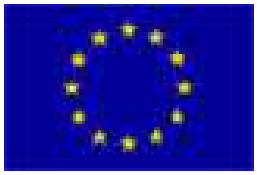

(NetSoc)

Deliverable D2.6 - Cross-Sectors Interactions

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Abstract

This deliverable is based on interactions with the communities coming from various application sectors including 'Health and Ambient Assisted Living', 'Energy', 'Transportation and Logistics', 'Environment and Agriculture' and 'Smart Cities'.

It completes the intermediate version D2.5 [28] provided during the first year of the project. The intermediate version defined the main challenges and requirements identified during discussions with the application sectors stakeholders.

The document has been opened in the public domain in order to collect comments, and the feedback received is now integrated in this updated version.

In addition to the ICT challenges and requirements, this deliverable includes the potential impacts from the inter-sectorial collaborations, impacts collected while defining the programme of the 5G PPP, which have been discussed at the 5th Usage Areas workshop."

Moreover a specific chapter has been added on this document to summarize the actions carried out by the NetSoc project related to the cross-sector integration.

Disclaimer

Impressum

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Executive Summary

This deliverable deals with ICT and vertical sectors. The NetSoc project has initiated discussions between ICT network research stakeholders and representatives from other ICT application sectors to understand their communications needs for the long-term future and the potential inter-sector collaborations. This has been achieved through document exchanges, joint actions and participation in respective activities. The NetSoc work has contributed to strengthen the place of networking and ICT in Horizon 2020.

During the two-year period of the NetSoc project, links with FI-PPP project have been fostered to reduce the risk that the heavily application-focused approach of FI-PPP currently being promoted will result in unsustainable demands on the networking infrastructure. It contributed to address in the same timeframe the network level issues and advances in order to meet the ever growing demands of the service scenarios of Horizon2020. In order to establish necessary collaboration with various vertical sectors, the project has contacted ETPs and further relevant communities to identify potential opportunities for synergies with ICT sectors addressing network infrastructure, as well as follow-up and facilitate inter-sectorial discussions. Moreover, in line with EC recommendations, the NetSoc project has contributed to the integration of various vertical sectors in the newly created 5G PPP association to improve their involvement in the 5G initiatives.

Based on the feedback received from the various communities, the work described in this document has been carried out on five application sectors ‘Health and Ambient Assisted Living’, ‘Energy’, ‘Transportation and Logistics’, ‘Environment and Agriculture’, and ‘Smart Cities’. The main related challenges and requirements have been identified. Among the most important ones:

In the **areas of Internet of Things** new mechanisms have to be created to manage the number of devices and processing of those data amounts. To provide connectivity among sensors and to allow user interaction from e.g. mobile devices with sensors, support by a range of heterogeneous networks with different appropriate radio protocols will be needed. Connectivity management will include realisation of communications among different devices using various communications technologies, interfaces, and protocols as well as interaction with existing IT infrastructures, providing necessary interoperability.

Cloud computing is strongly related to the needs of the vertical sectors, increasingly helping to reduce cost, increase efficiency, and work smarter. From a business perspective, cloud computing is a key concept to enable a global ecosystem, where organisations are able to be more competitive.

Network virtualization, Software Defined Networking and mechanisms for improved control decisions are needed to enable a new type of networks that support a wider range of services at greater efficiency.

Big data management is a highly relevant area of the Future Internet, requested by many applications in vertical sectors. Provision of networks capable to connect different applications and devices is requested, complex business relationships between multiple stakeholders and innovative business applications shall be made possible via new service platforms.

Privacy, Security and Trust will need to receive high priority in all of the investigated usage areas and shall be available as an intrinsic element of all aforementioned ICT

technologies. Privacy, Security and Trust requirements are top priorities for some sectors, such as the e-heath domain whereas privacy and patient data protection is mandatory

The collected requirements summarised in that document represent the needs of the covered vertical application sectors. No negative feedback was received during the public consultation of the intermediate version of the document, and the requirements have been completed in this version.

According to the set of requirements identified, the inter-sectorial collaboration has been maintained during the NetSoc project to iterate on the requirement definition and to foster the discussion between stakeholders. This inter-sector collaboration would in addition be a vector to widespread the knowledge of ICT innovative solutions through the different application sectors. Several actions have been performed by NetSoc partners to improve this inter-sector collaboration. One main achievement is the involvement of vertical sectors not directly related to ICT domain in the 5G PPP association.

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Acronym List

AAL	Ambient Assisted Living
API	Application Programming Interfaces
CCTV	Closed-Circuit Television
ETP	European Technology Platform
EU	European union
FI-PPP	Future Internet Public Private Partnership
GDP	Gross Domestic Product
ICT	Information and Communications Technology
IoT	Internet of Things
M2M	Machine to Machine
OECD	Organisation for Economic Co-operation and Development
QoS	Quality of Service
R&D	Research and Development
RFID	Radio Frequency Identification
WP	Work Package

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1 INTRODUCTION

One of objectives of the NetSoc WP2 “Building ICT network positions” has been to consolidate the ICT network research plan with ICT network technology user groups from so-called vertical sectors. The work has been focused on a selected domains such as ‘Transportation and Logistics’, ‘Energy’, ‘Health’, ‘Content’, ‘Security’, and ‘Smart Cities’. Thus, a dedicated project task (Task 2.1 “Cross sectors interactions”) has been included in the project work plan to expand the ICT cross ETP approach by discussions between ICT network research stakeholders and representatives from other ICT application sectors – the vertical communities. It is the objective to understand their communications needs for the long-term future, through document exchanges, as well as joint actions and participations in respective activities. Here, the final ambition has been to consolidate and enhance the ICT network research plan by incorporating the requirements of the targeted application sectors.

In order to achieve this objective, the NetSoc project has invited a number of application sectors/communities to collaborate in the identification of ICT requirements from the applications side. Formal invitations for collaboration had been sent to a number of ETPs, representing various vertical (non ICT) communities, as listed in [1]. The particular interest was to extract the application demands on future networks, aiming to improve ICT related research roadmaps with the applications domain needs.

After the first year of the project, an intermediate version of this document (D2.5) was prepared and provided in the public domain. The approached stakeholders were asked to provide their comments. Although the level of responses on this request was low, it was possible to raise some points which have been integrated in this issue of the document.

In the scope of the NetSoc project activities in WP2, the project organised two Usage Areas Workshops (spring 2013 and spring 2014), where stakeholders from ICT and so-called vertical application sectors (not from the ICT area) meet, exchange ideas, and discuss various activities enabling collaboration among the sectors.

Based on the workshop held in 2013 [4], the NetSoc project prepared and released the intermediate version of this document (D2.5). The second workshop held this year [29] was more focused on discussions on potential impact which can be achieved through collaboration among ICT and other sectors. The outcome of the discussions has contributed to the preparation of this deliverable D2.6.

2 RESULTS FROM CROSS-SECTORS INTERACTIONS

2.1 Health and Ambient Assisted Living

2.1.1 Sector-related scenarios

The areas of Health and Ambient Assisted Living (AAL) belong to a wide scope of the respective industry sector, aiming at development of numerous applications of different nature and type in the near future. According to this large perimeter, it is difficult to select a set of use case scenarios to represent all future developments in the sector. However, in order to identify requirements on the future networks and ICT at large coming from the AAL and Health sector and to define the main related research challenges, we chose to present the set of use case scenarios defined by FI-STAR Future Internet PPP project [8] which were also discussed at the 4th Usage Area Workshop organised by the NetSoc project in March 2013 [4].

The FI-STAR use case scenarios can be summarised as follows:

- New Interactive Future Internet based services for people with Mental Health problems – will include a new way of organising, ICT based, care causing an impact on each and every aspect of the patients; health results, satisfaction, patient and carer life quality, etc. It will include interaction with existing IT infrastructures, providing necessary interoperability and keeping sensitive medical data in a private environment.
- 2-D bar-coding to offer real time reverse medicament supply chain, preventing errors and providing interfaces to additional third party services - 2-D-barcode stickers will simply be attached to the prescribed medication boxes and end-users will be able to scan the tag, e.g. by using smart phones, and will receive information on when they purchased the drugs, which member of staff served them, how much they were charged, etc.
- Virtualization of operating theatre environments and real time data integration for monitoring and reduction of errors – Focus is on application of RFID technology in the minimal invasive theatre and has developed innovative methodologies to reduce the risk of objects being forgotten in the abdominal cavity, which in the past was a great concern among patients and surgeons.
- Improved access to care and quality of care by designing improved interactive online facilities for their cancer patients - The patients will be equipped with dedicated hardware (life monitoring sensors, tablets, cameras) and software (knowledge portal – also web based, treatment diary, mobile application, video conferencing client). The connection between patients and hospital will rely on the public Internet connectivity at patients' premises. Moreover a number of sensors that will enhance the tele-monitoring capabilities of the will be included as well.
- Online Cardiology service for people with heart failure and in particular for people after myocardial infarction - The target is establishment of an interactive cardiac rehabilitation program, by testing software applications in the integration experimentation site, real-time vital parameters internet-monitoring, improvement of physical training and improvement in secondary prevention programs. Patients will have attached to their wrist a wireless device which will monitor in real-time biological

parameters, location and movement parameters and additional parameters regarding the environment (humidity, light, maybe air quality and noise); this wrist device will communicate with a smart phone/tablet with wireless connection for real-time information uploading. Medical personnel will have real-time access to vital parameters of the patients especially in phase two when outpatients will perform physical exercises, thus allowing personalization of the cardiac rehabilitation program for each individual and also prompt intervention when dangerous situations occur.

- Improvement and extension of the tele-health network for Diabetes patients, aiming at the development of smart phone based multi-channelling allowing streaming of different related informative data – Tools for self-management dedicated to people with diabetes will be coordinated with the health care services leading to new services that support interoperability between new and existing services, the patients' self-management system, and new, beneficial interactions between these, including possibility to share information both among patients with similar profiles and needs as well as between patients and health care personnel.

Provision of a network capable to connect different applications and devices, where necessary medical information is collected and elaborated according to specific logics – It includes electronic prescriptions sent from the doctor's office, automatic return of specialist reports, letters of discharge from hospitals and emergency rooms, reports to the medical records of the doctor, etc. Here, intelligence, efficiency, sustainability and performance of already existing processes can be significantly improved by using Future Internet technologies.

2.1.2 High-level requirements on ICT

The Health domain has been very resistant to adopt Public Cloud technology. One of the reasons is clearly related to the special legal requirements for the protection of privacy and patient confidentiality. To overcome this, a reverse cloud approach – so called Private Cloud approach – will be chosen to send software to the data rather than the other way round, which will be more safe, secure and resilient and will consume less bandwidth.

The Private Cloud approach has to ensure proper management of customer/patients data and all other types of the medical information available, which includes data storage and protection, data processing, presentation, etc. It should also include all necessary functionalities, such as customer management, billing, etc., to ensure efficient deployment and commercialisation of the eHealth platforms. One of the particular requirements for implementation of the Private Cloud approach is ultra-light eHealth applications consuming as less as possible of the network resources. Of course, reliable and in particular cases fast data transmission, including provision of high bandwidth for specific transmissions as required, has to be ensured by the future network infrastructures.

The eHealth domain looks for respective platforms, hosting the Private Cloud framework, enabling the eHealth applications, etc., which have to ensure wide interoperability as well as open and unified interfaces for specific instantiations of users' applications of different kind. The eHealth platforms and devices should be designed to allow automatic software and configuration updates, efficient user recognition and authentication, reliable self-maintenance, etc. Proper measures for authentication and security within the eHealth platforms are of a very large importance in respect to achieving reasonable level of trust, in particular by the patients. Adequate measures for data protection should ensure that the

sensitive medical data never leaves secured and dedicated eHealth domains; e.g. by applying geo-fencing and further similar methods.

Finally, design and establishment of various interactive, mainly Internet based, services is of a particular importance for the eHealth sector. Such services will be dedicated to a wide spectrum of applications; awareness building among the patients in respect to eHealth opportunities in general or dedicated to particular diseases or medical programmes/treatments, remote patient observation and therapy, data exchange among various entities involved in the eHealth sector in everyday activities, experience exchange among medical personnel at large, etc.

Of course, besides technological requirements from the eHealth sector mentioned above, a particular set of requirements come from ethical and legal points of view and should be considered while implementing the eHealth framework.

eHealth is now a comprehensive concept regarding the supply of health care and health education over distance, empowering populations, patients and health professionals regardless of where they live. It can facilitate interaction between healthcare professionals and enables a rural practice to link with a larger hospital, usually in an urban centre. But providing eHealth in rural areas also presents particular challenges. If patients in rural areas have difficulties accessing healthcare services, they may also have difficulties getting to where the eHealth service is available. Still the quality of a remote consultation is very dependent on the quality of the system being used and a poor quality link may mean that images and sound are fragmented and distorted. In Doctor-patient teleconsultations, the patient often cannot be palpated or subjected to physical examination by the Doctor.

However, methods of addressing such difficulties are now considered. While the initial consultation with a patient may need face-to-face interaction, follow-up consultations usefully benefits from telecommunication. As the distance to alternative healthcare services increases, telemedicine obviously becomes a more attractive option. Isolated rural Doctors may particularly benefit from contact with colleagues. Interprofessional working involves professionals collaborating to work together more effectively to improve the quality of patient care. It allows for flexible and coordinated services and a skilled and responsive workforce. Collaborative and interprofessional working is now seen as an important element in improving rural health service delivery. The use is in a broad array of interactive videoconferencing applications, including mental health, diabetes management, primary care, specialty paediatrics, genetics, and dermatology.

2.1.3 Related ICT R&D challenges

The R&D challenges related to the use case scenarios and derived requirements from eHealth sector on the future network infrastructure and ICT at large, discussed above, can be outlined as follows:

- Development and implementation of the reverse cloud paradigm – aiming at establishment of an efficient framework to enable software to data approach, which allows design of the required private clouds.
- To design and instantiate a new generation of the eHealth applications tailored to functionalities of the future network infrastructures – This includes development of a dynamic interoperability concept for ultra-light applications utilising the future networks and also enabling design of usage specific ultra-light applications, while

necessary Quality of Service, security measures, and implementation of governance measures should be ensured.

- To build necessary level of trust for the eHealth domain ensuring proper protection of sensitive data – This includes development of general domain and specific internal data security strategies in accordance with adopted ethical and legal requirements as well as demands on efficient governance in the sector.
- Establishment of necessary knowledge based support system with a scalable and open architecture based on the sense-and-respond architectural principle to allow exchange of medical information.
- Definition of a generalised IoT reference architecture, where applications and frameworks from the eHealth and AAL domain can be easily included, ensuring efficient and cost effective implementation of the sectorial applications.
- The ICT infrastructure shall provide high bandwidth at high quality for video conferencing applications especially in remote areas and therefore broadband satellite network shall be smoothly integrated in the ICT infrastructure where appropriate.
- For sensitive application, such as remote surgery, it is vital that the communication system is 100% reliable. Backup or redundant systems have to be embedded in the proposed communication architecture to provide a resilient system to eHeath users.

2.1.4 Potential impacts from the inter-sectorial collaborations

An advantage of collaboration between eHealth and ICT sector is related to the spreading of ICT solutions. Any collaboration would increase among the eHealth sector the knowledge of ICT innovative solutions which can be developed to answer their needs.

The importance of this collaboration is amplified by the fact that usually ICT is not part of the core expertise of health specialists. They do not know that innovative solutions coming from ICT domain are already available and can be adapted to overcome encountered difficulties they have.

For example on IoT domain, the implementation of RFID devices can reduce the risk of having objects forgotten in patient during surgery [40] : Surgical towels can be tracked in the operating room by adding a RFID tag into them. Tracking towels by placing RFID antennas in important locations in the operating room decreases the possibility to forget them inside the patient and to be sure that all used towels have been already disposed .

The caring of patient is more and more external to the hospital environment and collaboration between ICT and eHeath sectors has to be intensified and extended to less ICT aware health practitioners.

As highlighted during the 5th Area Network workshop, the need for “outside hospital” healthcare is increasing with the burst of new practices which require ICT solutions in places less conventional for patient care: General practitioner practices, home nursing, and even over the Internet. This widespread of medical acts has to be accompanied by a virtualisation of the care and the deployment of associated communication solutions compliant with health practices and rules.

On that respect, the inter-sectorial collaboration shall take into account the number and the different profiles of skills of the eHealth sector.

This rapid evolution of eHealth practices, concurring with the evolution of modern societies which invest more on more on health and caring of its citizen - OECD country health expenditure has grown by 4% annually over the past decade, compared with a mean GDP growth of 1.6% [29] - generates new demands from stakeholders on ICT solutions. This quick pace of change requires that ICT stakeholders re-enforce their collaboration with eHealth on a large scale.

2.2 Energy

2.2.1 Sector related scenarios

Numerous on-going research activities world-wide are considering and implementing various solutions for establishment of so-called Smart Energy Grids, aiming to incorporate different types of energy sources and production, which includes centralised and decentralised energy production sites as well as a continuously increasing number of alternative/renewable sources, within a flexible and modern energy distribution infrastructure. The major Smart Energy Grids challenge is to ensure timely matching of energy demand and generation (demand response) and pursue maximum exploitation of green energy sources. Achieving such an objective requires putting in place mechanisms for energy use information exchange between the consumer and the producer over the grid network.

Concepts for integrating renewable and decentralised energy generation have to cope with volatility of renewable energy generation (solar and wind power) related to optimal use of existing grid infrastructures. Liberalisation of energy markets will lead to new services and new market players [9].

In general, there are three basic types of actors involved in the overall picture of the Smart Grid service structure; Consumption, Distribution (including retailers), and Productions sites. Authorities responsible for overseeing and eventually management of Smart Grids can be also seen as actors on a higher level, dealing with two or three basic actors, different production or distribution entities, etc. Thus, potential users of Smart Grid services in respect to utilisation of the respective communications and data infrastructure can be classified in accordance with customer size and potential:

- End users (private homes, office and manufacturing buildings, etc.) can optionally use Smart Grid services as a kind of Least-Cost Energy provision tool in accordance with energy consumption optimization service,
- “Producing end users” or “Prosumers” acting as both energy consumers and small energy producers will necessarily use Smart Grid services, in order to be able to inject produced energy in the large (global) energy distribution system.
- Small energy producers (e.g. maintaining a number of alternative sources) and distributors (owning distribution networks in range of several km) will also necessarily use Smart Grid services which will be rather offered from third party than by the producers/distributors,
- Medium size producers and distributors (e.g. on regional level), who will probably outsource large parts of necessary Smart Grid services,
- Large producers and distributors, probably with own Smart Grid service solutions, but with particular needs for realisation of necessary interconnections, and
- Smart Grid operator who needs to continuously monitor the state of the infrastructure and be able to take measure in case of failure which may have a dramatic cascading effect to other part of the Grid.

Furthermore, in order to achieve savings in electrical energy consumptions or its optimization within homes (as an example which can be generalised to cover similar use cases for buildings, factories, areas, etc.), operation of typical home appliances, such as white goods, lighting, heating/air condition, standard ICT equipment, construction

elements (e.g. darkening), etc., should be controlled in accordance with real needs of the customers and current availability of the electrical energy and corresponding energy price.

2.2.2 High-level requirements on ICT

In order to enable energy consumption optimization services in homes and buildings, it is necessary to realise at least basic metering services for demand response and fault management where it is required to provide connectivity among various appliances in homes, an appropriate service gateway at home, and service platforms which can be placed somewhere in the global communications network (Internet). Thus, the connectivity management in this case includes realisation of communications among different devices using various communications technologies, interfaces, and protocols. On the other hand, the metering and the related connectivity provision represent also a base for realisation of the Smart Grids, where in addition a number of reliable and secure connections have to be realised along the whole energy supply chain; from production sites over numerous distribution nodes at different voltage levels up to the end customers. Fault management requires short latencies and high reliability.

To implement and offer services for energy saving and Smart Grids concepts, a further extension and feature enhancement of the available communications infrastructure will be necessary. In particular, access and also home networks have to be further extended, possibly by implementation of common enablers for realisation of a set of various services with same or similar requirements for business models to shift energy consumption in time in order to reduce peaks in energy generation and to use cheaper energy. In addition, network and data security as well as privacy for detailed energy consumption data profiles have to be further improved, in particular for parts of the services acting directly on top of the critical infrastructures for energy production and distribution. Finally, very important issues in respect to the end customers will be implementation of proper identity management ensuring sufficient level of privacy. Besides efforts on the communications infrastructure, it will be necessary to implement and operate appropriate tools for managing a large number of end customers, extremely large number of devices (home appliances and sensors, communications and control nodes along the energy distribution network, etc.), various small but widely spread related services and applications, either as part of the provided service platforms or stand-alone solutions, and to deal with a very large amount of various types of data and aggregated data, available at different distant locations.

One particular requirement is to develop new surveillance and control strategies for both buildings and energy networks as stated in the Net!Works White Paper on ‘Smart Cities Applications and Requirements’ [10]. This will allow for the intelligent and adaptable management of the entire energy system, in the context of the stochastic distribution of energy supply and demand, especially taking the highly volatile nature of renewable energy sources into account. The underlying communication needs to include sharing sensor information among consumers, producers, and the grid, with various requirements in terms of reliability, real-time behaviour, and bandwidth. Those strategies include power quality control, as well as interactive feedback to the human users, and will increase the energy efficiency of e.g. entire Smart Cities, requiring all participants (grids, buildings, and consumers) to be connected with appropriate means of communication. Therefore, it is important to build a consensus upon a communications architecture, its underlying

communication technologies derived based on ICT requirements, and data models that are able to cope with specific services' or applications' needs.

Requirements on communications infrastructures for the Smart Grids, including necessary management and processing of collected data, can be summarised as follows [11]:

- Support for decentralized and bi-directional energy flow, caused by large number of involved distributed energy sources with possible temporary availability (e.g. alternative sources),
- Wide availability of metering services and collected data on real-time energy consumption and its prediction,
- Real-time management of the energy flow from local to very large (global) scale,
- High security requirements
- High availability and reliability,
- Easy to use for all (consumers, energy providers, distributors, etc.),
- Real time monitoring of the status of the global grid and capability to re configure grid element to prevent black-outs.

2.2.3 Related ICT R&D challenges

As a main recommendation, the cooperation between the ICT industry, other sectors, and public authorities should be stimulated to accelerate the development and wide-scale roll out of ICT-based solutions for smart grids and meters in order to provide a stable energy system based on volatile and distributed renewable energy sources and to enable a more efficient use of energy. The ICT sector should deliver the necessary communication network infrastructure, modelling, analysis, monitoring, and visualisation tools to evaluate the energy performance and emissions of cities and regions.

Available Assets of the ICT are cost-efficient information and communication infrastructure with outstanding scalability and economy of scale, well-proven Internet technologies (e.g. TCP/IP protocol suite) for re-use in private networks and openness to new service providers and business models. However, also limitations of today's Internet technology have to be seriously considered, such as no guaranteed high priority, security gaps introduced by the Internet and the fact that Internet technology does not fulfil the short and deterministic latency requirements [9]. Therefore, further advancements of communication technology are needed to meet these challenges.

At the NetSoc Usage Area Workshop, the FI-PPP project FINSENY raised topics where intensive effort will have to be invested form the ICT side to enable Smart Energy [12].

Connectivity: End-to-end connectivity between large varieties of grid elements, including distributed energy resources, building energy management systems and electric vehicles using public as well as private communication infrastructures.

Management: Smart Energy introduces a lot of new managed elements with increased data volume. Future Internet offers e.g. concepts for device registries, SW maintenance, Big Data analysis, network management and distributed processing.

Service Enablement: Future Internet enables new service platforms supporting e.g. multi-tenancy, dynamic pricing and billing services for instant collaboration between all relevant stakeholders including the prosumer.

Distributed intelligence: Future Internet Technologies will introduce new technologies into hardware and – even more so – in software, effectively injecting intelligence into the grid, e.g. to coordinate and control Distributed Energy Resources.

Security & Privacy: Future Internet Technologies will provide new and improved means to support security and privacy.

Further challenges as described in [10] include: availability of new communication and networking ICT technologies providing improved immunity to environment electro-magnetic noise, interferences and network performance; support of large unstructured mesh networks, including self-organisation, self-healing, fast and reliable routing; and open protocols for the development of new products and services, addressing authentication, security mechanisms, profiles, and certification); new affordable devices that gather environment data (e.g., weather sensors, small Doppler radars, computer vision systems) for efficient planning of energy production and consumption; new intelligent algorithms for smart ubiquitous environments; new light sources (i.e., next-generation-LED); advanced products and services based on IP to foster innovations, and possible economic growth in the SME sector, based on an open innovation scheme.

In a short summary, R&D challenges on future networks and ICT at large to meet requirements from the Energy sector can be listed as follows:

- Highly secure and reliable connectivity, including proper privacy and identity management,
- Interconnections among extra-large number of diverse devices (communication equipment, service platforms, appliances, sensors),
- Collection and processing of large amount of decentralised data,
- Establishment of applications and services (easy to extend and adapt) with certain level of flexibility, scalability, and portability,
- Enhanced customer care, including billing and support,
- Global grid monitoring and black-out management.

2.2.4 Potential impacts from the inter-sectorial collaborations

The close cooperation between the energy and ICT sector is essential to understand the communications requirements of the ICT sector in terms of supported data rates, latency for mission-critical applications and scalability. Such cooperation will also improve the mutual understanding what ICT can offer to the energy sector. Jointly developed solutions will be the precondition to enable smart grids and to integrate highly volatile renewable distributed energy sources into the overall energy system in order to ensure high stability and availability of energy provision.

The integration of the energy system and ICT will enable new business models to allow for a more efficient energy usage by avoiding high peaks in energy consumption and to consume energy at time, where energy will be cheaper depending on energy generation. The peak load in the energy distribution network can be reduced, which will allow for cheaper distribution systems.

Future communication networks and systems like the development towards 5G will benefit from an early cooperation by taking into account requirements from the energy sector in the design. Therefore, 5G will be future proof and will be able to support as many usage

areas as possible in order to avoid the deployment of parallel specific communication infrastructure. This will have positive impacts on the overall economy by making the energy system less dependent from unsecure sources and in the long run cheaper.

2.3 Transportation and Logistics

2.3.1 Sector related scenarios

Transportation and logistics are undergoing a profound transformation as a result of globalisation and development in certain ICT sectors. Traditionally, transportation means (road, rail, air, water/sea, pipeline, cable and space) were operated and managed separately with a limited number of handover points. With globalisation, the amount of goods and the number of people being transported grew enormously. This was made possible by the increasing level of ICT support in the logistics (see also NetSoc deliverable D2.4., [2]).

Increased mobility describes the fact that people increasingly do things (e.g. work, learn, pleasure) while on the move, and not at fixed, specified places. The field is huge and includes road-, air-, water-, rail-transport, and from other points of view: passenger transport, freight transport, containerised transport, bulk transport. New visionary ways of transport have to be found (for example pipeline passenger transport). This includes replacing “physical” mobility through “virtual” mobility using ICT.

A lot has already happened as far as people’s lives are concerned. They can e.g. use their ICT equipment from many places. However the means are limited and often very expensive. We might expect much better connection anywhere, anytime at maximum speed and with appropriate features.

Currently, about 15% of the global greenhouse emission is caused by transportation. Necessary measures for CO2 reduction and limited energy resources will force more efficient logistics and transportation systems, which will probably be more complex from organisational point of view and will have to be adopted by consumers.

Because of increasing energy prices and costs of the improved logistics and transportation systems, related services will remain expensive. Concerning transport there is no real integration of different sectors, nor have there been very visionary ways of transport. In future we might expect much more visionary concepts.

Regulation of logistics and transportation at various levels will have to be established, in order to support and motivate society and industry to establish new generation of services in this area.

As complexity grows and environmental factors become ever more important, the role of ICT will become even more important in tracking and management, optimising routes, maximising efficiency and keeping costs down, meeting time constraints (just in time delivery), etc.

Increased demand will be given for efficient control of transport and logistics including ICT based toll systems for road transport and also for “virtual” mobility services – to achieve as close to natural face-to-face experiences as possible.

Service continuity is key beyond urban areas in order to track gods transported over land in remote areas, over seas and in the air.

2.3.2 High-level requirements on ICT

In this section, ICT-related requirements are described as provided mainly be the FI-PPP projects Finest [13], FIspace [14] and InstantMobility [15].

The ultimate aim of the FInest project is to develop a Future Internet enabled ICT platform for better supporting and optimizing the collaboration and integration within international transport and logistics business networks. Transport&Logistics is concerned with the planning and execution of the world-wide shipment of goods and people. This constitutes the backbone of the European economy where Transport&Logistics service providers operate as global businesses [13].
The project requests that existing ICT solutions will be further developed to dynamically establish collaborative transport & logistics networks, leading to closed supply chains. Specific capabilities are requested for seamless integration of information and data in heterogeneous IT landscapes along with embedded facilities for real-world data acquisition and integration [16].

The objectives of FIspace (phase 2 project of FI-PPP) [14] are to drive the development of an integrated and extensible collaboration service together with an initial set of domain applications, thereby establishing the standard for supporting and optimizing inter-organizational business collaboration in global transport, logistics, and agri-food business. These objectives will be achieved through leveraging and capitalizing on the outcomes of two Phase I Use Case projects – FInest and SmartAgriFood –, as well as by utilizing the generic enablers available from the FI-PPP Core Platform (FI-WARE).

Requirements arising from these projects regarding robust inter-organizational integration and collaboration systems are related to the targets of improving business efficiency and optimization for all parties involved in the planning and execution of multi-organization value chain activities. Strong customer requirements for end-to-end tracking and tracing must be satisfied through combinations of human inputs and interventions, by overcoming heterogeneous information from incompatible ICT systems which create barriers to interoperability between network partner systems. End-to-end coordination of operational planning and execution activities is required to avoid extensive manual effort making network operations costly, non-transparent, error-prone, inefficient and environmentally non-sustainable [17].

The Instant Mobility project [15] has created a concept for a virtual “Transport and Mobility Internet”, a platform for information and services able to support radically new types of connected applications for scenarios centred on the stakeholder groups: multimodal travellers, drivers & passengers, passenger transport operators, goods vehicle operators, road operators & traffic managers[18].
This project defined requirements for Future Internet technology tools and enablers, to make sure that all these services will be available to any Internet-connected user, whether using a portable, vehicle-based or fixed terminal. Requirements from Instant Mobility [19]:

- Availability as needed of location information of each possible transport element and/or each traveller (all the time, anywhere, in real time)
- Availability of immediate communication with guaranteed QOS for the required bandwidth (anywhere, anytime)
- Capability to provide specifically crafted solutions to each traveller and adjust it in real time (simultaneously for millions of travellers)
- This information shall be made available in a secure & privacy safe way

Concluding this subsection, a short overview on major requirements of Transport& Logistics on future networks and ICT is given in the following:

- Realisation of localization and tracking functions, traffic monitoring and routing, including management of electro-charging
- Ubiquitous access, including ad hoc and specific services (M2M, …) , communications means (e.g. satellite communications), interconnections among extra-large number of different devices (communication equipment, service platforms, appliances, sensors).

2.3.3 Related ICT R&D challenges

In the highly competitive, distributed, and agile industry of transport and logistics, novel ICT solutions for optimizing the collaboration and information exchange in cooperative business networks are strongly requested but currently mainly available as restricted, stand-alone solutions. Future Internet technologies are strongly challenged by the task to facilitate radical improvements in business efficiency in this industry which is decisive for a positive socio-economic and ecological impact.

Modern business networks tend to be highly distributed inter-organizational entities spanning country boundaries composed of business partners who have limited insights into the overall network and who are only focused on optimizing their own small part of the value chain. Current ICT services generally just support this limited network focus, and thus provide only basic support for inter-organizational data and process integration. This means that complex inter-organizational collaboration activities today must be accomplished through manual efforts. End-to-end coordination of operational planning and execution activities requires extensive manual effort making network operations costly, non-transparent, error-prone, inefficient and environmentally non-sustainable. [16]. Seamless integration of information and data along with real-world data acquisition is therefore demanded. Electronic collection and transport of data is requested to efficiently support inter-organisational collaboration and contracting in cooperative business networks.

For gathering data-on-field activities, new technologies (such as new sensor technologies, scanners, and RFID) are creating the basis for data collection, distribution and management where existing Internet technology faces tremendous problems. Data sharing is also problematic as the requirements for privacy and security of these types of data are poorly supported by existing Internet services [17].

Finally, the Instant Mobility project [19] provides the following visions for future transport: Every journey and every transport movement is part of a fully connected and self-optimising ecosystem. Whatever the traveller's situation will be (office, home, on-trip…) useful Future Internet enabled services will be available to give him most efficient support:

- The traveller will receive personalised and real-time solutions to support him reaching his destination according to for instance real-time traffic status, public transport availability along his journey.
- Sustainable transportation practices will be available with a dedicated focus on sharing modalities of all kind of vehicles.
- New ways will be provided to optimize urban traffic. Fleet operators' management and goods delivery monitoring (key components of Instant Mobility holistic vision of urban mobility)

All this will be made possible through a web of online services and imposes severe but attractive challenges for a new Transport and Mobility Future Internet.

Smooth integration of satellite solutions where appropriate in the ICT system is necessary especially to support asset monitoring anywhere beyond terrestrial reach (low density populated areas, over seas, aeronautical) and hence ensure a permanent status report.

2.3.4 Potential impacts from the inter-sectorial collaborations

The close cooperation between the transportation and ICT sector is essential to understand the communications requirements of the ICT sector in terms of Quality of service (data rates, latency,…) and installation/operational constraints. Such cooperation will also improve the mutual understanding what ICT can offer to the transport sector.

Future communication networks and systems like the development towards 5G will benefit from an early cooperation by taking into account requirements from the transport sector in the design. Therefore, 5G will be future proof and will be able to support as many usage areas as possible in order to ensure a seamless service continuity.

2.4 Environment and Agriculture

2.4.1 Sector related scenarios

Shortage of natural resources:

Natural resources are materials that can be found in a natural environment, e.g. air, water, energy, etc. They can be separated in renewable resources, those that you can use more than once, e.g. wind, water; and the non-renewable ones, those that can be used only once, at least for a long period of time, e.g. coal, air. Some resources appear everywhere, e.g. air, wind; but most have them appear only in some locations, e.g. water, coal.

The demand for resources is affected by technology and societal needs, and this demand will have an impact on the economy, and sometimes on politics.

Europe has the goal of drawing 20% of its energy from renewable sources by 2020, also as part of its wider strategy for tackling climate change. This strategy aims to make Europe less dependent on imported energy, as well as boosting innovation and employment. But Industry must be boosted by European policies in order to bring competitiveness to the prices of investments in renewable energy sources comparing with the costs of fossil fuels.

Europe also set up plans for cutting emissions by over 80% without disrupting energy supplies and competitiveness, and committed to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050 by exploring the challenges of decarbonisation. The envisaged roadmap includes decarbonisation, energy efficiency, renewable energies, smart infrastructures, and a common energy market.

The ocean covers more than two-thirds of the world's surface, and its coastlines and beaches are being destroyed, its waters are polluted, acidity is increasing, water is warming, food webs are fraying, and key species and populations are vanishing. Oceans preservation is urgent, together with many other earth ecosystems that have been threatened for long but still can be saved with society awareness and protective policies.

The role of the ICT sector efficient usage of natural resources is crucial. The development and increased use of media technologies can also play an important role in natural

resources preservation, e.g. online distributed information can create awareness for biodiversity and natural ecosystems (see also [2]).

Evolution of production in agricultural industry:

Never before did the Earth have to feed more than 7 Bln people, and never before did we use so much bio material for other purposes, such as making fuel. Only modern agricultural methods could solve those problems. On the other hand people become increasingly aware of healthy food and request organically produced products.

The importance of agriculture for Europe is in the focus of the project SmartAgrifood [20], and highlighted in the following bullet points:

- 40 % of the EU's land area being farmed, agriculture has a very important impact on the natural environment
- The food and drink industry is representing 13% of EU manufacturing sector turnover
- The EU is the world's largest food and drink exporter with a share of EU exports to world markets of 17.5% in 2008
- Share of agri-food logistics in the EU road transport is about 20%
- 11% share of agriculture-related products in total export value of EU countries for 2009

There is a clear trend towards more efficient use of fertilisers due to costs, increased environmental awareness and demand for organic food. ICT methods such as soil monitoring can help optimising fertilisation. Also the usage of ever scarce water resources must be optimised. Monitoring the weather and controlling humidity can help here.

So there are two overlaying trends of the upcoming years: mass production and sustainability in agriculture. Those trends are somewhat contradictory and probably need a compromise. However, innovative methods and the use of ICT for controlling and managing can greatly help.

The forest-based sector includes all stakeholders with a major interest in forestry, forest-based materials and products. It also provides essential products and services for a more sustainable society. It accounts for 8% of manufacturing added value in the EU, using a renewable and continuously growing forest resource, counting 16 million private forest owners and providing nearly four million jobs, as stated in [21].

The forest-based sector operates mainly in rural areas and constitutes a vital part of the rural economy. In addition to the forest owners' income, more than 100.000 people are employed in public and large private forest enterprises, and an estimated 150.000 work as forest contractors. In addition to raw materials, forests also provide a wide range of other very important eco-system services. Biodiversity conservation and management, watershed management, non-wood forest products, recreational environments, and climate change mitigation are areas where forests play a very important role. No other industrial sector can offer equal products and services to ordinary citizens. Also in this area, it is considered as crucial to increase overall efficiency by taking benefit of ICT.

2.4.2 High-level requirements on ICT

The **SmartAgriFood project** [20] is part of the Future Internet Public-Private Partnership (FI-PPP) program, and addresses farming, agri-logistics and food awareness as a use case for this sector. Concurrently, the sector provides use cases for Future Internet design from the physical layer all the way up to the service layer.

Intensive application of ICT-tools and technologies is seen as a basic requirement of SmartAgriFood. Thus, introduction of information & decision support systems that are tightly integrated with advanced internet-based networks & services are expected to radically enhance the intelligence, efficiency, sustainability and performance of the agri-food sector. Consequently, the project focuses on the following sub systems and formulates related requirements to ICT:

- Smart farming, focussing on sensors and traceability
- Smart agri-logistics, focusing on real-time virtualization, connectivity and logistics intelligence
- Smart food awareness, focussing on transparency of data and knowledge representation

ICT underpins innovation and competitiveness across a range of private and public markets and sectors also in the forest-based sector. The **Forest-based Sector Technology Platform (FTP)** [21] provides a forum for European forest owners, companies, researchers, regulators and financial institutions to work together in support of the development of new forest management schemes, products, services and business models.

The importance of ICT for this sector and related requirements are described in the FTP Strategic Research Agenda [22]: The sector will benefit in particular from investment in ICT that supports the development of open platforms and technologies such as

- systematic use of radio frequency identification (RFID)
- embedded components and systems, process control as well as robotics
- micro- and nano-electronics

Working together in new applications, these technologies are expected to minimise waste in the production process, prevent illegal logging, and facilitate product recovery for recycling.

Furthermore, **water management** has to be taken into account as a strongly environment-related topic. People demand reliable access to water supply and sanitation services and water utilities companies are encouraged to perform a good service at the lowest cost. Environmental awareness and sensitivity are relevant facts in our society.

At the NetSoc 4th Usage Area Workshop an overview on this field with focus on ICT related issues has been presented by a-c Ing [23]. It was stated that Smart Water Management through the use of Future Internet tools provides strong requirements to meet efficiency improvements in processes such as:

- Demand management
- Customer management
- Technical operations
- Cost effective operations
- Environmental respect
- Service quality

Use of smart water metering technology is considered as essential to provide users with information in near real-time about their own water consumption, thus raising awareness about the cost of water use or the presence of leaks at their own networks or even malfunctions on water meters.

2.4.3 Related ICT R&D challenges

In the **agriculture environment** typical challenges for ICT are given in the following areas: Provision of sensor networks e.g. for soil monitoring, systems for automated quality control of healthy and/or organic food, focussing on transparency of data and knowledge representation, and provision of agri-logistics functions, based on real-time virtualization, connectivity, and logistics intelligence.

ICT has already reduced production costs both in **agriculture and forest-based industries** [22]. Mobile ICT solutions will continue to revolutionise the monitoring and management of forest resources. Light Detection And Ranging technology (LIDAR), an optical remote sensing technology, and other augmented reality and global tracking systems will play a crucial role in the whole value chain, from agriculture and forest management and harvesting operations to transportation and logistics, manufacturing and processing, product development and resource management.

ICT will assist in developing intelligent communication systems allowing complex participation in public decision-making processes concerning e.g. the forest-based sector [22]:

- Develop new (or adapt existing) ICT solutions for new, smart and integrated transport and logistics systems from local and regional to global scale
- Use information and communications technology (ICT) to meet highest process efficiency, improving material flow, resource efficiency, process stability, machine productivity, etc.
- Conduct standardisation and pre-normative research in ICT applied to the forest-based sector for improving information exchange, business-to-business models and consumer perception and interaction.

Challenges regarding controlling and steering **water management** are described in [23]. They are related to track water usage more accurately at the consumer end and implement intelligent water pricing plans which will encourage water conservation. In the case of industries or commercial uses, the stakeholders will be enabled to closely study the true cost of their water usage and the existing efficiency-gain potential across their supply chains for more active water management strategies.

The adoption of web enabled smart metering technologies, sensors and communication networks will be a further challenge finally providing information in near real time about demand, hydraulic values in networks, water quality parameters, about equipment status as well as about environmental variables such as temperature, soil moisture levels, rainfall, etc. Early warnings, accurate water network mode. Setting up ICT-based methods for billing and the analysis in real time of this information will allow the efficient operation of networks, the quick detection of leakages and the best control over water demand in the short, medium and long term with important savings in water resources and energy consumption.

By the use of the Future Internet (Big data management), water utilities companies may improve their processes for Invoicing and collecting, Applications for new users, for cancellations, and for Customer Service Centers and Providers Management (online marketplaces).

2.4.4 Potential impacts from the inter-sectorial collaborations

One of the relevant conclusions of the FIspace project [14], aiming at support for development of services and application for agriculture and other related sectors, is that it is difficult to identify individual "ICT products" which can be implemented and deployed in an efficient and an economically justified way serving one or just several needs of the sector. Therefore, it is necessary to ensure that a full set of services and applications from the agriculture domain can be supported by appropriate ICT solutions considering the entire sectorial needs. Furthermore, it can also be identified that the agriculture sector requirements can be considered together with the requirements coming from other sectors, such as logistics, ensuring a larger scale of the ICT resource utilisation and creation of affordable services and applications.

Particular areas of interests for future collaboration among the agriculture and the ICT sectors are listed below [37]:

- Provisioning of the related services and application in Cloud, ensuring that they can be accessed anywhere at any time via any device,
- Adoption of an open service approach, allowing extensions and customisation of solutions for specific sectorial demands, including appropriate involvement of open source communities and development of appropriate business models,
- Establishment of a domain specific Marketplace, offering the services and applications in form of apps or similar but also establishing a kind of community based collaboration platform,
- Needed techniques for using Internet of Things technologies,
- Integration of different legacy systems, and
- Necessary security and privacy measures.

The following two examples are provided, to illustrate related potential in food production and water management:

- An example calculation for a typical farm in Germany, presented in [38], shows that by application of the ICT technologies, a farm can save up to 50% of costs related to accounting, legacy, planning, consultancy, and IT equipment. On the other hand, average additional costs for establishment and maintenance of the related services would cause approximate costs of 6,000€ per year.

- Furthermore, a significant potential can be identified in the water management, in particular by considering other sectors, beyond water supply to the citizens, such as transport, heating, cleaning, production, etc., where water related costs can reach up to 25% of the total production costs in the industries with overall annual turnover of 1,500 billion Euro and 150 billion Euro of annual investments [39].

2.5 Smart Cities

2.5.1 Sector related scenarios

While considering various trends, it can be recognised that almost all of them have some interdependencies with other identified trends. Thus, some of the trends are affecting many other trends and cannot be easily assigned to only one industry sector.

Especially looking at the needs and requirements for building Smart Cities, strong impact and interaction of topics described in the former section such as Energy, Transportation& Logistics and Health&Assisted Living is seen. For this reason we have added this subsection on Smart Cities which gives a more combined and holistic view on the specific demands.

Cities have quite an impact in the economic development of a country, being the "platform" where many people live and work, where services are provided to citizens in a wide range of ways, and where local government officials have a close contact with citizens. It is only natural then that ICT (Information and Communication Technologies) plays an increasing role in the life of both people and private and public entities that are part of a city.

The concept of Smart Cities is gaining increasingly high importance as a means of making available all the services and applications (enabled by ICT) to citizens, companies and authorities that are part of a city's system, as described in the Net!Works White paper on Smart Cities Applications and Requirements [10]. It aims to increase citizens' quality of life and improve the efficiency and quality of the services provided by governing entities and businesses. This perspective requires an integrated vision of a city and of its infrastructures, in all its components, and extends beyond the mere "digitalisation" of information and communication: it has to incorporate a number of dimensions that are not related to technology, e.g., the social and political ones.

When looking at the potential impact that telecommunications, and the services made available by them, may have in cities, a number of opportunities, challenges and barriers can be identified. The deployment of these services imply that other sectors need to be brought to work together with the telecommunications one, hence, requiring that the latter is aware of a number of requirements and constraints, coming from the many applications made possible in a Smart City environment.

Health, inclusion and assisted living are believed to play an essential role, since the demand for related services is rising, because ageing is changing disease composition. Requirements address a number of technologies, beyond the ones related to mobile and fixed networks. An integrated perspective on healthcare solutions for the near- to long-term can be foreseen, bridging a direct gap in between the health area and the technological development of communications.

The needs for mobility in urban areas result into a number of problems, such as traffic congestion and energy consumption, which can be alleviated by exploiting Intelligent Transportation Systems and further adoption of vehicle-to-vehicle and vehicle-to-infrastructure communication networks. The information being managed for applications in this area can be relevant in other domains, which increases its potential. An effective deployment poses a number of technical, sociological, regulatory and economic challenges.

Smart energy grids are the backbone of the Smart City, a major requirement being to leverage energy consumption between the different producers and consumers. The successful combination of smart processes and technologies will enable energy efficiency and savings to be achieved in the residential and business markets. Intelligent systems and

integrated communication infrastructure are highly demanded, which can assist in the management of the power distribution grids in an optimised way. Smart grids are seen as a major opportunity to merge power and ICT industries and technologies.

2.5.2 High-level requirements on ICT and related challenges

All the domains discussed in the field of Smart Cities raise challenges in security and privacy, and although security is not the main selling point for most applications, users implicitly expect systems to be secure and privacy-preserving. If users consider a system as insecure or threatening their privacy it will not be able to establish itself successfully in the market.

The FI-PPP project Safecity [24] deals with smart Public safety and security in cities taking benefit through advanced Internet networking and computing technologies. The main objective is to enhance the role of Future Internet in ensuring people feel safe in their surroundings. A main goal of this project is to collect specific requirements driven by relevant users on the Future of Internet.

Requirements towards ICT given from Safecity are given here [25]:

- Video Analytics for decision support: Connection to city-wide CCTV cameras; analyze video inputs with e.g. orphan objects detection, intrusion detection; facial detection, face recognition; anomalous pattern detection. Generate alerts to users when positive detections.
- Ad-Hoc Networks as physical network support: provide connectivity among sensors; allow user interaction from mobile devices with sensors; support other networks with different radio protocols.
- Sensors Gateway with pre-processing capabilities: Allow sensor-sensor low-level communication, decentralise some command centre functionalities; reduce traffic in the network.
- Road and environmental sensors for traffic safety: Detect unusual traffic patterns and identify incidents; sense critical environmental changes; take preventive safety measures.
- Information Security: Self-organization of sensor networks; flexible mechanisms considering wireless nature of sensors; heterogeneous systems, privacy issues.
- Data fusion: extracts the meaning of raw data ontology definition and semantic-based fusion of data.

Evolution towards Smart Cities by concentrating on the development of five innovation ecosystems is targeted by the FI-PPP project OUTSMART [26]: Water management, water and sewage, water as a resource, sustainable transport, smart meter and street lightening. These clusters are the motor of the project and provide a set of domain specific requirements for the Future Internet. This approach is intended to contribute to more sustainable utility provision and, through increased efficiency, lower strain on resources and on the environment. Reaching this goal requires the whole value chain, namely city authorities, utilities operators, ICT companies as well as knowledge institutions in order to have an industry-driven approach when developing advanced services and technologies.

OUTSMART services and technologies will be based on an open and standardised infrastructure as envisioned by the FI Private Public Partnership (FI-PPP) and provided by a service framework designed to facilitate provisioning, development and access.

A range of requirements have been set [27] for wireless sensors, gateways and service platforms which are basic elements in the OUTSMART ecosystems:

- Standard-compliant radio interfaces for sensors allowing for aggressive duty cycling and native support of routing; sub-GHz radio frequency allowing for sufficient communication range allowing for mesh networking. Also, provision of remote re-programmability under secure conditions
- Gateways that give multi-access network support, including cellular, optical, Ethernet, Wifi, and others.
- Highly advanced, modular, scalable and secure service platforms supporting technologies from large players in the smart city market, such as IBM, Cisco, Google, SAP, Oracle.

Many challenges directly related to the requirements arising in the context of Smart Cities are tackled in FI-WARE, the Core Platform project of the FI-PPP program. Enablers and platforms are being defined and developed to serve those demands, amongst them [3]:

- Internet-of-things/Machine-to-Machine Enablers to connect apps to the physical world
- Data/Context Enablers to manage data at large scale and transform it into knowledge
- Integration and Composition Enablers to provide benefit from open innovation (open data, co-creation)
- Security Enablers ensuring Privacy, Security and Trust
- Advanced Cloud and network capabilities in order to keep investment in infrastructures lower and under control

In the security field current limitations and thus challenges for future work as described in the Safecity project [4.2] are:

- Situational awareness: Digital CCTV security systems in EU cities require visual monitoring of hundreds of cameras
- Command Centres lack of pre-processing capabilities at sensor side and high degree of command centralization yields to large amount of traffic in the network. Most of current Public Safety applications are focused on responding phases of incidents/emergencies but there is an enormous lack of anticipation and prevention capabilities.
- Ad-hoc networks lack of proper communication networks in terms of coverage, reduced availability, saturation.

2.5.3 Potential impacts from the inter-sectorial collaborations

A use case clearly demonstrating the interrelation amongst various key functionalities of Smart Cities is given by offering “Car-Sharing” for electric vehicles [30]. In this case the following services are required:

- Smart Grids, serving the high peak power consumption of quick re-charging. Offers and demands for electric capacity have to be aligned to avoid network overloading.
- Traffic telematics system, to provide information to the customer on closest location of available vehicles. The parking vehicles thus need to register in a data bank.
- Connection to the public transport system, providing real time information on alternative transportation in case that no „Car-Sharing“-vehicle is available.
- Billing and accounting system, used by the customer to pay his bill via chip card or credit card. This requires respective ICT infrastructure to exchange information amongst vehicle/charging-station, providers of the various services and the relevant banks.

In total, the following stake holders are involved in the "Car-Sharing" use case: Car-sharing-provider (city itself or private company), the customer, electric vehicle, re-charging station, metering point and metering service provider, energy & energy network provider, and banks for accounting, all depending on a highly reliable future safe ICT infrastructure.

A very general challenge with **impact critical for overall success** is arising from the needs for standardisation and interoperability which are key requirements for the widespread adoption of technologies and services to provide e.g. e-government at the city level [10]. Cities need to be able to integrate new services and technologies with their existing services and infrastructure – this requires open and common approaches, based on the development and use of shared and public APIs (Application Programming Interfaces), which support the continuous development and evolution of Smart Cities.

During the 1st European Conference on the Future Internet (ECFI 2014) a session was held on network infrastructures for Smart Cities in connection with the 5th Usage Area workshop of NetSoc [31]. It was devoted to discuss and understand the role of Future Internet technologies and experimental infrastructures for the development of Smart Cities services and solutions: Future Internet technologies and federated infrastructures are core components and enablers for the effective creation and offering of Smart Solutions and Services in what is envisaged as the Smart City Open Innovation Marketplace.

The various presentations at the session showed and discussed how the FI-PPP activities, technologies and offering are paving the way for the Smart Cities vision to become true. This session brought together:

- The users' perspective by representatives of public authorities and municipalities' participation to help characterizing and understanding what are the main needs and boundary constraints on the cities side.
- The technology providers' perspective by key players in the FI-PPP scene to present technologies available for the creation of a new generation of solutions and services for the Smart City vision to become true.
- Work and efforts in the Smart Cities scene by key representatives of FI-PPP projects which developed experimental platforms that are already being used by a number of cities to become smarter.

This session raised direct relevance to both political stakeholders and ICT industry representatives as it was showing in which way public authorities, municipalities, and industrial ICT stakeholders will be able to benefit from Future Internet technologies and infrastructures to realize the Smart Cities vision.

Presentations on FI-WARE, FI-Lab and FI-Ops [32, 33, 34] clearly showed that starting from requirements for ICT and realization of enabling functionalities from ICT side, now the step is done to apply open standard platforms for open innovation ecosystems in the Smart City environment. Proof of concept for this broad spread and open applicability was given with examples of Smart City ecosystems in Santander, Seville and Malaga [32], as well as in Trento [32, 35].

Dimensions covering non-technical issues (which are, however, essential for the overall success) like governance models, communication structures and policy decisions for cities were covered by the presentation of the FP7 project FUPOL [36]. Via collecting, analyzing and interpreting opinions from Internet and Media, by involvement of stakeholders through multichannel social computing and simulating the effects of policies and laws, methods are

being developed to hopefully remove road blocks for successful implementation of Smart City features at an early stage.

As a conclusion, good progress can be observed facing on one hand strong challenges to achieve the goal of Smart Cities from the technical point of view e.g. dealing with thousands of sensors in city environment, respective interactions, and processing of an enormous data amounts. On the other hand, further extremely important issues towards making cities smarter are being tackled related the difficulty in changing organisations and currently existing ways of working to use these new technologies.

3 NETSOC DEDICATED ACTIONS

The purpose of this chapter is to summarize the main events which have been directly managed by the Netsoc project and have contributed to the consolidation of this document. The first year activities which contributed to the edition of the intermediate version D2.5 and have been integrated in that version are not recalled there (e.g. 4th Usage Area Network).

3.1 5th Usage Areas Workshop

A 5th Usage Area workshop has been organized on April, the 3rd, 2014 by the Netsoc project during the European Conference on the Future Internet in order to foster exchange with vertical sectors.

The session aimed at cultivating a common discussion between the stakeholders from ICT and vertical application sectors using, and planning to use, the services and facilities of the future communications network infrastructures. For example, the addressed vertical sectors included, but are not limited to: Energy, Smart Cities, Transport, Tourism, Agriculture, Health, and Manufacturing. Besides addressing and discussing the needs of the big industry players in these application sectors, the session focused particularly on the role of innovative SMEs, their areas of interests, and opportunities to participate.

This workshop session followed the successful Future Internet usage area workshops, organised by FP7 projects EX-FI and NetSoc in 2010, 2011, 2012 and 2013. A key theme of the session has been the identification of opportunities for supported ICT cross-sector collaborative research in FI-PPP Phase 3 and planned Open Calls for developers of innovative applications. The workshop also addressed related opportunities for SMEs and further industry and academic players in the European research and innovation programmes Horizon 2020 and Celtic-Plus.

The presentation and the discussions moderated by Halid Hrasnica from Eurescom have addressed several vertical sectors as illustrated in the agenda below. The outcome of discussions, mainly dedicated to potential impacts of collaboration among ICT and vertical application sectors, has been integrated in the relevant chapters of this document

- Requirements on ICT from transport, logistics and agri-food sectors
- Smart Grids requirements on ICT
- Manufacturing and ICT sectors interaction
- eHealth domain and Future Internet
- Supporting Creative SME Content Creators
- Start implementing FI-PPP 3rd phase: the INSENCE project
- Dynamic Collaboration in Supply Chains handling Perishable Goods – Focus on Food and Flowers

At the Usage Areas Workshop, the NetSoc project also asked all participants to consider the NetSoc deliverable D2.5 (intermediate version of this deliverable) and provide a feedback as well as to contribute to the document by providing additional inputs.

3.2 5GPPP consultation of vertical sectors

The Association membership (A-members) is based on the elected Steering Board of the Networld2020 ETP. Following advices from the EC, the 5G PPP has offered 6 seats to such sectors in the 5G value chain, which are not or not sufficiently represented in the Networld2020 Steering Board coming from the two founding platforms (ISI and Net!works).

The Networld2020 ETP Steering Board issued a call for candidates for the election of 6 additional members (B-members) to the Association in order to complement the 5G value chain in the Association. The deadline to submit candidatures was set up end of January 2014 and election was organised between the Networld2020 ETP members.

33 candidatures have been received, and have been grouped per sector. Note that some organisations belong to several sectors and were candidate in more than one sector.

The repartition par sector is detailed in the following tables

Sector „Terminal devices, smart cards"

Organisation	Country	Representative
Fraunhofer Institute for Integrated Circuits IIS	Germany	Rainer Wansch
Intel Mobile Communications	Germany	Michael Färber
InterDigital Communications	United Kingdom	Alan Carlton
Samsung Electronics Research Institute Ltd. (SRUK)	United Kingdom	Dr Maziar Nekovee

Sector „Optical communications“

Organisation	Country	Representative
ADVA Optical Networking SE	Germany	Dr. Jörg-Peter Elbers
Fraunhofer Heinrich Hertz Institute	Germany	Prof. Dr. Martin Schell
MITSUBISHI ELECTRID R&D CENTRE EUROPE	France	Sophie Pautonnier
Politecnico di Torino	Italy	Vittorio Curri
Universitat Politècnica de Catalunya	Spain	Fernando Orejas

Sector „IT Sector“

Organisation	Country	Representative
ADVA Optical Networking SE	Germany	Dr. Jörg-Peter Elbers
Fujitsu Laboratories of Europe Ltd	United Kingdom	Dr. David Snelling
Future Intelligence	Greece	Nikos Zotos
i2CAT Foundation	Spain	Sergi Figuerola
IBM Research	Israel	Dr. Yaron Wolfsthal
iMinds	Belgium	Piet Demeester
INDRA SISTEMAS, S.A.	Spain	Jesús Angel García Sánchez
Intracom S. A. Telecom Solutions	Greece	Dr Artur Krukowski
IST – University of Lisbon	Portugal	Luis M. Correia
ITI – Instituto Tecnológico de Informática	Spain	Daniel Sáez-Domingo

Let's Gowex, S.A.	Spain	Luis Manuel Calvo
TSSG	Ireland	Kevin Doolin
Universitat Politècnica de Catalunya	Spain	Fernando Orejas
University of Piraeus	Greece	Panagiotis Demestichas
VTT Technical Research Centre of Finland	Finland	Pertti Raatikainen

Sector „IOT, M2M "

Organisation	**Country**	**Representative**
EURECOM	France	Christian Bonnet / Nussbaum Dominique
Future Intelligence	Greece	Nikos Zotos
i2CAT Foundation	Spain	Sergi Figuerola
iMinds	Belgium	Piet Demeester
INDRA SISTEMAS, S.A.	Spain	Jesús Angel García Sánchez
Infineon Technologies AG	Germany	Dr. Franz Dielacher
InterDigital Communications	United Kingdom	Alan Carlton
IST – University of Lisbon	Portugal	Luis M. Correia
ITI – Instituto Tecnológico de Informática	Spain	Daniel Sáez-Domingo
King's College London	United Kingdom	Hamid Aghvami
MEDIATEK	United Kingdom	Dr Gilles Charbit
Qualcomm CDMA Technologies GmbH	Germany	Dr.-Ing. Wolfgang Granzow
SnT @ University of Luxembourg	Luxembourg	Latif Ladid
TNO	Netherlands	Toon Norp
Ubiwhere	Portugal	Rui A. Costa
University of Piraeus	Greece	Panagiotis Demestichas
VTT Technical Research Centre of Finland	Finland	Pertti Raatikainen

Sector „Microelectronics "

Organisation	**Country**	**Representative**
Fraunhofer Heinrich Hertz Institute	Germany	Prof. Dr. Martin Schell
Fraunhofer Institute for Integrated Circuits IIS	Germany	Rainer Wansch
Infineon Technologies AG	Germany	Dr. Franz Dielacher
Intel Mobile Communications	Germany	Michael Färber
MEDIATEK	United Kingdom	Dr Gilles Charbit
Qualcomm CDMA Technologies GmbH	Germany	Dr.-Ing. Wolfgang Granzow
TEAMCAST TECHNOLOGY	France	Gérard FARIA

Sector „Security "

Organisation	**Country**	**Representative**
EURECOM	France	Christian Bonnet / Nussbaum Dominique
Fujitsu Laboratories of Europe Ltd	United Kingdom	Dr. David Snelling
HdM Stuttgart, University of Applied Science	Germany	Christiane Reinsch

IBM Research	Israel	Dr. Yaron Wolfsthal
SnT @ University of Luxembourg	Luxembourg	Latif Ladid
TSSG	Ireland	Kevin Doolin

6 additional members (one per sector above) have been elected by the Networld2020 members during the first quarter of 2014 and results have been announced during the March 2014 5G Infrastructure Association General Assembly. The new members are:

- Sector "Terminal devices, smart cards": Samsung Electronics Research Institute Ltd.
- Sector "Optical communications": ADVA Optical Networking SE
- Sector "IT": IST – University of Lisbon
- Sector "IoT, M2M": TNO
- Sector "Microelectronics": Intel Mobile Communications
- Sector "Security": IBM Research

A key activity has been carried out by the NetSoc project in involving vertical sectors to the set-up of the 5G PPP association. An effort has been done toward the different vertical sectors in order to advertise the 5G PPP initiative within these communities and to offer them opportunities to contribute to the initiative. Associated Membership is part of the 5G Infrastructure Association statutes in addition to the 36 members. Although associated members have no voting rights, they can participate to the activities of the association mainly by providing information on their ICT requirements and needs to 5G PPP and to get a better understanding on what the ICT domain can offer. Additional stakeholder groups will be represented such as

- Representatives from other ETP and PPPs for vertical sectors
- Representatives from user groups (end users)
- SMEs and entrepreneurs

3.3 Collection of Requirements – NetSoc Experience

During its work on gathering requirements from the vertical application sectors, NetSoc contacted a large number of relevant stakeholders and had a large number of discussions with representatives of the application sectors, in order to cover all needed aspects and collect as many requirements as possible and consolidate it in its reports/deliverables. After been completing the deliverable D2.5 (pre-version of this deliverable) was provided in the public domain and the approached stakeholders have been asked to provide their comments.

We have to admit that level of responses on this request was low, but from the received information we can conclude the following

- The collected requirements represent well needs of the covered vertical application sectors – no negative feedback was received.
- On the other hand, no additional inputs have been received during this exercise. However, in direct contacts with representatives of the application sectors, we learned that more detailed requirements would be, of course, valuable for wide research communities to plan their activities. However, they also stated that it might be very difficult to work on the detailed requirements in the public domain

because the related knowledge is of big value for organisations involved, in particular in the industrial and commercial domains.

- Furthermore, collaboration with ETPs representing the vertical application sectors in gathering the requirements was not as interactive as expected, which can be explained by following:
    - All ETPs were in a so-called transition period between FP7 and Horizon 2020 during the life time of the NetSoc project and, therefore, less responsive (some of the ETPs even were not aware that they will be re-established, causing additional delays in responses)
    - The ETPs do not have and or have very limited resources to perform their activities (no dedicated support action projects) and, therefore, were not able to participate in the NetSoc activities
    - Some of the ETPs have complex decision making processes, which represented an additional barrier to perform some collaboration activities with NetSoc.

On the other hand, after establishing cooperation with projects already working on topics related to the ICT and non-ICT sectors with involvement of the related communities, it could be concluded that collaboration of the communities in such activities is very good. Furthermore, such collaborative projects (e.g. from FI-PPP programme) are rather open to discuss interactions among the sectors and its further needs in public, based on the experience from collaborations on the projects level. Therefore, the NetSoc project focused on interaction with such collaborations in the second project year and at the 5th Usage Areas Workshop.

4 CONCLUSIONS

This document, NetSoc Deliverable D2.6 “Cross-Sectors Interactions” summarizes the discussions held among ICT and vertical sectors. Expanding the ICT cross ETP approach, the NetSoc project has initiated discussions between ICT network research stakeholders and representatives from other ICT application sectors to understand their communications needs for the long-term future, through document exchanges, joint actions and participations in respective activities.

This document integrates the results of the first year of the NetSoc project already presented in the intermediate version of the “Cross sector interaction” delivered one year ago [RD 28], completed by the activities carried out during the second year of the project.

The NetSoc project has helped to strengthen the place of Networking and ICT in Horizon2020. The heavily application-focused approach of FI-PPP currently being promoted in Framework Program 7 may result in unsustainable demands on the networking infrastructure unless the network level issues are addressed in a similar time frame to meet the ever growing demands of the service scenarios of Horizon 2020. Research on networking technologies and systems takes more time than on applications and thus networking research has to start early to be prepared for new application requirements. It is of utmost importance to prepare the underlying network infrastructure in advance of anticipated service demands. Therefore, early cooperation with vertical sectors is essential to understand requirements of other sectors to take this into account from the beginning in the system design and to improve the knowledge of the other sectors on ICT trends.

The overall impact of the deliverable consists of:

- Support community building activities between the usage areas and communications sectors, and within the networking sector itself.
- Increased and shared awareness of requirements on networks and opportunities for economic growth generated by the synergies that can be achieved in the areas of terrestrial, satellite and content delivery networks and their usage scenarios.
- Concentration of expert resources into a single systematic effort to develop a set of Strategic Research and Innovation Agendas contributing to the capability of Europe to introduce a new generation of networking facilities tailored to the needs of usage scenarios in the coming decade.
- Building a new cross-sector community of experts sharing a common vision of requirements, visions and roadmaps, achieving thereby the effective information processes involving sector actors, including national administrations, leading-edge users and the interested public.
- Outlining the necessity for ICT network research stakeholders and representatives from other ICT application sectors to come together and talk and collaborate, and providing input for measures to be established by EC in H2020 as well as by public authorities in other programmes (e.g. CELTIC Plus, National Programmes).
- Recalling, through the analysis done on a subset of application sectors, the interest for ICT and application sectors to continue and to intensify inter-sectorial discussions.
- Highlighting how the 5G PPP association has started to involve vertical sector communities to the discussion on future 5G systems.

In order to establish necessary collaboration with various vertical sectors, the project has contacted ETPs and further relevant communities to identify potential opportunities for synergies with ICT sectors addressing network infrastructure, as well as to follow-up and facilitate inter-sectorial discussions.

The work described in this document has concentrated on the following application sectors 'Health and Ambient Assisted Living', 'Energy', 'Transportation and Logistics' 'Environment and Agriculture' and 'Smart Cities'.

This deliverable is strongly relying on the outcome of the Usage Areas workshops organised by the NetSoc project in March 2013 and in April 2014.

By analysing the identified selected trends and potential impacts on the future networks and ICT in general, among the identified main challenges and requirements, the following can be noted:

In the **areas of Internet of Things** new mechanisms have to be created to manage the number of devices and processing of those data amounts. To provide connectivity among sensors and to allow user interaction from e.g. mobile devices with sensors, support by a range of heterogeneous networks with different appropriate radio protocols will be needed. Connectivity management will include realisation of communications among different devices using various communications technologies, interfaces, and protocols as well as interaction with existing IT infrastructures, providing necessary interoperability.

Cloud computing is strongly related to the needs of the vertical sectors, increasingly helping to reduce cost, increase efficiency, and work smarter. From a business perspective, cloud computing is a key concept to enable a global ecosystem, where organisations are able to be more competitive.

Network virtualization, Software Defined Networking and mechanisms for improved control decisions are needed to enable a new type of networks that support a wider range of services at greater efficiency.

Big data management is a highly relevant area of the Future Internet, requested by many applications in vertical sectors. Provision of networks capable to connect different applications and devices is requested, complex business relationships between multiple stakeholders and innovative business applications shall be made possible via new service platforms.

Privacy, Security and Trust will need to receive high priority in all of the investigated usage areas and shall be available as an intrinsic element of all aforementioned ICT technologies. Privacy, Security and Trust requirements are top priorities for some sectors, such as the e-heath domain whereas privacy and patient data protection is mandatory

According to the set of requirements identified, inter-sectorial collaborations should be intensified to iterate on the requirement definition and to foster the discussion between stakeholders. This inter-sector collaboration would in addition be a vector to widespread the knowledge of ICT innovative solutions through the different application sectors. Several actions have been performed by NetsSoc to improve this inter-sector collaboration. The main achievement is the involvement of vertical sectors not directly related to ICT domain in the 5G PPP association.

For the future activities on gathering requirements on ICT and future networks from vertical application sectors and in order to perform a more detailed requirement analysis, so far the requirements can be considered in the public domain, the NetSoc project would recommend the following:

- To establish projects with focus on limited number of vertical application sectors with direct involvement of relevant stakeholders, e.g. from ICT and non-ICT ETPs.
- To organise or collocate an annual event at European level, where collaboration activities of the considered sectors can be presented and discussed, where experts from various sectors have an opportunity for direct discussions with experts from other sectors, and where it would be possible to ensure targeted dissemination activities promoting this type of collaboration and its positive impacts.
- To make profit of the participation of non ICT sectors in the 5G PPP association to improve mutual knowledge between ICT and application vertical sectors and to encourage active participation of both communities in 5GPPP sponsored events.

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