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Deliverable D2.5 - Cross-Sectors Interactions (Intermediate Version)

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Abstract

This deliverable aims to intensify discussions among ICT and vertical application sectors, strengthening the place of networking and ICT in Horizon 2020. Based on interactions with the various communities, the work has concentrated on the application sectors 'Health and Ambient Assisted Living', 'Energy', 'Transportation and Logistics' as well as 'Environment and Agriculture' and 'Smart Cities'.

Across these areas, the main challenges and requirements identified are related to Internet of Things and sensor applications, support by heterogeneous networks with different radio protocols, Cloud Computing helping the sectors to reduce cost and increase efficiency, network virtualization and big data management. 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 the aforementioned ICT technologies.

The list of identified common fields of interests is not yet complete and will be extended and further elaborated. NetSoc will follow-up all potential opportunities involving the vertical communities in definition of the ICT (in particular network related) challenges.

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Executive Summary

This deliverable is devoted to intensify discussions 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.

The NetSoc work is intended on strengthening the place of networking and ICT in Horizon 2020. There is a risk that the heavily application-focused approach of FI-PPP currently being promoted will 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 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. The deliverable is strongly relying on the outcome of the Usage Area workshop organised by the NetSoc project in March 2013.

The content of D2.5 is characterized by sketching major sector related scenarios, and by identifying requirements and major challenges for advancing in networks, based on a dialogue with a wide range of usage areas and discussion in the networking domain. Based on the received feedback received from the various communities, the work described in this document has concentrates on the application sectors ‘Health and Ambient Assisted Living’, ‘Energy’, ‘Transportation and Logistics’ as well as on ‘Environment and Agriculture’. More general issues of ‘Smart Cities’ have also been addressed. The following main related challenges and requirements have been identified:

In the areas of Internet of Things new mechanisms have to be created to manage the numbers 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 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 the private sector 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.

The list of the identified requirements and main challenges is not yet complete and will be extended and further elaborated. NetSoc will follow-up all potential opportunities in involving the vertical communities in definition of the ICT (in particular network related) challenges and motivate members of these communities to actively collaborate.

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1 INTRODUCTION

One of objectives of the NetSoc WP2 “Building ICT network positions” is to consolidate the ICT network research plan with ICT network technology user groups from so-called vertical sectors in the domains such as ‘Transportation and Logistics’, ‘Energy’, ‘Health’, ‘Content’, ‘Security’, and potential synergies relating to ‘Smart Cities’ by driving cross sector relations. 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 – 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 is to consolidate and enhance the ICT network research plan 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 is to extract the application demands on future networks, aiming to improve ICT related research roadmaps with the applications domain needs. Basic information on potential impact of the sectorial trends on the ICT had been given in deliverable D2.4 [2]. Furthermore, direct interactions with FI-PPP projects have been established, amongst them with the FI-PPP project FI-WARE [3].

A Usage Areas workshop had been organised by NetSoc [4] and held in Brussels on 20 March. Major focus at this workshop was set on dialogue among ICT and non-ICT community members, exchange of experiences and best practices in applying ICT technologies in various application sectors, and definition of requirements from the vertical sectors for the future networks and ICT at large. Much of the information provided in this deliverable is arising from the outcome of this workshop. This workshop was also highly beneficial in providing information of representatives of the European Commission on Societal challenges (Health, Transport, Energy, etc.) covered in Horizon2020 [5], as well as from CELTIC Plus, where a ‘Use Case Factory’ concept was presented covering a wide range of Cross-sectors-Interactions [6]. FI-PPP related discussions were raised by the FI-PPP project CONCORD on facilitation and support for the FI-PPP programme [7].

This document, NetSoc Deliverable D2.5 “Cross-Sectors Interactions (Intermediate Version)” provides information gained from all the above mentioned interactions with vertical sectors. It will be used to intensify discussions among ICT and vertical sectors. Thus, in the next chapter, sector related scenarios for the vertical sectors ‘Health and Ambient Assisted Living’, ‘Energy’, ‘Transportation and Logistics’, and ‘Environment and Agriculture’ are described, followed by high-level requirements on ICT, as from the various contacts with those vertical sectors. Finally, related ICT R&D challenges were worked out for the mentioned sectors.

This intermediate document will be discussed with vertical communities, in order to gather specific requirements on future network and service evolution from different usage areas addressing various societal challenges. The final document will then cover all material gained from the interactions with the vertical sector over the whole project duration.

2 INITIAL RESULTS FROM CROSS-SECTORS INTERACTIONS

2.1 Health and Assisted Living

2.1.1 Sector-related scenarios

The areas of Health and 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. Accordingly, it is difficult to identify 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 present 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 äparameters, 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.

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.

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. One of the Smart Energy Grids challenges is to ensure timely support of the energy demand 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 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, 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” 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 service 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 part of necessary Smart Grid services, and
- Large producers and distributors, probably with own Smart Grid service solutions, but with particular needs for realisation of necessary interconnections.

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 service 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.

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. On the other hand, network and data security have to be further improved, in particular for part of the services acting directly on the 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 very large amount of various types of 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 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 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
- Easy to use for all (consumers, energy providers, distributors, etc.)

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 development and wide-scale roll out of ICT-based solutions for smart grids and meters. The ICT sector should deliver 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].

At the NetSoc Usage Area Workshop, the FI-PPP project FINSENY raised topics where intensive effort will have to be invested form 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, 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 created inside EU to foster innovations, and possible economic growth in the SME sector, based on an open innovation scheme inside the EU.

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

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, 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.

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 types of communications (M2M, etc.), 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.

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 Usage Area Workshop an overview on this field with focus on ICT related issues have 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).

2.5 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

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.

2.5.3 Related ICT R&D challenges

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.

A very general challenge 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.

As a conclusion, we encounter 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, an extremely important issue towards making cities smarter is not only related to the development of appropriate technologies per se, but is given by the difficulty in changing organisations and currently existing ways of working to use these new technologies to deliver smarter cities.

3 CONCLUSIONS

This document, NetSoc Deliverable D2.5 “Cross-Sectors Interactions (Intermediate Version)” is devoted to intensify discussions 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.

The NetSoc work is intended on strengthening the place of Networking and ICT in Horizon2020. There is a risk that the heavily application-focused approach of FI-PPP currently being promoted will 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 Horizon2020. Research on networking issues 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.

The overall impact of the deliverable shall consist 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 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)

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 output of the deliverable is characterized by sketching major sector related scenarios, and by identifying requirements and major challenges for advancing in networks, based on a dialogue with a wide range of usage areas and discussion in the networking domain. Based on the received feedback, the work described in this document has concentrated on the following application sectors ‘Health and Ambient Assisted Living’, ‘Energy’, ‘Transportation and Logistics’ as well as on ‘Environment and Agriculture’. More general issues of ‘Smart Cities’ have also been addressed. It is expected to attract further vertical sectors to join the dialogue.

This deliverable is strongly relying on the outcome of the Usage Areas workshop organised by the NetSoc project in March 2013. By analysing the identified selected trends and potential impacts on the future networks and ICT in general, the following main related challenges and requirements can be identified:

The area related to Internet of Things and Machine-to-Machine Communication is set to explode as we will more and more delegate responsibility to our devices to interact and negotiate on our behalf. This will be even more dramatic when we consider the millions of sensors that may exist in the near future which will all have communication capabilities.

Dealing with this amount of sensors and respective interactions, new mechanisms have to be created to manage huge numbers of devices and processing of those data amounts. Network architectures need to be developed, where sensor data can be collected, aggregated, processed and analysed to derive contextual awareness ensuring efficient and cost effective implementation of the sectorial applications. Seamless integration of information and data along with real-world data acquisition will be highly demanded under the commitment to keep sensitive data in a private environment.

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 radio protocols will be needed. Evolution of communication networks and new infrastructures will be based on new wireless and wired technologies which will have to provide increased bandwidth but also Classes of Services approaching real-time requirements.

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.

An element strongly related to the needs of the vertical sectors is Cloud Computing, which is increasingly helping the private sector 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. Today's Cloud Computing technologies provide suitable execution platform for many transaction- or batch-oriented applications. However, they are not suitable for many other types of applications. In particular, delivering telecommunication services that are time-sensitive, media-based, mission-critical, or persistent (long-lived) is highly challenging.

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. These major fields of Future Internet will play a decisive role in the 'Cloud Networking', 'Network as a Service', 'Infrastructure as a Service' concepts where the potential for greater and greater demands on the infrastructure exist.

Big data management is a highly relevant area of the Future Internet, requested by many applications in vertical sectors, improving e.g. data collection and analysis for invoicing, applications for new users, Customer Service Centers and Providers Management (online marketplaces).

Furthermore, 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.

Last but not least, security enablers ensuring Privacy, Security and Trust will need to receive high priority and shall be available as an intrinsic element of all aforementioned ICT technologies. Development of data security strategies in accordance with adopted ethical and legal requirements as well as demands on efficient governance in the sector is a must for Future Internet technologies in order to become well suited enablers for vertical sector applications.

The list of the identified requirements and main challenges is not yet complete and will be extended and further elaborated. To do so, the project will distribute this deliverable to the vertical sectors in order to launch wide discussions and establish the necessary dialogue among ICT and other industry sectors.

The NetSoc project will continue to approach the vertical communities which did not respond to the initial invitations for collaboration by active participation and project representation at the events and meetings of the addressed communities. NetSoc will follow-up all potential opportunities to directly present its approach in involving the vertical communities in definition of the ICT (in particular network related) challenges and motivate members of these communities to actively collaborate.

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