

Answer to the European Commission public consultation on the early challenges regarding the "Internet of Things"

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If you reply on your own behalf, please indicate:

- Name: Cesar Pacheco – PhD Student Politecnico di Torino – DISPEA - ISMB
- Telephone: +39-011-2276227
- Email: pacheco@polito.it
- Country of residence: Italy

The present document proposes our initial point of view related to the Internet of Things (IoT), specially focused on supporting the technology adoption and diffusion processes with Agent Simulation Techniques in order to evaluate in advance the trends, the policies options and the possible impacts on economy and society.

The Internet of Things

In our research we have found many attempts to define IoT, in simple words it refers to the complex systems conformed by objects with embedding identification, communication and smartness capabilities. The concept is extended to the networks between this “smart objects” and other things and beings (humans, animals, plants, cities, forests).

Technically is related with a mix of many other concepts that we organize in this table:

Generalization	Technology or concept
Identification, infrastructure	RFID, EPC, URI, ONS, IPV6
Virtualization	augmented reality, virtual worlds, virtual double
Internet and web evolution	mobility, semantics, web 3D, distributed and cloud computing
Intelligence and sensors	ambient intelligence, ubiquitous-pervasive computing or more recently everywhere, intelligent agents.
Applications	domotics, wearable computer, sensor network systems, M2M applications, development in services

The current interest in the Internet of Things derives principally from some of this technological evolutions, principally RFID and EPCGlobal demonstrations that show the potentiality to develop applications using this and other technological advances. Now the question is if the socioeconomic systems will be able to transform this potentialities in real fruitfully applications. We believe that this will depend principally in the ability of the governments and policy makers to produce coherent policies to coordinate and manage the diffusion of the innovation.

Only with the correct structured policies the process of diffusion of the innovations will be able to stimulated investments and the complementarities in the socioeconomic system necessities to achieving the critical mass and then the economies of scale. The system will produce standards and the network of externalities will be developed creating more an more value and competitiveness for the system.

For this reason we believe that in this moment the best strategic action is to develop government competitiveness that will support the development of intelligent policies and the ability to simulate and understand the impact of policies in the socio-economic system.

In the evolution from web 1.0 to web 2.0 the user consciously decide to become an active producer of content. In the evolution toward the Internet of Things a much more radical evolution happens because in an ubiquitous embedded smart world of things, the user become an unconscious and continuous producer of information. The integration of this technologies in our things, places to life, activities, and homes will have a much more higher impacts that ever in our lifes. This impacts will depend on the present and future

policies that will support, orientate and coordinate the efforts for the development and use of the Internet of Things.

With policy intelligence for intelligent policies, the policy makers will be able to stimulate the diffusions of innovations and also protect the rights and common interest of citizens.

Policies for the Innovation Diffusion

In the evolution toward the Internet of Things the role of our governments becomes even more critical than in the past because inadequate decisions and policies will have higher impacts and implications in our lives.

The policies related with the Internet of Things should support a virtuous diffusion of innovations that consider:

- Real usability and utility of the potential applications and services
- Direct and indirect benefits for the society
- Sustainable competitive benefits for the potential investors in infrastructure development
- Coordination between investments to permit and stimulate large scale economies
- The necessary conditions for a diffusion of the technologies
- possible actions to stimulate the diffusion
- Socio-economic impact of technologies and increased social competitive
- The learned lessons of the diffusion of Internet and other technologies

In this complex scenario the policy makers needs new methods and tools to support the continuous decision making process. The complexity and the high number of stakeholders, relationships, market conditions and factors, legal constraints to protect citizens rights, requires complex systems techniques like agent simulation techniques to be able to understand the diffusion of innovation and the option and impact of policies.

For this reason we believe that our most important strategic option is to help the policy maker in the policy decision making process with appropriate instruments to support the decision making process.

Policy Makers challenge for the Internet of Things

In the development of the Internet of Things which will be the function of the policy makers and governments? In this future, governments must be able to understand rapidly or even anticipate problems caused for an incomplete or inappropriate policy, will react simulating the policy options and evaluating the impacts. Forecast and backcast analysis can be used to decide the long-term strategy and evaluate its future impact. Governments will be also able to communicate with citizens through efficient and transparent channels and citizens will be able to participate actively in the decision making process with more decisional power near him.

But now policy makers need to develop a more clear scope, a common system of basic principles and objectives in order to coordinate efforts for common scopes. Then instruments to evaluate the correct options for stimulate the diffusion of the Internet of Things applications and technologies, instruments to support the management of

innovation and help in the decision making process and methods to measure the maturity and diffusion level of technologies, to identify and analyze early trends and simulate and predict long-term impact of policies.

Supporting the technological and social evolution

We believe that a future Internet of Things must be able to be flexible to society needs and changes, must be continuously modified and sculpted by the use of Internet and smart things by the society. For that reason a technical approach is insufficient, it's necessary to consider the social, economic and ethical dimensions together with the technical analysis (a multidisciplinary approach).

From the study of Aaron Rajan of Unilever, the progress of RFID technology in the context of retail is reaching the slope of enlightenment¹. But we are quite far to said that the Internet of Things will be based on RFID technologies, instead of an alternative solution.

We believe that is necessary to intensify the discussion and analysis related to the scope of the Internet of Things in the future society. We must studied deeply the needs of our citizens, the potential sustainable competitiveness for the enterprises that the development of IoT offer and the policy options to manage the innovation process and the development of standards oriented by governments.

From a technical point of view is necessary to continue in the development of technical and practical mechanisms, systems and technologies to share and manage the data (identification and measurements) of smart objects and its sensors, extract the pertinent information and manage the knowledge in a secure manner. The smart objects will be able to make smart decisions for a specific contextual scope enabled by some actor (citizens, government and enterprises). In this scenario, one of the biggest challenges that IoT present is to preserve and manage the privacy and rights of citizens in every particular context in the ubiquitous digital world.

Standardization process to the Internet of Things

The technological standardization process has been managed by: market, industry (like EPCGlobal)², standardization organizations and governments. The risk of inappropriate standardization processes guided by specific industry needs or specific economic interest is high. Open standards are a good principle (like EPCGlobal and the BRIDGE project)³, but not sufficient, its also necessary the consensus with governments that can decide the best path to protect the rights of citizens without blocking the innovation process for the common interest of the society.

It's difficult to predict the trend for future innovations, so we need to establish the principles and conditions that will facilitate the future standardization processes dynamically to support the innovation process and society principles. We also need

¹ J. Fenn, M. Raskino, "Mastering the Hype Cycle" - Gartner, Harvard Business Press 2008

² <http://www.epcglobalinc.org>

³ <http://www.bridge-project.eu>

policies to harmonize the contemporaneously standardization processes of technologies related with the Internet of Things.

ICT systems and organizational change

Traditionally the ICT systems was created with a top-down approach with the scope of supports the organizational changes in an organization: the structure of the systems represents in a quite rigid model the real processes and relationships. For the Internet of Things a mix of top-down and bottom-up approach for ICT systems is needed in order to support open innovation and also to contextualize sharing and management information generated automatically by the smart objects.

The new self-organized and fast-changing institutions will need to respond to fast-changing environments and provide solutions for contextual necessities of sharing information and personalize product and services. Objects, systems and humans sharing information in a global dynamic and unpredictable spontaneous system without a centralized control but regulated by policies; in this scenario we need open adaptive information systems, and systems with open and adaptive interfaces.

Economic Aspects of Internet of Things

The economic aspects of IoT depends on the particular scenario of IoT that we are referring to. We can analyze the economic aspects of IoT with a similar method used to evaluate the development of other technologies. But the development of the Internet of Things depends on the development of many other technologies (RFID, Wireless Sensor Networks and Nanotechnologies) and in the same way the economic model of the Internet of Thing will depend on the models for the particular maturity phase of every technology. For this reason we need to continually reevaluate the economic models, reevaluate the potential applications of the different scenarios, the potential new markets, the customization services markets, location-based services, and the possible technological and economical conditions to develop this markets.

We can also evaluate the enabling and blocking economic factors for different scenarios, the market potential and the critical mass necessary for the real market development. As an example we can evaluate the conditions and factors to develop a sustainable business model that will guarantee in rational times the return of the investments for a new infrastructure to support the Internet of Things. The question here is how this stakeholders can capture and maintain the value in the application development phases and contemporaneously stimulate the participation of the market to develop economies of scale?