(1) 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 (please refer to the documents referred to on the above websites for inspiration)?

A smart Distribution Automation System (DAS), comprised of smart RTUs would increase the efficiency, reliability and ensure economic feasibility of the electric distribution industry. Typically a Distribution System (DS) includes medium voltage (MV) transmission lines, electrical substations and pole mounted transformers, low voltage wiring and sometimes electrical meters for energy selling through MV. Monitoring and control of the DS equipment, maintaining required quality and availability metrics regarding electrical parameters, fault detection, isolation and restoration are among the crucial responsibilities of a Distribution Company (DISCO). These responsibilities are generally enforced by the regional energy regulators (ERGEG is a regulators group for EU member countries). Besides, a smart DAS is a step towards an efficient electricity market, in which the consumers are fed with the real-time electricity price information. Demand Management systems based on Demand Response concept integrated on the smart DAS would provide substantial economical impact by preventing/delaying DS expansion investments with peak shaving functionalities [1]-[4].

Smart DAS depends on substantial communication capabilities and FI should be planned to have the required infrastructure. There are a number of subprojects that have to be accomplished through the realization of a smart DAS:

<u>Development of a main control center</u>: The monitoring and control of the DAS should be performed from the main control center. The operators would be able to monitor the DS via large displays. The locations of the DS equipment (substations, switches, lines, etc.) will be represented on a GIS map for better visualization. Database servers will record the DS process parameters such as electrical parameters, changes of states in the DS equipment. Other than these basic activities, other workstations with distribution load flow, load forecasting, economic dispatch capabilities, available DER capacity forecasting would be integrated to the main control center.

<u>Development of a smart RTU</u>: The smart RTUs would be responsible of interfacing the DAS to the field DS equipment. The smart RTUs should benefit from the latest developments in the IT industry, in order to perform complex activities as fault detection, isolation and restoration, high precision recording of electrical parameters during DS faults, remote firmware/software updates, and diagnostic capabilities. Such a network of smart RTUs should monitor and keep record of the electrical energy availability power quality metrics at substations. This tool would be used by the DISCO to conform to the EMRA requirements. Finally the smart terminals might communicate with the smart meters that are installed at LV consumer sides and propagate the real-time tariff. Such a meter, smart RTU communication provides a framework to implement Demand Response Programs.

<u>Development of the Renewable Energy Resources (RES) related functionalities and interface of the DAS</u>: The bidirectional power transfer concept should be carefully considered while integrating the DERs into existing DS. DERs (PV, micro wind turbines, Demand Response/virtual generator) that are to be introduced to the network from the DS level will also source the fault currents in their network. DER interface of the DAS should be capable of detection and isolation of the DS faults considering this concept. The financial bid data of the DERs might be aggregated at this interface and these might be evaluated by the DISCO to cover for energy outages due to generation contingencies. Such an interface will enable optimal utilization of the DER, contributing to the environmental sustainability.

[1] U.S. Department of Energy, "Benefits of demand response in electricity markets and recommendations for achieving them", Feb. 2006

[2] F. Boshell, O.P. Veloza, "Review of Developed Demand Side Management Programs Including Different Concepts and their Results," IEEE/PES Transmission and Distribution Conference and Exposition: Latin America, 2008

[3] F. Rahimi, "Overview of Demand Response programs at different ISOs/RTOs," IEEE/PES , Power Systems Conference and Exposition, 2009

[4] Goran Strbac, Daniel Kirschen, "Assessing the Competitiveness of Demand-side Bidding," IEEE Trans. Power Syst., vol. 14, no. 1, pp. 120–125, August 1999

(2) 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.)?

Smart DAS would require extensive communication infrastructure. Managed broadband connectivity and services would be needed to address the time critical communication activities for fault detection, isolation, and restoration activities (GOOSE protocol in IEC 61850 context). FI infrastructure is suitable for such an application. The smart DAS would be able to utilize the internet infrastructure where available with the priority access to the communication media in order to handle time critical activities. Power Line Communication (PLC) would be an appropriate technology to provide communication means where applicable.

The smart RTUs and SCADA servers should be designed in a way to handle vast amounts of data originated from the smart RTUs. In that context, the distributed data processing technologies should be utilized while developing the smart RTUs. Consider the scenario of transferring the fault related signal data to the SCADA server. For instance, smart RTUs could process the raw data regarding the electrical parameters before transferring it to the main server.

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

Managed broadband connectivity and services has to be first addressed to enable a network of smart RTUs to achieve a higher DS reliability. The realization of the smart DAS requires a robust communications infrastructure with well-defined performance metrics.

A foundation including communication protocols and standards has to be defined prior to the deployment of a smart DAS using the FI infrastructure. The interoperability and development of standard protocols are crucial to integrate devices from different vendors to realize the system. A standard communication protocol suite should be developed or expanded from the already available protocols (i.e. IEC 61850) to enable the discussed functionality.

(4) 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?

The coverage of the smart DAS starts from the MV side of the HV/MV transformers, to the LV side of the MV/LV substations. First a subset of feeders and DS substations would be determined to launch the pilot application that should be determined cooperatively with the regional DISCO (TEDAS and the regional DISCO in the case of Turkey). Smart RTUs and communication infrastructure or appropriate technologies to enable the smart RTUs to securely access the public internet would be deployed in the first phase. The operation of smart DAS for the pilot DS region should be monitored to identify the possible shortcomings of the design. The smart DAS with the larger coverage should be updated due to the pilot system experiments. Tubitak-UZAY has already implemented a DAS for BEDAS, which is the DISCO for Istanbul city European Side.

The mentioned functionalities should be deployed in a sequential manner. The fault identification, isolation and restoration function should be first experimented. This function should be first operated in the monitoring mode for the pilot subarea of the DS. Once it is ensured that the smart DAS identifies the fault in the correct location through a large number of trials then the isolation function and restoration function should be enabled respectively. The deployment of other mentioned functions such as DS load flow, economic dispatch, load forecasting, DER forecasting should follow.

(5) 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?

TUBITAK-Uzay, Power Systems Department (PSD) has finished a large Distribution Automation project for the client BEDAS (Bogazici Electricity Distribution Company) [1], [2]. BEDAS is responsible of DS activities of the European side of Istanbul metropolitan city. All components of the distribution automation system are developed by the PSD and the group was also responsible of the operation of the system during the development phase. More than 600 RTUs are in service in the region, already performing some of the activities described in the smart DAS context. Tubitak-Uzay, PSD is willing to convey the experiences and would like to contribute the ongoing research about a smart electricity grid at DS level. We believe our hands on experience through our distribution automation projects would contribute to the vision that is tried to be drawn in the FI-PPP.

[1] Ozay N., Guven A.N., Buyuksemerci A., Fettahlioglu M. , "Design and Implementation of a Feeder Automation System For Distribution Networks", PowerTech Budapest 99. , Hungary, 1999

[2] Ozay N., Guven A.N., Tunalı E., "GIS Based Outage Analysis System for Electric Distribution Networks" , MELECON '96, Ankara, Turkey, August 2002