TOWARDS A FUTURE INTERNET PUBLIC PRIVATE PARTNERSHIP

SECOND USAGE AREA WORKSHOP, 21-22 JUNE 2010, BRUSSELS, BELGIUM

SMART ENERGY usage area

Position Paper on issues and open questions to be addressed during the workshop on the **usage area of smart energy,** input from the research center IBBT.

(Q1) *What use case and scenario in your area would you consider the most appropriate and representative one for large-scale experimentation with the Future Internet platform to be built starting from 2013?*

In the domain of smart grids - with its many, fluctuating and distributed, renewable power generators - there is a need for large-scale experimentation of flexible, fine-granular power balancing on all levels of the power grid, including the low-voltage segments. Such a pilot will allow studying both the technical, economic and power quality impact of large-scale aggregation of distributed power generators (solar, wind), large-scale aggregation of flexible demand and dynamic pricing models. While currently a household has a subscription with only one energy provider, a new architecture should enable multiple energy providers, energy brokers and energy management service providers to participate in offering and selling (low-carbon) green energy to and from end-users. This large-scale usage scenario should illustrate:

- how energy consumption flexibility can be modelled in a uniform way, throughout Europe, taking into consideration the project results from ongoing, smaller-scale (national) projects
- which information on local, measured power quality can be shared with energy service providers, and how to deal with missing information (eg. From a substation which can not yet be remotely monitored)
- how to plug-in a new energy service into the framework and use data on local power quality, flexibility and predicted renewable energy generation to optimize energy cost and CO2 footprint for individual energy consumers

From a research point-of-view, there are challenges with respect to software architecture design, (distributed) coordination algorithms, safety and reliability, common data modelling (with contribution to standardization organisations) and need for (distributed) energy storage.

Such a large-scale scenario will help defining a European standard in the field of demand side management, and is the logical first step to further facilitate for example the increasing demand for electricity by electrical cars or heatpumps.

(Q2) *What innovative Internet functionality and technologies would you consider important for your suggested use case and scenario (e.g. context awareness, sensor networks, advanced real time processing capabilities handling huge volume of data, ad hoc service composition and mash-up, managed broadband connectivity and services, embedded media support for interfaces easing the interpretation of processed contextual data, etc.)?*

To realize the use case of flexible, fine-granular power balancing, the Future Internet platform should contain intelligent building blocks that co-ordinate optimal balancing of the many distributed energy sources and flexible energy consumers, taking into account the end-user's flexibility:

- Algorithms are required to balance the energy demand and supply on a local base (on the level of a household), on a substation or feeder level, on a neighborhood level, on a mid-voltage level. These algorithms should consider a.o. the cost of energy, the waste of energy (cable losses and unbalanced energy), storage cost of energy, flexibility and confort of end-users, the mix of energy and the CO2 footprint of the energy sources.

At IBBT, we have developed a Smart Grid ICT Simulator to evaluate different algorithms and strategies to balance energy in households, streets and large-scale regions. Different types of energy consumers and generators can be configured per household, and large topologies can be created. With these simulations, local algorithms can be compared with distributed (or hybrid) algorithms, while the impact on the ICT infrastructure can be monitored and evaluated.

The Future Internet platform should also include technology and functionality for reliable end-to-end connectivity between all involved "balancing" parties to ensure optimal matching between supply and demand, at any time during the day. To obtain a high reliability, the reliability mechanisms of different technologies should be stacked:

- The reliability mechanisms of broadband network protocols (re-transmit, FER, …). On the physical layer a combination of multiple transport protocols should be possible (DSL over copperline, cable, PLC, WiFi, ZigBee, GPRS, …)
- Service frameworks with realtime discovery and monitoring of the status of flexible demand, distributed energy generation, scheduled load and failing/re-covered devices. The Smart Grid ICT Simulator at IBBT builds upon a service framework definition that allows to deploy discovery and monitoring functionality at any node in the network, and study algorithms that make benefit of this additional information.
- Intelligent algorithms, that are aware of (part) of the power network topology, available capacity on individual power segments or feeders, and power quality per managed segment. This information should help to predict potential outages, to design react accordingly, preventing the outage and thus increasing the reliability.

To ensure technical compatibility, common understanding (semantics) and fast adoption of new service features, there is a need for:

- standardized, common data models to exchange data about flexibility, power consumption, power generation, pricing, load schedules, etc. These models should be published by the core platform.
- functionality that manages smart aggregation of data, decreasing the load on the network and increasing the privacy of data-owners.
- a standardized, open power meter in the home
- pluggable service framework in the home

At IBBT, we study software architectures that bridge the Smart Grid functionality in households (using protocols such as ZigBee) with Smart Grid functionality in the power grid (using the CIM data model, SCADA architectures), and allow for cost-effective remote management and deployment of new (third party) services. Such bridging components are crucial forsmooth, large-scale deployments.

With respect to privacy of data and tampering of data, the core platform should offer functionality for secure data transfer, secure configuration of energy preferences and smart intrusion detection systems to monitor possible attacks.

(Q3) *Which of the identified functionalities would you expect the Future Internet core technology platform to deliver to support your and other usage area scenarios?*

The core technology platform should provide functionality for:

- reliable connectivity and secure data exchange
- a store with intelligent algorithms for energy balancing on different levels, and an interface to select an algorithm based on a set of criteria:
  - Algorithms for balancing on household level
  - Algorithms for balancing of local neighborhoods (low-voltage)
  - Algorithms with "longer-distance" balancing (mid-voltage)
  - Algorithms to reduce peak-loads on particular bottleneck cables
  - Algorithms to schedule large consumers such as electrical cars, electrical heating or airco, …
  - Combining algorithms that include cost of energy storage, flexibility of end-user
  - …
- flexible service architecture with functionality for:
  - discovery of services
  - discovery of supported data models and bridging components
  - (ontology-based) functionality to create workflows of cascaded energy services, and to properly aggregate data to be used as input for intelligent algorithms
  - support for remote management, monitoring, logging, troubleshooting, upgrading
  - integration with other services like weather forecast services, pricing services, …
- areal-time evaluation / simulation component to decide a balancing strategy

(Q4) *What kind of experimentation environment would you consider necessary for broad large scale testing of the platform to be developed in your use area? What would be needed to experiment new services and applications cutting across use areas (services and application mash-up) and building a new services and application ecosystem around the prototype implementations of the platform?*

Preferably, the experimentation environment should include at least 10 000 end-users per involved region to ensure that a critical mass of flexibility can be reached (assuming for example 500Wh flexibility per end-user per day, this gives an aggregated flexibility of 5MWh), and to allow that a representative (virtual) market place is created with dynamic pricing or time-of-use price incentives.

For new services to be tested on top of this usage area, the core platform should allow each service provider to publish the open interfaces of the smart grid service.

(Q5) *How do you see the potential role of your organisation in the FI-PPP, in the context of Usage areas taking a prominent role in the Initiative, to ensure an appropriate application driven approach.*

IBBT (Interdisciplinary Institute for Broadband Technology) is engaged since its beginning in 2005 in user-centred inter-disciplinary research. The research projects initiate explicitly from the user needs and the analysis of the user's expectations. Effort is being made at the kick off of the projects, in order to make all non-technical issues explicit in the research track, such as: usability, legal issues, value network analysis, techno-economical issues, potential factors inhibiting future valorisation. Close collaboration in-between technical research groups, non-technical research groups, industry and user communities are built-in into the IBBT GBO and ICON project structure. IBBT has built-up valuable knowledge in the area of inter-disciplinary research methodologies.

Next to this IBBT is engaged in finding sustainable business models for this type of applications: Exploring value network models, identifying the different roles that needed to be fulfilled. A detailed analysis of the capital and operational costs, as well as direct revenues and indirect savings (due to optimizations in operational processes) are elaborated.

Last but not least IBBT has a track record on technological research in the future internet area. In particular, in the domain of the Smart Power Grid, IBBT is involved in the national LINEAR project, the IBBT SmartE project and 15 other projects that aim to increase the energy efficiency of ICT solutions. Our research has its main focus on ICT-driven energy efficiency and balancing algorithms (peak shaving, balancing, cost reductions, etc.), simulation of ICT enabled power grids and design of multi-party service architectures.

Partners involved in our Smart Grid Research:

- *EANDIS - Distribution Net Operator*
- *INFRAX – Distribution Net Operator*
- *LABORELEC – Energy Lab of the SUEZ Group*
- *Luminus / SPE – Energy Provider*
- *Alcatel-Lucent – Telecom Solution Provider*
- *Ferranti – Power Measurement Services*
- *Xemex – Power Meter Provider*
- *Niko – Provider Domotica Solution*
- *FifthPlay – Provider Energy Gateway*
- *Belgacom – Telecom Provider*
- *Telenet – Telecom Provider*

National Reference Projects

→*in relation with the usage scenario of balancing power supply and flexibility:*

- IWT – LINEAR – project on demand side management (fieldtest with 1000 users), energy efficiency algorithms and simulation-driven evaluation of ICT architecture
- IBBT – SMARTE – project on software architectures for energy-efficient applications in the home

→*in relation with ICT for green / Green ICT:*

- IBBT MOBIROUTE – Optimizing road traffic (carbon foot print) considering traffic congestion information
- IBBT OMUS – Optimisation of Multi-media Services ensuring QoS and low energy consumption

- IWT-SBO Symbionets – Symbiotic networks to support cross-layer/cross-network cooperation between co-located networks.
- IWT-CELTIC Kusanagi – Efficient networked 3D Multimedia gaming platforms
- IBBT NGWiNeTs - Energy-aware cooperation of heterogeneous wireless networks

European Reference Projects – in relation with ICT for green / Green ICT:

- FP7 NoE TREND - Towards Real Energy-efficient Network Design
- FP7-STREP CONSERN - Cooperative and Self growing Energy aware Networks
- FP7-STREP Mobithin – Energy-efficient, mobile thin clients
- FP7-IP ALPHA–Architectures for flexible Photonic Home and Access Networks
- FP7-NoE BONE–Building the future optical network in Europe
- FP7-IP OASE–Optical Access Seamless Evolution (Ultra-high capacity multilayer)
- FP7-IP STRONGEST - Multi-terabit NGOA architecture
- FP7-IP CREW - Cognitive Radio Experimentation World
- FP7-IP GEYSERS – Energy-efficient architecture for provisioning of optical resources.

About IBBT

The IBBT (Interdisciplinary Institute for Broadband Technologywww.ibbt.be) is an independent research institute for ICT innovation in Flanders, Belgium. It has over 600 researchers dealing with the technological, economic, legal and social dimensions of the development and exploitation of broadband services. IBBT participates in different national and international projects in the field of Green ICT and ICT for Green. With respect to Smart Power Grids, our research has its main focus on ICT-driven energy efficiency and balancing algorithms, simulation of ICT enabled power grids and design of service architectures.

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