhammer	VDI/VDE-IT	IoT-A
Carsten Magerkurth	SAP	IoT-A
Julien Mascolo	CRF	Automotive
Alain Pastor	Alcatel-Lucent Bell Labs	IoT-A
Jean Prevost	Groupe Casino	Retail
Alain Berne	Groupe Casino	Retail
Laure Quintin	VDI/VDE-IT	IoT-A
Gérald Santucci	European Commission	
Christoph Thuemmler	Edimburgh N. University	Health
Rob van Kranenburg	Moderator of the SW1	
Markus Witte	Lufthansa Cargo AG	Logistics

Special thanks to Francesco Tangorra (Department of Veterinary Sciences for Animal Health and Food Safety, University of Milan), Eleni Kosta (Faculty of Law, Katholieke Universiteit Leuven) and Joan Batlle Montserrat (Barcelona City Council) who could not attend the workshop but who were kind enough to answer the questionnaire.

Appendix B – Questionnaire template

Nature and advantages of IoT	
1	While the definition of "Internet of Things (IoT)" is still quite fuzzy, we need to mark clear boundaries of our effort. In order to do so, could you give your characterization of IoT and also state what you think does not belong to the IoT field?

2	Which future (and currently envisaged) service or application in your area of interest would be ready tomorrow if "some of" the IoT technologies were ready today (and, which technologies would you need for it)?
2bis	In your opinion, which future (and currently envisaged) service or application would be ready tomorrow if "some of" the IoT technologies were ready today (and, which technologies would you need for it)?
3	Apart from your market, which area do you think IoT will impact first?
IoT and your business	
4	Do you see IoT as a part of your business model, or do you believe that IoT will bring a disruptive change in the way your business is conducted, introducing new actors belonging to new business models?
5	In which part of your business area value chain do you think that IoT-related technologies will bring a significant advantage in the next 5 years / 10 years?
5bis	Do you think that legal issues will have a significant impact on IoT technology development and why?
5ters	Do you think that standardisation issues will have a significant impact on IoT technology development and why?
6	According to you, what will be the major social impact and its consequences by maintaining a pervasive IoT infrastructure?
Technical aspects	
7	Talking about sensor, actuators and RFID technologies, that are relevant to your business area, if you have to pick one of the following characteristics – more powerful, cheaper, and smaller – what would you pick and why?
8	If you had to choose between focus on a central control or allow a greater flexibility in IoT related application in your business area, which one would you choose and why?
9	Which IoT resources (or set of), not belonging directly to your business domain, if accessed seamlessly via a unified IoT Architecture, will bring benefits to novel applications / benefits in your field that are impossible to achieve in the current situation?