Extending ICT Research Co-operation between the European Union, Eastern Europe and the Southern Caucasus

FP7 ICT Work Programme 2011 – 2012

Challenge 1: Network and Service Infrastrures

Objective 1.3 Internet-connected Objects

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Trajectory…

- From Internet of Things (WP 2009-2010)

….

- To Internet-connected Objects (WP 2011-2012)

The Internet of Things

'The Internet of Things' is a concept originally coined and introduced by MIT, Auto-ID Center and intimately linked to RFID and electronic product code (EPC)

"… all about physical items talking to each other.."

Like RFID it is a concept that has attracted much rhetoric, misconception and confusion as to what it means and its implications in a social context

The concept of the Internet of Things is now being influenced strongly by developments in computing and network ubiquity and developments in the next generation Internet - and considered at all levels including United Nations

"We are heading into a new era of ubiquity, where the users of the Internet will be counted in billions, and where humans may become the minority as generators and receivers of traffic. Changes brought about by the Internet will be dwarfed by those prompted by the networking of everyday objects " – UN report

The concept is also central to Commission thinking on RFID and associated research funding in Europe

"… a new phase of the Information Society – the Internet of Things in which the web will not only link computers but potentially every object created by mankind." – Viviane Reding – On RFID: The next step to The Internet of Things – Lisbon Conference 2007

Even in concept some thought has to be given to the implications of such statements in respect of population-partitioning of identifiable objects and connectivity dynamics – Analysis of the Concept!

The Internet of Things* (2007 Commission view):

The Internet of Things viewed as a network for communicating devices and based upon four degrees of sophistication, involving:

- Purely passive devices (RFID) that yield fixed data output when queried
- Devices with moderate processing power to format carrier messages, with the capability to vary content with respect to time and place
- Sensing devices that are capable of generating and communicating information about environment or item status when queried
- Devices with enhanced processing capability that facilitate decisions to communicate between devices without human intervention – introducing a degree of intelligence into networked systems

* European Commission (2007) From RFID to the Internet of Things – Pervasive networked systems

Mega Trends in Information & Communications Technology (ICT)

- SAP Research International Research Forum 2006 – 27 academics, technologists, policymakers, entrepreneurs and associated intellectuals – to question, discuss, debate and frame the future of information and communication technologies (ICT) – Outcome:
  - **Megatrend 1: Web 2.0 and the semantic web**
  - **Megatrend 2: IT Security**
  - **Megatrend 3: Real World Awareness (RWA)** – "great promise of RWA agreed to be automation – systems will be able to collect data without human intervention or errors and use it to react to events more quickly and effectively"
  - **Megatrend 4:IT as a Tool for Growth and Development**
- **Relevant to the "Internet of Things" – Architecture must accommodate the connectivity of the Internet and next generation developments (addressing in the process the inherent limitations)**

The Internet and the Internet of Things

The BLED Declaration[1] and other supporting statements, assert that the Internet of Things is expected to be an integral part of the next or future generation Internet

Service-oriented architecture (SOE), exploiting integration with Internet and interfacing with wide ranging edge technologies and associated networks is a key objective.

1. Revision 1.1 of the BLED Future Internet Manifesto (08-02-2008)

Principal challenges:

1. **Disconnect between logical and physical worlds**
2. **Lack of interoperability – structural and semantic heterogeneity**

Limitations of Enterprise application integration (EAI) for enterprise-wide and inter-enterprise integration

Developments in information integration – schema integration, semantic mediation and ontology merging – more intelligent search engines

Introducing Objective 1.3: Internet – connected objects

- **Objective 1.3 in the context of Challenge 1**
  a) Objective's contributions to the "Network and Service Infrastructures"
  b) Towards cooperative objects in Future Internet:
     - Beyond IoT for business: architecture and S&T foundations for cooperative smart objects (enterprises and stakeholders)
     - Towards integration and decentralized intelligence
  c) Manage an unprecedented volume of new information to improve citizens' quality of life and organisation efficiencies
  d) Maintain competitive Europe's position on global market

- **Target outcomes**
  a) An open networked architecture
  b) Adaptive software supporting data acquisition
  c) Coordination and support actions

a) An open networked architecture for Internet-connected objects

Funding scheme: IP & STREP

- **Open networked architecture**
  - End to end advanced characteristics
  - Conceal the heterogeneity of networks technologies
  - Manage a large population of devices
- **Architecture with large and dynamic capabilities**
  - Interoperability across providers and consumers of information and services, re-use of object entities
  - Open interfaces to manage the physical entities
  - Self-management, self-configuration properties
- **Technologies should ensure:**
  - Integration of the IoT into the service layer of future Internet
  - Distribution and aggregation of information
  - Communication among networked objects

a) An open networked architecture for Internet-connected objects

Remarks and clarifications

- Link to the "Future Internet" initiatives
- Evolution from identification (RFID) to sensing (WSN) and to feedback and control (IoT)
- Role of IPv6 (e.g., large number of address spaces, improved routing, enhanced security & QoS, real IP address network architecture,…)
- Research to go beyond technical developments towards the architecture of the future

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- What technologies need to interoperate, interconnect or integrate and at what level?
- Novel resolution infrastructure for efficient real-world integration (scalable look-up and discovery of resources, entities, etc.)
- Large scope of research for IPs

b) Adaptive software supporting data acquisition

Funding scheme: IP & STREP

- **Integration with business platforms and components**
  - Large number of sensors delivering heterogeneous data
  - Compatibility with existing business environment
- **Interpretation of the environmental and context information**
  - Information from human behaviours and multi-modal interactions
  - Act on behalf of the users' intention
- **Additional functionalities**
  - Interoperability, privacy, security
  - Discovery and mapping of real, digital and virtual entities
  - Integration in advanced business processes

b) Adaptive software supporting data acquisition

Remarks and clarifications

- Intelligent management of the information with value-added : automatic events and processes, interaction with the environment
- Autonomous and adaptive services
- Automatic interpretation of events (context, semantic)
- Enhanced communication capabilities between entities
- Intelligent interfaces
- Multi-modal interactions
- Horizontal solutions

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- What application domains (in industry, business or public interest areas) can benefit from cross-domain fertilisation?
- Possibility, in IPs, to test and demonstrate novel IoT applications and business models in real settings (e.g., smart cities)

c) Coordination and support actions

- Roadmaps, standards, benchmarks, … for future industrial developments of IoT applications
- International collaboration:
  - Analysis of research agendas, preparation of concrete initiatives (China, Japan, USA, Brazil, …)
  - Coordination of related EU R&D programmes/activities

Remarks

- International aspects to be strengthened
- Synergy will be created with IoT cluster (IERC), IoT Expert Group and European Standard Org.

Impact and Funding schemes

- **Expected impact**
  - New range of Internet services based on interconnected objects communications and integration with business processes
  - Novel business models on objects connectivity
  - Emergence of new companies (SMEs) offering innovative solutions
  - Consensus by industry (standards, benchmarks) and by stakeholders (governance) of the IoT
- **Background information**
  - **Vision and challenges**
    http://ec.europa.eu/information_society/events/shanghai2010/pdf/cerp_iot_clusterbook_2009.pdf
  - **Roadmap (Sept. 2009)**
    http://ec.europa.eu/information_society/policy/rfid/documents/in_cerp.pdf
- **Funding schemes**
  - a), b): IP, STREP; c): CSA
- **Indicative budget distribution**
  - IP/STREP: EUR 27 million; the objective is to support 2 IPs
  - CSA: EUR 3 million
- **Call**
  - ICT call 7