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European IoT International Cooperation in Research and Innovation

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The IoT is now a global happening that is requiring cooperation at international level to address its key challenges. Europe has established as a priority the international cooperation on IoT research and innovation. The work revolves around aligning strategies and plans for IoT globalisation

but also exploring differentiations, and specificities for local exploitation of IoT. Notice: EU is cooperating with African countries on cost-effective open IoT innovation; Europe is supporting Brazil to build-up its IoT ecosystem supported on EU best practices; the EU-China IoT Advisory Group is active on pushing global IoT standards while developing competitive IoT solutions; the EU-Japan joint cooperation follows-on on the integration/federation of IoT with Big Data and Cloud; and the EU-Korea engagement is looking at major global IoT standardisation activities; EU-US cooperation is active especially via the respective global IoT initiative frameworks, the AIOTI and IIC. And cooperation is expected to start with India on the vision of a connected and smart IoT based system for their economy, society, environment and global needs. This chapter reports on EU international cooperation activities with partner countries and regions on the Internet of Things (IoT).

10.1 Introduction

The importance of international cooperation in science and technology is explicitly recognised in the European Union's Innovation Union flagship initiative and the projects for Horizon 2020, the EU funding programme for research and innovation. On September 14$^{\text{th}}$, 2012, the European Commission set out its new approach to international cooperation under Horizon 2020 in a communication entitled "Enhancing and focusing EU international cooperation in research and innovation: a strategic approach" [1]. In-line with this approach, international cooperation activities developed under Horizon 2020 should contribute to the objectives of:

- Strengthening EU excellence and attractiveness in research and innovation and its economic and industrial competitiveness;
- Tackling global societal challenges; and
- Supporting the Union's external policies.

The Commission's Communication document calls for a systematic and coherent identification of priorities for international cooperation with the EU's partner countries and regions, with a view to subsequently implementing these through activities with the necessary scale and scope, in particular in the context of Horizon 2020. The Communication equally stresses that this strategic priority setting exercise should fully reflect the state of play in the policy dialogues between the EU and its partner countries.

To ensure that international cooperation activities are developed on the basis of common interest and mutual benefit and create win-win situations, the Communication offers four criteria for guiding the identification process. International cooperation adds value when:

- Synergies and complementarities can be created in research and innovation capacity;
- There are opportunities for access to new or emerging markets;
- The activities contribute to meeting the EU's international commitments, as e.g., in the Millennium Development Goals;
- There are adequate legal and administrative frameworks in place to engage in cooperation, also including lessons learnt from previous cooperation.

The Communication also calls on this priority setting process to be reflected in multi-annual road maps for international cooperation with its key partner countries and regions. The road maps for international cooperation, which are included in a Staff Working Document [2], provide examples of the outcome of this priority setting exercise. For each of the partner countries and regions, they provide a full overview of the framework governing the cooperation and the current state of play as regards the cooperation, including information on the way this has been addressed in the first Horizon 2020 work programmes. Most importantly, they provide an overview of what are considered to be the priorities for future cooperation (using a medium term perspective) with the partner in question, reflecting the current state of agreement in the policy dialogue.

As far as International cooperation in IoT is concerned, we can recall on important cooperation aspects as presented above:

- Need to think global for tackling global societal challenges;
- Need to identify synergies and complementarities that can be created in regards to research and innovation capacity;
- Need to look at economic dimension and business opportunities for strengthening EU's excellence and attractiveness in research and innovation and its economic and industrial competitiveness; opportunities to access new or emerging markets.

The cooperation with countries presented in this chapter highlights either important cooperation actions leading to get global solutions (e.g., on standardisation, governance, privacy) or important differentiation to address new markets (e.g., affordable solutions for Africa, new IoT solutions for Brazil, etc.).

10.2 IoT in South Korea and Cooperation with EU

South Korea is known early adopter of new technology and ranked in IDC's 'IoT Index' for 2013. South Korea government has established the 'Mid- and Long-term R&D plan for IoT' that links existing R&D projects classified into

parts of the entire ecosystem. Based on the roadmap, many activities and projects are occurring across South Korea. While South Korean's government is helping collaboration between companies, research institutions and universities, individual companies and developers are contributing the entire IoT ecosystem. Also there are strong R&D cooperation between the private sector and the military, which is expected to contribute to advancement of the military applications, and improve leadership in international standards through joint research with major countries including the EU[1]. A recent IoT related R&D direction in South Korea is moving towards integrating AI technologies to IoT in order to support intelligent IoT services. Here, various IoT related activities fostering the IoT ecosystem in Korea are described.

10.2.1 Open Innovation and Open Platform

One of the key criteria that the South Korean government highlights in strategy and planning is 'Open Innovation and Open Platform'. Different from traditional industry, IoT has a characteristic that anyone interested can develop and provide services using global standards based open platforms. In such environment, ideas can easily be developed into new services, and the potential of each individual can be maximised.

In order to launch IoT services quickly, there needs to exist an ecosystem so that developers and users can actively participate and share their technologies and experiences. Open Alliance for IoT Standard (OCEAN) is an example of open innovation and platform to foster the IoT industry supported by the government. OCEAN is a consortium sharing open source and software products that are developed based on the IoT international standard oneM2M to help enhance coordination between companies and help develop the IoT industry. The consortium started with some 50 firms and institutions but now has more than 350 firms worldwide. The IoT platform distributed via OCEAN had been developed through government support.

10.2.2 Large-Scaled IoT Pilot Projects

In order to foster the deployment of IoT solutions in South Korea, the South Korean government have identified several areas including smart city and

[1]EU and Korea reaffirmed to strengthen the agreement of the Nov'2013 summit, where both sides agreed on promoting R&D collaboration in the area of ICT including the IoT.

daily healthcare. The government selected these areas based on their large influence to on people's daily life.

In the case of IoT-enabled Smart Cities, Busan, which is the second largest city in South Korea (3.6 M population), teams up with a consortium that comprises of industry and academic members in order to foster an ecosystem for smart city industry and support for Korea's small- and medium-sized companies in various sectors, e.g., social security, transportation, energy efficiency and urban life. A main purpose of the Busan smart city is to establish an open smart city platform based on a global IoT/M2M standards (i.e., oneM2M) and implement an IoT enabled test bed in Busan. The city is designed to guarantee an interoperability between S (Service) – P (Platform) – N (Network) – D (Device) – Se (Security) ecosystem and meet global standard to prepare global City-to-City interoperability and enable expansion to the ecosystem in Busan intends to provide public information about infrastructure, transportation, security and safety, so that new services and technologies using such information can be boosted. The planned services included smart streetlights, a lost child prevention system, smart parking and a building energy management system.

The government also supports a similar large-scaled IoT pilot project together with the city of Daegu focusing on daily healthcare. In order to make sure all IoT data, devices and services are interoperable, all IoT enabled large scaled projects are recommended to use the same global IoT/M2M service layer standards, i.e., oneM2M. In this way, these large scaled IoT test beds can guarantee sustainability even after finishing project periods.

10.2.3 Global Collaboration

The IoT is commonly recognised as a fundamental game changing technology across many industrial sectors and social solutions. Many experts and studies agree that the biggest challenge for the IoT is to overcome market fragmentation and to achieve interoperability between many established silos and global IoT platforms. Therefore, South Korea government strongly supports global collaboration. A new project called WISE-IoT has been started as part of jointly funded R&D programs between South Korea and EU. As shown in table Table 10.1, the project is a joint endeavour with leading IoT companies, research institutes and universities to provide global semantic interoperability.

WISE-IoT has a plan to extend existing IoT reference architectures for achieving interoperability and interworking while strengthening oneM2M deployments. The project started from the existing test beds and experimental

Table 10.1 WISE-IoT EU-Korea joint IoT project members

European Union	South Korea
Easy Global Market	Sejong University
NEC Europe Ltd.	Korea Electronics Technology Institute
Telefonica	SK Telecom
Commissariat à l'énergieatomique et aux énergies alternatives	Korea Advanced Institute of Science and Technology
University of Cantabria	Samsung SDS
Liverpool John Moores University	Kyungpook National University
Telecom Sud Paris	Axstone
Ayuntamiento de Santander	Gimpo Big Data
University of Applied Sciences and Arts Northwestern Switzerland	Gangneung Science Industry Foundation IreIS

systems built upon current reference implementations for the various IoT systems, e.g., oneM2M systems in Korea, FIWARE in Europe, LoRa in both regions, and various local IoT technologies such as OCF and AllSeen. These solutions will be made interoperable by semantic annotation of the basic data and a specific reasoner with the knowledge for using semantic information.

The economies in Europe and South Korea are high-tech, knowledge-based societies that are selling products and services across the globe. WISE-IoT aims to enable new business in which essential features like information analytics, intelligent decision making, and reliable execution of workflows and processes can remain in the control of the knowledge workers, while services can be quickly applied to any new IoT data lake as it becomes available in a new city or factory. The outcome of the project will help to establish new global value chains. The cooperation of South Korea and EU is essential to lead the way to the global IoT services and new value chains around the world.

Apart from the WISE-IoT project, South Korea also established a "Global Council of Public and Private sectors for IoT" and the 'IoT Innovation Center' to improve partnerships between software, device, or user businesses and large businesses/SMEs. This scheme aims to foster small yet strong IoT businesses for global expansion by providing education for creative entrepreneurship and conducting projects in teams of large companies and SMEs.

10.3 Global IoT Challenges Seen from China

Note: For five years, EU and China experts met about twice a year to discuss cooperation on IoT. The result of discussion is now available in a white paper

on EU-China cooperation for IoT [3]. The summary below is based on the content of the white paper.

In China, the IoT has become an important carrier for strategic information industries and integrated innovation. The Central Government and local authorities have consistently attached great importance to IoT through the Inter-Ministerial Joint Conference, the tenth action plans for the IoT development and the annual special fund for IoT development giving substantial support for industrial development. As a result, China's IoT development shows now a strong momentum of development. In 2014, China's IoT industry scale expanded beyond 620 billion yuan, with a year-on-year growth of 24% [22]. The M2M terminals in China exceeded 73 million units, with a year-on-year growth of 46%, accounting for 30% of the global total [4]. Beijing-Tianjin, Shanghai-Wuxi, Shenzhen-Guangzhou, and Chongqing-Chengdu form the four core industry clusters with their unique features, where a number of leading enterprises have emerged. Moreover, IoT third party operation service platforms are rising in traffic, security, health care, IoV, energy-saving areas, and IoTaaS.

10.3.1 China Policy on IoT

China's IoT policies emphasise on demonstration and cluster effects, and the policy environment will continue to be improved from the top design, organisational mechanisms, think-tank support and other fields of activities:

- Planning documents pointing out directions for development of stages: following the 12th Five-Year-Plan for IoT development, China's State Council issued the Guidance on Advancing Orderly and Healthy IoT Development, which further clarified the goals, ideas and areas of focus of China's IoT development;
- Establishment of the Inter-Ministerial Joint Conference system and the Expert Consultation Committee for IoT development: the NDRE, the MIIT, and the most coordinated for the top-level design of the IoT development and promoted IoT development in China;
- Formulation of ten action plans for IoT development: the plans cover various perspectives, including top-level design, standard development, technology development, application and promotion, industry support, business models, safety and security, supportive measures, laws and regulations, personnel trainings, etc.;
- Financial support such as the special fund for IoT development: the annual support directions of the special fund are set against the

development demands from key IoT technology R&D projects and IoT systems development projects in key are as during the year; additionally, the annual support measures will to be adjusted and optimised.

10.3.2 IoT Applications in China

From a macroscopic perspective, China's IoT application development presents two typical types: "focus-oriented objective" and "overall and global covering objective". The "focus-oriented objective" are IoT applications in specific industries: CPS (Cyber-Physical Systems) for mapping virtual models to the real world, while IoT is the core of CPS.

In the field of industrial manufacturing, IoT has been widely applied in intelligent equipment management, environmental real-time monitoring, materials/product tracing and other areas. The applications of CPS will enhance the efficiency of intelligent manufacturing by 20%, cut the cost down by 20%, and save energy/reduce emission by 10% [5].

In the field of agriculture, IoT cuts the personnel costs for crop cultivation by about 50% and improves the overall economic benefit by about 10%. High precision environmental control in greenhouse facilities can be realised with the help of sensor-based automatic adjustment, and the high-quality green vegetables products cultivated for a high-end customer segment are priced 10 times higher than normal green vegetables [6].

In the field of energy conservation and environment protection, dynamic energy efficiency models can be established based on large data through energy management virtualisation, which can precisely locate the peak and valley electricity consumptions and then balance the peak and valley consumptions to save energy and reduce emission. For large industrial parks, the lighting energy reduction alone can be reduced by more than 30% [7].

In areas of urban management, pipe network monitoring, and intelligent transportation, the IoT has greatly enriched the urban management instruments and enhanced the urban management capacity. In transportation, 65% of the buses and near 70,000 taxis [8], passenger cars and dangerous chemicals vehicles in Beijing have been fitted with satellite positioning equipment, and five taxi monitoring centres and rail traffic control centres have been set up for intelligent management of all kinds of transportation.

10.3.3 IoT Trends and Standards

China has acquired important knowledge in network architecture, new types of sensors, M2M and other technologies. The WIA-PA (Wireless Networks

for Industrial Automation – Process Automation) has been applied on a large scale in the oil and the electricity areas. The Huawei LTE-M system, which features low power consumption, low cost, low data rate and wide coverage, meets the needs of M2M applications and is now in the experimental stage for business deployment.

In the area of network structure, the release of the international standard ITU-T Y.2068 led by CAICT was completed in 2015. The Wuxi IoT Industry Research Institute and the China Electronics Standardisation Institute under the MIIT jointly promoted the approval of the ISO/IEC 30141 project, and have also proposed a consistent system decomposition model and an open standard design framework.

In the area of MEMS (Micro-Electro-Mechanical Systems) sensors, China's sensor enterprises sensibly grasped the new needs and new technologies of MEMS sensors, and have developed core technologies such as the MEMS acceleration meter technology, the MEMS sensor chip development and production test technology based on proprietary thermal detection method, the 5 million pixel CMOS image sensor based on the back lighting technology, the CMOS-MEMS process and the wafer level integrated package process. The first pilot-scale production line for the complete MEMS process has been built and the manufactured systems have been widely used in security monitoring, automotive electronics, consumer electronics and other fields.

For M2M (Machine-to-Machine) network platforms, both China Mobile and China Telecom are vigorously promoting the construction of M2M platforms. Studies on the optimisation of the existing networks and the M2M narrowband networks represent the current focus of activity. China will continue to promote standardisation work for network optimisation, including terminal triggering, low power consumption and wide coverage, as well as network congestion. Huawei and other device manufacturers have been carrying out research and development on narrowband M2M business supporting technologies, and have promoted the standardisation of the narrowband network.

10.3.4 The Internet and the Reconstruction of the Industrial Ecology

Chinese enterprises have demonstrated strong innovation ability in application services and business models. With the mobile Internet extending to IoT in recent years, Chinese Internet enterprises have emerged as the most dynamic powers in the development of IoT, and have been strongly influencing the

patterns, models and industrial ecological system of China's IoT development. Major Chinese Internet companies have entered the field of IoT through wearable intelligent terminals, smart home, mobile health care, IoV, security, and other businesses, and have made rapid development in some of these areas.

On one hand, IoT applications can expand to be national-level applications in no time by virtue of mobile Internet portals and the large user scale. On the other hand, mobile APPs have become the data aggregation centres and feedback nodes for IoT. The anti-lost devices for children are integrated with a Bluetooth function, indicating children's distance from their parents, an alarm function when children are being beyond safe distance of their parents, and a four-fold location function, allowing parents to know the locations of their children at any time from a mobile APP.

10.3.5 EU-China Cooperation Proposal in IoT

The EU-China joint white-paper, published in January 2016 [3], has provided a list of cooperation items. The main ones are presented next.

10.3.5.1 Policy Level Cooperation

Encourage and actively promote research and innovation cooperation, and publication of results. Improve the EU-China cooperation policy and mechanisms in scientific research and innovation from a strategic and operational perspective, for elaborating policy recommendations. Encourage enterprises, institutions, and individuals on both sides to actively participate in cooperation projects and to form a long-term cooperation mechanism between the EU and China. At a later stage, and given that conditions are right in terms of fully reciprocal access to each other's RDI programmes, joint undertakings and calls will be considered as a further step.

The mechanism should be installed on two levels: governmental level and project level, preferably on a larger scale. For the first mechanism, policies should be investigated on both sides and provide input for the yearly EU-China ICT Dialogue. For the second mechanism, a wider scope of beneficiaries shall be considered including IoT Large Scale Pilots and Megaprojects.

10.3.5.2 Technical Cooperation

Carry out twinning activities between IoT Large Scale Pilots and Mega projects on IoT key technologies such as the IoT architectures, test-beds and platforms, semantic and technical interoperability, thus making full use of the knowledgebase and advantages of both regions. Encourage enterprises to carry out technical cooperation in strategic sectors on key product development,

which can help each of the parties involved to break through technical bottlenecks and promote the process of high-tech industrialisation on a reciprocal basis. Expertise can be enhanced and cultivated through short, medium and long-term exchanges of PhD and post doctorial students, faculty staff, industry researchers. This should also be considered for entire institutes and companies.

10.3.5.3 Standards Cooperation

Encourage EU-China mutual support and jointly push the development of international standards for the IoT business layer, in the activities of international standardisation organisations such as OneM2M, ETSI, CEN/ ISO, IEEE, ITEF and ITU-T. A joint position paper on EU-China IoT standardisation mapping including recommendations should be elaborated, which can thus provide a reference for the future EU-China standards cooperation. This should also include a consideration of domain specific standards which could be done in conjunction with large scale projects as mentioned in previous section.

10.3.5.4 Market Cooperation

Strengthen EU-China information exchange and cooperation between the technology innovation strategic alliance of the IoT industry in China and Alliance for IoT Innovation in the EU to establish an effective market supply and demand platform for European and Chinese enterprises, which can expand bilateral industrial research and innovation activities. Joint market analyses of potential applications of IoT in diverse fields are needed to instate confidence. Mutual studies on topics related to IoT large scale projects could be a means of providing this confidence.

10.4 Adapting IoT to New Needs: Challenges from Brazil

The IoT has received a lot of attention in Brazil in the last years by the academic communities, companies and Brazilian agencies. Innovation and entrepreneurship communities formed by start-ups and SMEs are very active in IoT. In fact, IoT has been viewed as one of the best opportunities in decades to foster Brazilian economic and social development. In order to promote IoT development, Brazilian funding institutions have also provided funding lines addressing IoT, Smart Cities, Smart Utilities and Advanced Manufacturing. Large companies such as Intel, Huawei, Cisco, Ericsson, IBM and Samsung, have invested in RD&I centres in Brazil. Joint calls EU-Brazil are also an

important mechanism to foster research in IoT and IoT related technologies and applications.

However, the adoption of IoT in Brazil has been slow, mainly due to the required investments. In order to foster IoT development, it is still necessary to address also points like human resources education and training, standardisation, interoperability, adoption of open standards and platforms, privacy and security, among others. Furthermore, Brazil needs to increase its participation in international standardisation bodies and also get better conditions to collaborate with international initiatives.

10.4.1 IoT RD&I Funding in Brazil

Recent calls for proposals from important funding institutions, such as FAPESP (São Paulo Research Foundation), addressing Smart Cities innovative projects, and BNDES (Brazilian Development Bank), addressing a technical study to diagnose and propose a public policy to foster IoT development and application in Brazil, show the importance Brazilian agencies are starting to give to IoT.

The BNDES calls for proposals complements other efforts at Federal government level in IoT. Additional actions include: 1) elaboration by the Brazilian Agency for Industrial Development (ABDI) of a technical study diagnosing the Brazilian industrial competence in Smart Grids and Smart Cities; draft document of these studies have mapped the Brazilian ICT Industrial Supply-Chain Smart Grids [9]; and 2) Ministry of Communication (MiniCom) that coordinates the special chamber for M2M/IoT matters. The actions are not completed, however funding agencies such as FINEP (Funding Authority for Studies and Projects) and BNDES are members of the chamber and certainly will be looking for respond on the demands of the M2M/IoT chamber.

10.4.2 IoT Success Cases in Brazil

IoT applications in Brazil normally have been made in small scale, and the corresponding business models are to be better studied and developed. Many different types of development have been made, ranging from medical support, agriculture, smart cities and smart grids. Currently, in Brazil, IoT use cases have been more focused in logistics, applying Real Time Location Systems (RTLS) technology. Today there are many systems in development and/or in operation. One system (Clever Care) made by Kidopi start-up (http://kidopi.com.br/) in the medical area was considered by ONU (World

Summit Award – United Nations – World Summit on the Information Society 2015) one of the five better medical applications in the world.

10.4.2.1 RFID/IoT Change of Paradigm

The most successful case of IoT application in Brazil corresponds to BRASCOL, a wholesale company. BRASCOL successfully employed RFID to introduce a new management of inventory model. It reached a tremendous success in term of performance and cost savings. And this was possible because the owners took the risk to identify all the products that they sell independent of its sale price. This decision was made against the "orthodox thinking" that each product should be able to pay for its cost. The gains in the total operation were very significant proving that it was a savvy decision.

10.4.2.2 Smart Metering and Smart Grids

As a result of the effort that has been made by the government and companies in order to achieve a better energy efficiency. It is expected a roll-out of smart-meters in the electric sector, starting in 2016 with 1 million units in the state of Rio de Janeiro, going to 2 million by 2017 in the state of São Paulo and reaching its peak by 2020. Notably, the Total Available Market (TAM) of Brazil in respect to smart meters is of 78 million units.

In Smart Grids, the ABNT (Brazilian Association of Technical Standards) along with the COBEI (Brazilian Committee of Electronic, Electricity and Lighting) are working on standards for Smart Meters through 8 working groups. In telecom, several companies are conducting studies and trials on LPWA (SigFox by Telefonica Vivo Brazil) and LoRa (Unitec).

10.4.3 International Standardisation Related to IoT

In the international scenario, it is observed a large number of IoT related standardisation initiatives: ISO, OMG, ITU, IEEE, etc. These standardisation efforts compete with each other in standards. Being a founding member of ISO the Brazilian National Standards Organisation (ABNT) follows ISO Standards. Historically, Brazil have not been a strong participant in standardisation entities. In the IoT, there is some activity only in specific application areas, such as Smart Grids and Telecommunications.

10.4.4 EU-Brazil Collaboration on IoT

EU-Brazil cooperation in the area of ICT is regarded as having a crucial strategic value and high societal impact. It has been developing since the

launch of the first coordinated joint call back in 2011. The cooperation is supported by an EU-Brazil dialogue on Information Society with specific working groups in some areas addressing not only research and innovation matters but also ICT policy and regulatory aspects. The main activities in the IoT are presented next.

10.4.4.1 EU-Brazil Joint Call for IoT Pilots RIAs

The Brazilian government and the European Commission have decided to launch the 4^{th} coordinated call, to open in November 2016, in two main areas: cloud computing and IoT Pilots. Priorities for the call and for the development of future technologies are the 3O's: Open data, Open platform, Open science.

The IoT pilots call is to fund actions that validate and demonstrate IoT approaches and already developed IoT technologies and tools, to specific socio-economic challenges in real-life settings. The call will support three projects proposing pilots in five areas of interest, namely: (1) environmental monitoring; (2) smart water management; (3) energy management at home and in buildings; (4) smart assisted living and wellbeing; and (5) smart manufacturing focused on customisation.

Pilots are expected to empower citizens, both in the public and private spheres, and businesses, as well as improve the associated public services, for improved sharing of information, approaches and solutions, as well as expertise. Pilots should take place on both sides and across the Atlantic, involving end-users, establish common benchmarks, contribute to standardisation, open-source and open-data repositories and link with ongoing work in the IoT Focus Area.

10.4.4.2 EU-Brazil Mapping and Comparative Study

European stakeholders are supporting Brazil in the context of the sectorial dialogues for cybernetic policy on the development of the M2M/IoT ecosystem by performing an EU-Brazil mapping and comparative study. The action is being promoted by the Ministry of Communications of Brazil.

The general objectives of the project are: – establish the basis for the participation of Brazil together with Europe in the development of policies and regulation to overcome any trade, technological or legal barriers that might hamper the development of the IoT ecosystem; – collaborate with setting IoT standards and features in Brazil and Europe; – Extend the existing collaborative research between Brazil and Europe; – Brazil's participation and contribution to future cooperation agreements for research; – Harmonize actions between the Brazilian and European IoT chambers.

The outcomes are expected to: (i) provide valuable information for the development of Brazilian public policies for the promotion and application of the IoT/M2M ecosystem. (ii) improve capacity of the Brazilian state for international cooperation and joint action in the field of telecommunications and IoT platform applications; (iii) be input to define concrete steps to integrate an action plan (roadmap) of collaboration; (iv) be a contribution to define possible agreements for research activities and joint work between the thematic chambers of M2M/IoT from Brazil and Europe.

10.4.4.3 The EU-Brazil FUTEBOL Project

The H2020-688941 FUTEBOL project works towards the creation of a federated control framework to integrate test beds from Europe and Brazil for network researchers from academia/industry with unprecedented features. The major goal is to allow the access to advanced experimental facilities in Europe and Brazil for research and education across the wireless and optical domains.

The FUTEBOL project consortium argues that the needs of future telecommunication systems, be it from high data rate applications in smart mobile devices, machine-type communications (M2M) and the IoT, or backhaul requirements brought about from cell densification, require the co-design of the wireless access and the optical backhaul and backbone.

As an example, FUTEBOL will integrate the Bristol-is-Open (BiO) city-scale and real-life test bed and will offer it to experimenters. BiO supports IoT and data centre infrastructure integration with the wireless and optical backbone of a city infrastructure ecosystem. This will create opportunities for wider adoption of FUTEBOL's experimental facility, both within smart cities and the wider industry.

10.4.4.4 Further Work on EU-Brazil Cooperation

Since Horizon 2020, Brazilian entities are not entitled to receive funds from the European Union. This situation weakened the presence of SME's as the Brazilian structure of funding does not allow any type of company to get funds from the federal government. So, the EU needs to keep working with Brazil to find other ways for this funding. One option is to work more synchronised with FAPESP and Foundations from other states also.

Also it would be very useful to get joint works that can map the Brazilian companies that are interested in cooperative projects and their interest areas. The Brazilian IoT Forum has done some works in this direction and is now in a process to assemble an International Advisory Committee and could be an agent to disseminate in Brazil this collaboration EU-Brazil in IoT.

10.5 Do More with Less: Challenges for Africa. Low-Cost IoT for Sub-Saharan African Applications

ICT in the African context must be seen as a horizontal enabler in all areas of service delivery: eHealth, eGovernment, eAgriculture, eEnvironment, eEducation and eInfrastructures [10]. In several cases, ICT has enabled convergence of productive sectors, serving as platform for more holistic development. In fact, there are many examples of ICT developments in Africa that cut across traditional sectors: notable examples are the introduction of micro-health insurance and health-savings accounts through mobile devices; index-based crop insurance; crowd-sourcing to monitor and manage the delivery of public services. These innovative applications – for several reasons more disruptive in social terms than many counterparts in the EU – recognize and leverage commonalities between sectors, blur traditional lines, and open up a new field of opportunities.

Most of ICT success stories in Africa address very concrete issues of local populations. For instance, it is reported that 70% of the population of Senegal relies on cattle raising as their main source of revenues. When those animals are stolen, some families are left in such dramatic situation that cases of suicide are not unheard of [11]. DARAL [12] was a first attempt to fight against cattle rustling with the help of technology. For instance, it provides a web application for cattle identification and is currently implemented in 5 zones with 1500 farmers and 18000 cattle registered. DARAL emerged from an initiative of Coders4africa where 5 teams of 4 developers worked from collecting end-user requirements to the development of the final application. DARAL was one of those. For now, the current system is mostly a human-based cooperative alerting system based on SMS exchanges but automatisation can be foreseen by integrating active communicating components in the process, following the IoT trends.

Therefore, the opportunity of IoT applications in Africa is huge and it is not a question any more on whether IoT will come or not: many companies have already defined internal business activities to go along with this global move. However, when developed countries discuss about massive deployment of IoT, African countries are still far from being ready to enjoy the smallest benefit of IoT: lack of infrastructure, high cost of hardware, complexity in deployment, lack of technological eco-system and background, etc. [13].

In Sub-Saharan Africa about 64% of the population is living outside cities. The region will be predominantly rural for at least another generation. The pace of urbanisation here is slower compared to other continents, and the rural population is expected to grow until 2045. The majority of rural residents manage

on less than few Euros per day. Rural development is particularly imperative where half of the rural people are depending on the agriculture/micro and small farm business, other half faces rare formal employment and pervasive unemployment. For rural development, technologies have to support several key application sectors like health, water quality, agriculture, livestock farming, climate change, etc. Therefore, when deploying IoT in Sub-Saharan African countries, it is necessary to target the removal of three major barriers: (1) Lower-cost, longer-range communications; (2) Cost of hardware and services; and (3) Limit dependency to proprietary infrastructures, provide local interaction models. These are further detailed next.

10.5.1 Lower-Cost, Longer-Range IoT Communications

Vast distances and poor infrastructure isolate rural areas, leaving those who live there poorly integrated into modern ICT ecosystems. Deploying IoT in this context must use longer range wireless communication to decrease both the complexity and the cost of data collection. Using the telco mobile communication infrastructure, when coverage is available, is still very expensive (e.g., GSM/GPRS) and definitely not energy efficient for autonomous devices that must run on battery for months. Recent so-called Low-Power Wide Area Networks (LPWAN) such as those based on Sigfox$^{(\mathrm{TM})}$ or Semtech's LoRa$^{(\mathrm{TM})}$ technology definitely provide a better connectivity answer for IoT as several kilometres can be achieved without relay nodes to reach a central gateway or base station. When adding the financial cost constraint and the network availability, LoRa technology, which can be privately deployed in a given area without any service subscription, has a clear advantage over Sigfox which coverage is entirely operator-managed. Some LoRa community-based initiatives such as the one promoted by The Things Network [14] may provide interesting solutions and feedbacks for dense environments such as cities but under the agriculture/micro and small farm business model an even more ad-hoc and autonomous solution need to be investigated and deployed. On the software side, the software service platform will also need to offer highly innovative monitoring, recommendation, notification services based on the data coming from multiple rural application sectors, taking into account that, in most cases, the mobile phone is the unique technological terminal for end-users.

10.5.2 Cost of IoT Hardware and Services

The maturation of the IoT market is happening in many developed countries: innovative and integrated products are available for smarter home and various

monitoring applications. While the cost of such devices can appear reasonable within developed countries standards, they are definitely still too expensive for very low-income sub-Saharan ones. The cost argument, along with the statement that too integrated components are difficult to repair and/or replace definitely push for a Do-It-Yourself (DIY) and "off-the-shelves" design orientation. To be sustainable and able to reach previously mentioned rural environments, IoT initiatives in developing countries have rely on an innovative and local business models. We envision mostly medium-size companies building their own "integrated" version of IoT for micro-small scale services. In this context, it is important to have dedicated efforts to design a viable exploitation model which may lead to the creation of small-scale innovative service companies.

The availability of low-cost, open-source hardware platforms such as Arduino-like boards is clearly an opportunity for building low-cost IoT devices from mass-market components. For instance, boards like Arduino Pro Mini based on an ATmega328 microcontroller offers an excellent price/performance/consumption trade-off and can be used to provide a low-cost platform for generic sensing IoT with LoRa long-range transmission capability. In addition to the cost argument (cost can be less than 15 euro for a fully operational long-range sensing device) such mass-market component greatly benefits from the support of a world-wide and active community of developers. See in Figure 10.1 the experimental set-ups with Arduino Pro Mini.

With the gateway-centric mode of LPWAN technology, commercial gateways are usually able to listen on several channels and radio parameters

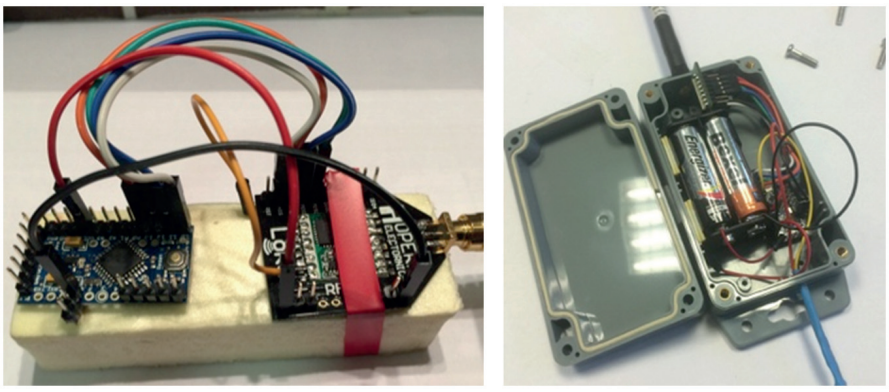


Figure 10.1 Generic platform with Pro Mini (left), packaged for battery-operated and outdoor deployment (right).

simultaneously. They use advanced concentrators radio chips that alone cost more than a hundred euro. Here, again, the approach can be different in the context of agriculture/micro and small farm business: simpler "single-connection" gateways can be built based on a simpler radio module, much like an end-device would be. Then, using Linux-based platforms such as the Raspberry PI that has high price/quality/reliability trade-off, the cost of such gateway can be less than 45 Euro. See in Figure 10.2 the prototypes of the low-cost gateway.

Therefore, rather than providing large-scale deployment support, IoT platforms in developing countries need to focus on easy integration of low-cost “off-the-shelves” components with simple, open programming libraries and templates for easy appropriation and customisation by third-parties. By taking an ad-hoc approach, complex mechanisms, such as advanced radio channel access to overcome the limitations of the low-cost gateway, can even be integrated as long as they remain transparent to the final developers.

10.5.3 Limit Dependency to Proprietary Infrastructures, Provide Local Interaction Models

Once data are collected on the gateway, they usually have to be pushed/uploaded to some Internet/cloud servers for storage and visualisation; and eventually for further processing tasks. It is important in the context of developing countries to be able to use a wide range of infrastructures and, if possible, at the lowest cost. Fortunately, along with the global IoT uptake, there is also a tremendous availability of sophisticated and public IoT clouds platforms and tools [15], offering an unprecedented level of diversity

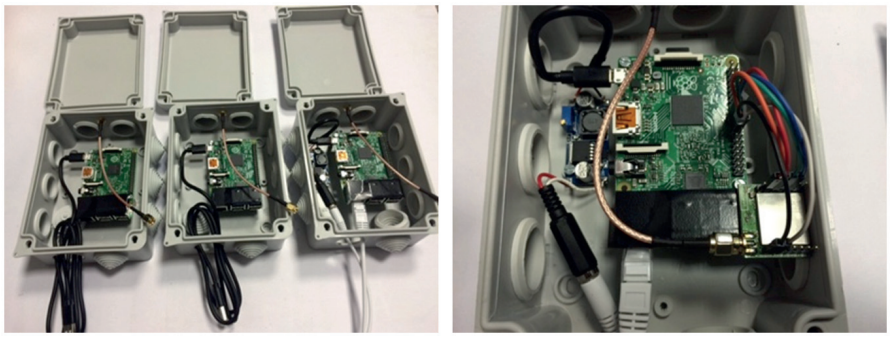


Figure 10.2 Several versions of the low-cost gateway (left), close-up view on the PoE version for easy integration into existing network infrastructures (right).

which contributes to limit dependency to proprietary infrastructures. Many of these platforms offer free accounts with limited features but that can already satisfy the needs of most agriculture/micro and small farm business models we are referring to when addressing IoT for Sub-Saharan African applications. What are the impacts on the design architecture/choices of the deployed IoT platforms? One simple design orientation is to highly decouple the low-level gateway functionalities from the high-level data post-processing features, privileging high-level languages for the latter stage (e.g., Python) so that customizing data management tasks can be done in a few minutes, using standard tools, simple REST API interface and available public clouds.

One additional important issue that needs to be taken into account in the context of sub-Saharan Africa is the lack or intermittent access to the Internet. Data should also be locally stored on the gateway which can be directly used as an end computer by just attaching a keyboard and a display. This solution perfectly suits low-income countries where many parts can be found in second markets. The gateway should also be able to interact with the end-users' smartphone through WiFi or Bluetooth to display captured data and notify users of important events without the need of Internet access as this situation can clearly happen in very remote areas.

10.5.4 The H2020 WAZIUP Project

Most of the challenges illustrated in here are planned to be addressed in the H2020-687607 WAZIUP project. The WAZIUP project, namely the Open Innovation Platform for IoT-Big Data in Sub-Saharan Africa is a collaborative research project using cutting edge technology applying IoT and Big Data to improve the working conditions in the rural ecosystem of Sub-Saharan Africa. First, WAZIUP operates by involving farmers and breeders in order to define the platform specifications in focused validation cases. Second, while tackling challenges which are specific to the rural ecosystem, it also engages the flourishing ICT ecosystem in those countries by fostering new tools and good practices, entrepreneurship and start-ups. Aimed at boosting the ICT sector, WAZIUP proposes solutions for long term sustainability. See Figure 10.3 for the project's general technical approach built around the low-cost gateway and (Future) Internet technologies.

The consortium of WAZIUP involves 7 partners from 4 African countries and partners from 5 EU countries combining business developers, technology experts and local Africa companies operating in agriculture and ICT. Central to WAZIUP's concerns is the inclusion of developer communities

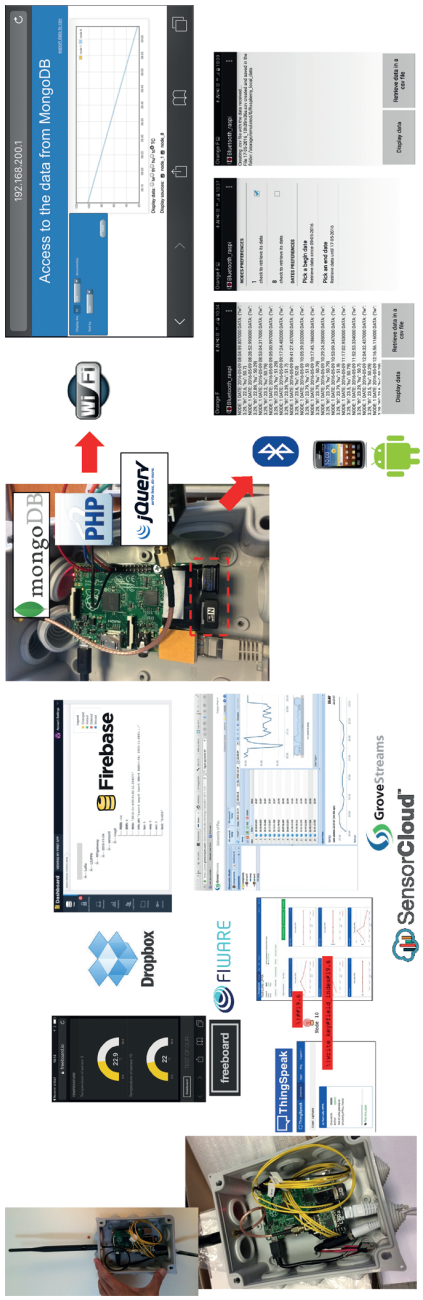


Figure 10.3 The gateway can push data to Internet cloud resources (left) or provide local connectivity with WiFi-based web server or Bluetooth-based smartphone app (right).

(e.g., Coders4Africa) and innovation hubs (e.g., CTIC, iSpace) who have experience to train, adapt, validate and disseminate results. Quick appropriation and easy customisation by third-parties is ensured by tightly involving end-users' communities in the loop, namely rural African communities of selected pilots, and by frequent training and hackathon sessions organised in the sub-Saharan African region.

10.6 EU-Japan Collaboration for a World Leading Research in IoT

The world is facing a number of critical challenges such as global warming, economic crisis, security threats, inequality, natural disasters and ageing society. Urban areas are particularly affected, given that the world population is increasingly concentrated in those areas. Currently more than 75% of the population in Europe and more than 90% of the population in Japan live in urban areas[2]. Further, those areas are expected to absorb the majority of the population growth expected over the next four decades, while at the same time drawing in some of the rural population, thus world population in urban areas is expected to be 66% by 2050.

While occupying 2% of the earth's surface, cities use 75% of the world resources. Those resources in civil infrastructure such as water, energy, public transportation, parking spaces, buildings, roads, bridges, etc., as well as natural resources and economic resources need to be shared by this increasing population. This has direct consequences for urban citizens and for the city itself.

Ranging from social to economic aspects, IoT provides countless possibilities to enhance the quality of life and security of people, while at the same time reducing inequalities and providing new revenue opportunities for enterprising businesses, from large groups and public administrations to SMEs, start-ups and web entrepreneurs. Considering this potential, European Commission and two Japanese funding agencies, namely NICT (National Institute of Information and Communication Technologies) and MIC (Ministry of Internal Affairs and Communication) have launched the first joint call for projects on IoT in 2012 in the context of the FP7 Programme. It is followed by two other calls in 2014 and in 2015 within the H2020 programme. The following sections give an overall summary of three projects from those calls, namely ClouT, FESTIVAL and iKaaS.

[2]Uexküll, Jakob. Shaping our future: Creating the World Future Council. Foxhole, Devon.

10.6.1 ClouT: Cloud of Things for Empowering Citizen ClouT in Smart Cities

ClouT is a collaborative Europe – Japan project that has developed a smart city platform which benefits from the latest advances in IoT and Cloud Computing domains. ClouT, which stands for Cloud of Things, provides a virtualisation framework to provide a uniform way of representing various city data sources such as IoT devices, legacy devices, social networks, mobile applications and World Wide Web. Based on a reference Cloud + IoT architecture and smart city domain model, ClouT platform has been developed allowing secure access to real-time data as well as historical data with easy-to use tools targeting municipalities, citizens, service developers and application integrators to create, deploy and manage smart city applications. The ClouT project has been jointly coordinated by CEA and NTT East, and it is further bringing together prestigious private companies such as ST Microelectronics, Engineering IngegneriaInformaticaSpA, Panasonic, NTT R&D as well as academic institutes such as University of Cantabria, Keio University and National Institute of Informatics, which have strongly committed to bring this first EU-Japan initiative on IoT and cloud to a success.

The project has developed several smart city applications using the developed platform and tools and deployed them in 4 pilot cities of the project: Santander, Genova, Fujisawa and Mitaka. Applications e.g., environmental monitoring, context aware coupons, city dashboards, citizen safety applications, elderly care social networks, have been validated via field trials involving real end-users. See in Table 10.2 a few examples.

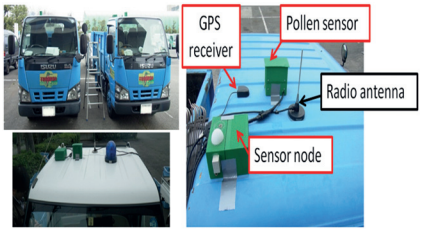
The project has provided its outcomes in terms of deliverables, reusable software, fried trial descriptions, newsletters, videos, etc. All the information from the project is available at the project website: http://clout-project.eu.

10.6.2 FESTIVAL Federated Interoperable Smart ICT Services Development and Testing Platform

There have been long years of research work in Europe and Japan on federation of test beds and more recently on IoT test beds. FESTIVAL aims at leveraging those test beds by a federation approach where experimenters can seamlessly perform their experiments taking benefit of various software and hardware enablers provided both in Europe and in Japan. Facilitating the access to those test-beds to a large community of experimenters is a key

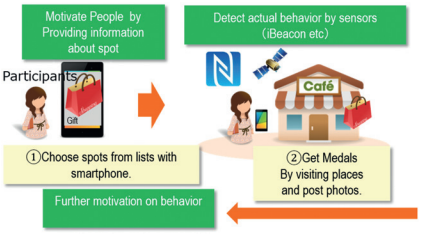
Table 10.2 Field trials performed in the ClouT project

Fujisawa: Sensorised garbage cars
This application aims to collect atmospheric information by mobile sensor system installed on garbage collection cars in Fujisawa City. Fujisawa municipality can monitor the location and operational status of each garbage collection car through the Control Center application.



Santander: Smiley Coupon
After the successful trial of the Smiley Coupon in Fujisawa, ClouT replicates it in the Santander city. The application provides customized coupons for the citizens and visitors according to their degree of smile. Commercial firms (restaurants, bars, shops, etc.) participate with a wide range of special offers.

Mitaka: Sanpoki Stamp rally
The application contributes to the prevention of isolation of young and elderly people, by encouraging them to go out and walk through suggested routes that match their interests. It allows to post attractive photos about Mitaka and share information among the citizens.



Genova: "I don't risk" application
This application informs citizens about good practices and general information about environmental risks and emergency situations by using environmental data from weather sensors, hydrometers, webcams, etc. It has become one of the top mobile applications of the Genova City with more than 4000 downloads and average rating of about 4/5.

asset to the development of a large and active community of application developers, necessary to address many challenges faced by European and Japanese societies.

FESTIVAL is a H2020 European-Japanese collaborative project that aims to federate heterogeneous IoT test beds, making them interoperable and building an "Experimentation as a Service" (EaaS) model. FESTIVAL test beds connect cyber world to the physical world, from large scale deployments at a city scale, to small platforms in lab environments and dedicated physical spaces simulating real-life settings. IoT is related to the physical world, thus real-life conditions are essential to validate the IoT applications. The involvement of end-users is also of tremendous importance to validate the quality of user experience. Going beyond the traditional nature of experimental facilities, related to computational and networking large scale infrastructures, FESTIVAL test beds have heterogeneous nature and in order to be federated they have been clustered in four categories: "Open Data" (i.e., open datasets), "IoT" (i.e., sensors and actuators), "IT" (i.e., computational resources) and "Living Labs" (i.e., people). Figure 10.4 illustrates the FESTIVAL's federation architecture.

Considering that every test bed category provides specific resources, the main challenge for FESTIVAL is to develop a platform that can allow experimenters to access very different assets in a homogeneous and transparent way, supporting them in the phases of the experiments. The architecture aims at providing the blueprint to be used to build the federated FESTIVAL test bed. It specifies a common resource data model and a set of uniform APIs that will be used by the experimenters to build and deploy rapidly and efficiently their experiments. Thanks to the FESTIVAL's uniformed approach, the experiments will be portable across several test beds and replicable with minimum effort of adaptation.

Furthermore, FESTIVAL tools include the possibility to access FIWARE Generic Enablers allowing to deploy predefined components to address specific needs in the experimentation (e.g., data analysis, big data management etc.). The FESTIVAL platform will be tested on various application domains across Japan and Europe such as smart city, smart energy, smart building and smart shopping.

FESTIVAL project is jointly coordinated by CEA and Osaka University and brings together 12 other institutions from Europe and Japan (www.festival-project.eu).

Figure 10.4 The overall view of the FESTIVAL architecture.

10.6.3 iKaaS – Intelligent Knowledge as a Service

Smart Cities are happening, and while the increasing sensor deployment in urban public and private spaces provides invaluable data about resources and services demand, the sheer amount of data that is available in data bases and data stores or that can be collected through IoT influences urban life is staggering. Understanding this data, deriving knowledge from it to improve service provision as well as usage of resources is of the utmost importance. And moreover, the lessons that can be learned in one city and the knowledge derived can be applied to other cities, in other parts of the world.

However, independent of the location, this relies on the participation of the citizens and they will only be willing to provide personal information if their own data is secure and is being kept private, both before and after knowledge has been derived from it. The iKaaS (intelligent Knowledge-as-a-Service) project brings the essential building blocks for this together; it defines a platform that integrates the three concepts of cloud computing – big data analytics – IoT. iKaaS defines and builds a secure data storage and privacy-preserving analytics engine over heterogeneous multi-cloud environments spanning across national borders.

As user participation, and personal data sensed around and about the user, are at the core of building and operating such a knowledgebase, the iKaaS platform builds privacy, security and trust into storage, access and analysis capabilities already "by-design" rather than as an add-on. It implements technical and organisational measures and procedures in such a way that the processing will ensure the protection of the rights of the user (citizen). And this also includes the definition and implementation of mechanisms that help ensuring that privacy is preserved even when personal data have been processed. The iKaaS approach applies privacy-preserving data release methods that guarantee some anonymisation, the iKaaS approach goes beyond this and builds empirical models to quantify the risks associated with those methods, and relates those risks using the notion of "costs of attacks".

iKaaS brings together cloud computing – big data analytics – IoT to derive knowledge, the project intends to apply these means to platform instances in different cities, across different countries and across the boundaries of administrations and data regulation. These form clear implementation challenges, especially over multiple cloud environments in different administrative domains and a myriad of connected personal computing devices. The iKaaS platform will cater for applications built atop a knowledgebase to provide end-user as well as business-to-business or business-to-government services.

iKaaS tackles three use cases around the wider topic of personal and public health, as this implies that citizens' personal health related data is being used to derive new knowledge, the requirements to data and privacy protection are immense. However, at the same time, the knowledge that can be gained from personal data together with environmental observations (air quality, weather conditions, etc.) will help the wider community to improve conditions or prevent individual exposure to potentially harmful conditions/situations. Based on the existing regulations for the treatment of personal information among member countries, iKaaS investigates solutions for flexible and privacy enhanced treatment of cross border data which is transitioned via iKaaS platform. This includes demarcation points of responsibility of data holders, data transfers or data receiver's and remedies if problems occur. Via a multi stake-holder scheme, iKaaS defines best practices for privacy and data protection treatment of cross border data.

Multi-Cloud Architecture: iKaaS designs an open, adaptable and secure Everything-as-a-Service framework for incorporating optimal service deployment which includes migration and parallelisation as well as distributed management of smart objects, associated storage, processing and communication of data, targeted to enable re-usability of applications across different domains and platforms as well as Knowledge-as-a-Service.

Knowledge as a Service: iKaaS investigates and develops mechanisms that facilitate re-use of smart objects as a distributed data processing capability, across different administrative and business domains. iKaaS also develops mechanisms to analyse data and derive Knowledge-as-a-Service (KaaS).

Security, Privacy, and Trust: iKaaS designs an open, adaptable and secure Everything-as-a-Service framework for incorporating optimal service deployment which includes migration and parallelisation as well as distributed management of smart objects, associated storage, processing and communication of data, targeted to enable re-usability of applications across different domains and platforms as well as Knowledge as a Service.

To reach its aims and implement the iKaaS platform, the project team requires expertise and partners from various domains. The consortium is coordinated by the University of Surrey and KDDI R&D Labs and consists, altogether, of six partners from Japan and nine partners from European Countries, their skillset and expertise are complementarity in the specified iKaaS problem domains. iKaaS demonstrates their use cases in Sendai, Japan (i.e., the town of Tago-Nishi) as well as in Madrid, Spain. (www.ikaas.com).

10.7 EU-US IoT Cooperation

Today there are two main initiatives for the IoT created at global level and organised as alliances/consortia: the Industrial Internet Consortium (IIC) and the Alliance for the IoT Innovation (AIOTI). Both these IoT alliances/consortia create unique value with their organizational entities, by engagement, by stimulating and matchmaking relationships between companies creating new applications, increasing revenue, industry reach and shared knowledge and experience, and support for a long-term value-creating, collaborative relationship, leading to success for the partners involved as well as for the eco-system as a whole.

IIC, founded by AT&T, Cisco, GE, IBM, and Intel, brings together the organizations and technologies necessary to accelerate the growth of the Industrial Internet by identifying, assembling and promoting best practices. Membership includes small and large technology innovators, vertical market leaders, researchers, universities and government organizations. The goals of IIC are to:

- Drive innovation through the creation of new industry use cases and test beds for real-world applications
- Define and develop the reference architecture and frameworks necessary for interoperability
- Influence the global development of standards process for internet and industrial systems
- Facilitate open forums to share and exchange real-world ideas, practices, lessons, insights
- Build confidence around new and innovative approaches to security

The Industrial Internet Consortium Working Groups coordinate and establish the priorities and enabling technologies of the Industrial Internet in order to accelerate market adoption and drive down the barriers to entry. There are currently 19 Working Groups and teams, broken into 7 broad areas:

- Business Strategy and Solution Lifecycle
- Legal
- Marketing
- Membership
- Security
- Technology
- Test beds

These groups are comprised of Industrial Internet Consortium member company representatives. Member companies can assign an unlimited number

of individuals to the Working Groups, which follows the one vote, one company rule.

The Alliance for IoT Innovation, AIOTI, was initiated following the European and global IoT technology and market developments and aims to create and master sustainable innovative European IoT ecosystems in the global context to address the challenges of IoT technology and *applications* deployment including standardisation, interoperability and policy issues, in order to accelerate sustainable economic development and growth in the new emerging European and global digital markets.

The AIOTI mission statement covers the following points:

- Develop IoT ecosystems across vertical silos including start-ups and SMEs
- Identify, communicate and champion EU spearheads to speed up the take up of IoT
- Mapping and bridging global, EU and Members States' IoT innovation activities
- Gather evidence on market obstacles for IoT deployment in a Digital Single Market context
- Contribute to Large Scale Pilots to foster experimentation, replication and deployment and to support convergence and interoperability of IoT standards.

AIOTI strategy translates the vision and mission into goals and actions that provide unique value by the Alliance to its stakeholders. Key strategic elements include:

- A unique *application*-driven IoT initiative bringing together the demand and supply side stakeholders beyond technology and complemented by horizontal research, innovation, standardisation and policy cross-cutting working structures
- A goal oriented Alliance aiming to be agile, flexible, lean and project driven applying clear stimulus measures among its members
- The European reference platform addressing IoT in the global context
- AIOTI aims to be strongly and firmly positioned in the global IoT landscape.

AIOTI Working Groups coordinate and establish the research, innovation priorities and enabling technologies in the area of IoT (consumer/business/industrial) in order to accelerate sustainable economic development and growth based on IoT technology and applications deployment and

adoption. There are currently 13 Working Groups, broken into 4 horizontal groups and 9 vertical groups:

- IoT European Research Cluster (IERC)
- Innovation Ecosystems
- IoT Standardisation
- Policy issues
- Smart living environment for ageing well
- Smart farming and food security
- Wearables
- Smart cities
- Smart mobility
- Smart environment (smart water management)
- Smart manufacturing
- Smart energy
- Smart Buildings and Architecture

In this context, the cooperation between EU and US is very important. The mechanism of cooperation are installed on two levels: governmental level and project level, preferably on a larger scale. Policies should be investigated on both sides and provide input for the yearly EU-US ICT Dialogue. In addition, a wider scope of beneficiaries shall be considered including IoT Large Scale Pilots and IoT Test beds.

In this context there are a number of European projects and initiatives [18–21] that are addressing the EU-US cooperation and collaboration. PICASSO project created the framework to bring together experts in the field of 5G, Big Data, IoT, CPS to focus on identifying the key issues in each specific field and on policy issues that touch upon all of these domains. The ICT Policy Expert group will focus on Privacy and Data Protection, in recognition that policy issues relating to this touch all ICT developments across the Atlantic. UNIFY-IoT project as part of the European Platforms Initiative (IoT-EPI) is leading the task force on international cooperation in order to define the strategy and activities for international collaboration with global players working at initiatives and projects in the IoT domain. The task force is coordinating the activities to be planned and executed for liaising, interacting and then follow-up with the relevant projects' stakeholders and IoT ecosystems. The group is coordinating the interaction with international initiatives by supporting the IoT ecosystems to meet global challenges and to be adopted worldwide in order to be successful. The intent is to get a clear overview of the priority policy issues in ICT collaboration, and insights in how

these issues can be addressed from a bilateral multi stakeholder perspective in a global context.

In the context of establishing liaisons with key stakeholders outside the EU the cooperation and meeting with the US stakeholders offer the possibility to present a panorama of the ICT and IoT landscape and programmes currently underway in Europe and the US as well as programmes in the rest of the world. Existing funding opportunities for collaboration are highlighted. The views of the EU-US Expert Groups on 5G Networks, Big Data, IoT, CPS are presented identifying gaps and opportunities, a map of challenges, open problems, and the needs for supporting policy measures and strategic EU-US initiatives (both policy and research related). Key actors, i.e., NIST, NSF, IMS, are involved together with the European projects and representatives from EC to highlight existing opportunities for collaboration.

10.7.1 Policy Level Cooperation

The IoT policy issues is addressed in Europe by 2014 European Commission's Article 29 Working Party on Data Protection [16] setting forth its interpretation of how EU data protection laws apply to IoT and in US by the 2015 Report on the IoT, from FTC [17] setting forth privacy and security best practices for IoT.

The WP 29 Report looks at IoT via EU data protection principles, highlighting these concerns for IoT manufacturers, developers and data collectors:

- Lack of control – Interconnectivity means a greater potential for automatic flow of data among devices (and vendors) without notice to users.
- Additional purposes – Interconnectivity also may lead to use of gathered data by third parties for other than the original intent.
- Consent – Because users lack full disclosure of data flow, their consent to initial data collection may be inadequate.
- Profiling – Fine-grained user monitoring and profiling could result from the type of information collectable from connected devices.
- Limiting anonymity – More use of connected devices suggests lower likelihood for maintaining anonymity.
- Security – Large volumes of data transferring over connected devices may lead to considerable security risks.

The WP 29 Report recommendations are the security and privacy concerns and recommends that IoT manufacturers, developers and data collectors:

- Conduct a privacy impact assessment before releasing a device.
- Delete raw data from the device as soon as it has been extracted.
- Follow privacy-by-design and privacy-by-default principles.
- In a user-friendly way, provide a privacy notice, and obtain consent or offer the right to refuse.
- Design devices to inform both users and people interacting with them (e.g., people being recorded by a camera in a wearable technology) of the data processing by the entity providing the device.
- Inform users of data that has been collected and enable them to access, review and edit that data before it is transferred.
- Give users granular choices on the type of processing as well as time and frequency of data gathering.

These principles apply whenever a connected device is used in the EU, even if the device did not originate in the EU. While the WP 29 Report is not binding law, it is persuasive to EU regulators, when deciding how to apply data protection law to the IoT. Once the new EU Data Protection Regulation takes effect, fines for violations of EU data protection law could be up to 5 percent of global turnover for a company. Thus, flouting the WP 29 Report principles, which are considered persuasive authority on the interpretation of EU data protection law, could result in very significant fines.

The FTC Report focuses on security (considered as harm to consumers from unauthorized access and misuse of personal information, attacks on other systems and safety risks) and privacy that are considered as following:

- Remote access to smart meters could enable thieves to determine when a house is empty, leaving it susceptible to robbery.
- A connected device could be used to gain control of a consumer's internal network and in turn, attack a third-party system.
- Remote access to stored financial data could enable fraud.
- Privacy-related concerns over the collection of sensitive information (geolocation, financial and health data), the sheer volume of data collected and the potential for misuse.

The FTC Report recommends best practices to IoT manufacturers, developers and data collectors, focusing on:

- Data security – The FTC recommends that device manufacturers adopt a privacy-by-design approach, including a privacy and security risk assessment made prior to release, use of "smart defaults" (e.g., forcing changes to default device passwords) and security and access control measures, and monitoring throughout the device's life cycle.

- Data minimization – While endorsing the necessity to limit collection and retention of users' data, the FTC calls for a "flexible approach," urging companies to "develop policies and practices that impose reasonable limits on the collection and retention of consumer data."
- Notice and choice – The FTC recognizes notice and choice play a "pivotal role," but – in contrast to the WP 29 view – acknowledges that notice and choice are not always necessary. Instead, the FTC calls for notice and choice where sensitive data is collected or where there is unexpected collection or sharing.

The EU-US expert groups, created by a number of European projects and initiatives [18–21], have identified different candidate policy issues as input for further bilateral discussions:

- Addressing global societal challenges, respecting Human Rights, supporting Sustainable Development Goals (SDGs),
- Trust and confidence, privacy and data protection encryption, censorship, surveillance, security, anonymity,
- Innovation ecosystem, start-ups, incubators, accompanying measures,
- (Open) standards, certification, transparency and choice.

These possible policy subjects are provided as a starting point, and are the baseline for the policy issues to be discussed in dialogue.

Trust and usability are very important success factors for IoT, and IoT security and privacy need to be addressed across all the IoT architectural layers and across the domain applications. Performance, complexity, costs are all factors which influence adoption in addition to those that engender trust. While there have been important progress made and actions planned to address usability there are nevertheless remaining a number of potential gaps in the overall "trust" framework that can be evaluated.

In this context the EU-US cooperation is seen at company level in the AIOTI Working Group 04 (WG04), where EU and US companies are addressing these issues. The AIOTI WG04, is to identify existing or potential market barriers that prevent the take-up of the IoT in the context of the Digital Single Market, as well as from an Internal Market perspective, with a particular focus on trust, security, liability, privacy and net neutrality.

10.7.2 Technical Cooperation

The IIC and AIOTI members could, in the future, maintain a technical exchange to identify mappings, research priorities, differences and enhancements, support the alignment of IoT architecture efforts for the benefit of

interoperability of systems from the different domains, map of IoT reference architectures/platforms showing the direct relationships between elements of the models and a clear roadmap to ensure future interoperability.

AIOTI and IIC, as the global leading initiative frameworks for the IoT, create unique value with their organizational entities, by engagement, by stimulating and matchmaking relationships between companies. This approach is creating new applications, increasing revenue, industry reach and shared knowledge and experience, and support for a long-term value-creating, collaborative relationship, leading to success for the partners involved as well as for the IoT ecosystem as a whole.

Future EU-US cooperation can be seen in activities addressed in IoT Large Scale Pilots and IoT Test beds by discussing the main challenges related to IoT key technologies such as the IoT architectures, scalability and sustainability of large scale IoT deployments, IoT platforms, semantic and technical interoperability, thus making full use of the whole digital value chain and IoT applications and use cases deployed in both regions. In this context, the development of a common communication strategy that fully exploits the possible synergies between EU-US initiatives is important for the future collaboration.

10.7.3 Standards Cooperation

IoT is a global concept, and is based on the idea that anything can be connected at any time from any place to any network, by preserving the security, privacy and safety. The concept of connecting any object to the Internet could be one of the biggest standardization challenges and the success of the IoT is dependent on the use/development of interoperable global standards.

Global standards are needed to achieve economy of scale and interworking. Interconnected edge devices are evolving to intelligent devices, which need networking capabilities for a large number of applications and these technologies are "edge" drivers towards the IoT, while the network identifiable devices will have an impact on telecommunications networks.

Encourage EU-US mutual support and jointly push the development of international standards for the IoT business layer, in the activities of international standardisation organisations such as OneM2M, ETSI, CEN/ISO, IEEE, ITEF and ITU-T. Cooperation foreseen with NIST in the area of Smart Cities and application of IoT technologies in the cities. The cooperation could look at the development of performance standards, measurement tools, and guidance that enable city stakeholders and technology providers to design and implement effective solutions. The cooperation can address the coordination

of the development of standards and guidelines for smart city interoperability and exchange experiences on smart city test beds or IoT large scale pilots.

The EU-US cooperation is coordinated at the company levels in the AIOTI Working Group 03 (WG03) that address IoT standardisation. The AIOTI WG03 has provided common views of the IoT stakeholders on the IoT standardisation that are covered in 3 documents "IoT Landscape and IoT LSP Standard Framework Concepts", "IoT High Level Architecture (HLA)", "IoT Semantic interoperability". The documents offer an extensive overview of the global IoT standardisation landscape allowing the stakeholders involved in IoTprojects to be flexible and innovative in their use of the information, while assuring that they provide standard-based and interoperable IoT implementations. The cooperation EU-US will extend on the alignment of requirements for standardization bodies to review and influence global standards.

10.7.4 Market Cooperation

Strengthen EU-US information exchange and cooperation between the technology innovation strategic alliance of the IoT industry in US like tie IIC and AIOTI in the EU to establish an effective market supply and demand platform for European and American companies, which can expand bilateral industrial research and innovation activities. Many European and American companies are members of both AIOTI and IIC. The EU-US cooperation at the level of alliances can support the exchange use cases and architectural requirements focused on industrial/business/consumer markets in order to meet the requirements in its specification for the different IoT solution implementations. The EU-US cooperation will focus as well on common support to accelerate the delivery of a cross sectorial IoT architectural framework (consumer/industrial/business).

10.8 Conclusions: Cooperation to Balance Globalisation and Differentiation of IoT Solutions Worldwide

Europe has devoted strong attention to international cooperation with the EU's partner countries and regions, developed on the basis of common interest and mutual benefit and create win-win situations. Many of these activities have been implemented to the appropriate scale and scope in the context of the Horizon 2020 framework programme. The IoT, in the large scope of ICT, has been further developing as a key area of international cooperation aiming especially at global IoT agreements but also on developing differentiation of IoT solutions for addressing specific needs and challenges for both EU and partner countries and regions.

The South Korean government has established the 'Mid- and Long-term R&D plan for IoT' that links existing R&D projects classified into units with the entire ecosystem. South Korea government strongly supports global collaboration with major countries including the EU. The WISE-IoT project has started, as part of jointly funded R&D programs, gathering lead contributors from Europe and South Korea to on-going major global IoT standardisation activities with the objective to strengthen and expand emerging IoT standards and reference implementation using feedback from user-centric and context-aware pilots. Further cooperation activities are expected in IoT standardisation and reference architectures but also on promoting the use of EU methodologies and models in the implementation of large-scale pilots in South Korea, especially in smart cities and healthcare application areas.

In China, the IoT has become an important carrier for strategic information industries and integrated innovation. The EU-China IoT Advisory Group, established in February 2011, is active on pushing global IoT standards while developing competitive IoT solutions. An EU-China joint white paper on IoT, published in January 2016, has laid down the areas of cooperation. Main ones include: (i) Policy level cooperation to encourage and actively promote research and innovation cooperation, and publication of results; (ii) Technical cooperation carrying out twinning activities between EU IoT Large Scale Pilots and China Megaprojects and enterprise-level cooperation in strategic sectors on key product development; (iii) Standards cooperation for EU-China mutual support and jointly push the development of international standards; and (iv) Market cooperation to strengthen EU-China information exchange and cooperation between the technology innovation strategic alliance of the IoT industry in China and Alliance for IoT Innovation in the EU.

EU-Brazil research cooperation in the area of ICT is regarded as having a crucial strategic value and high societal impact. It has been developing since the launch of the 1stcoordinated call, back in 2011, to include a specific focus on IoT Pilots, in the context of the 4th coordinated joint call. Furthermore, Europe is supporting Brazil in the context of the sectorial dialogues for cybernetic policy on the development of the M2M/IoT ecosystem by performing an EU-Brazil mapping and comparative study. And, the EU-Brazil FUTEBOL project is working to create of a federated control framework to integrate test beds from Europe and Brazil to support network researchers from academia/industry looking out for the IoT and M2M future needs. The strategic cooperation of EU with Brazil is expected to be further supported and animated by the IoT Focus Area CSA project (to be awarded) on realisation of joint cooperation activities for active knowledge sharing

and promotion of EU and Brazilian IoT ecosystems/technologies and the alignment of EU LSP and IoT pilots to be launched as part of the EU-Brazil research cooperation.

In respect to Africa, the opportunity for IoT applications is huge but African countries are still far from being ready to enjoy the smallest benefit of IoT due to the lack of infrastructure, high cost of hardware, complexity in deployment, lack of technological eco-system and background, etc. As such, and when deploying IoT in African countries, it is necessary to address three major barriers: (1) Lower-cost, longer-range communications; (2) Cost of hardware and services; and (3) Limit dependency to proprietary infrastructures, provide local interaction models. Most of these challenges are being practically addressed by the H2020-687607 WAZIUP project collaborative research project by using cutting edge technology applying IoT and Big Data to improve the working and living conditions in the rural ecosystem of Sub-Saharan Africa. International collaboration of EU with African countries, and particularly with South Africa, will pursue towards IoT approaches and solutions that especially address the development goals.

Europe and Japan are two leading economies which have the necessary potential to provide world leading technologies for smarter citizen life. The report "Digital Economy in Japan and the EU"[3] identifies common challenges between the European and the Japanese economies, including the "scaling up of smart city projects". To respond to those challenges and following the success of the preceding joint calls, European Commission and Japanese agencies have decided to continue collaboration in the context of the H2020 and launched new joint calls on, not only IoT and smart cities but also on related topics such as 5G, experimentation test beds, ICT-assisted well-ageing, cyber-security, etc. The first conclusions from the achieved projects confirm that Europe and Japan can provide a strong and reliable partnership to face together emerging social, economic and environmental challenges.

The EU-US cooperation will increase in the future in the area of IoT on several levels, governmental, alliances, companies and projects levels.

European Commission gives a strategic dimension to IoT for the Digital Single Market (DSM), not only in terms of regulatory challenges but also with regards to overcome interoperability issues and fragmented standards, probably one of the most dominant obstacles at the moment with the key objective to develop, implement and deploya collaborative, responsible and

[3] EU-Japan Centre for Industrial Collaboration, March 2015: http://www.eu-japan.eu/digital-economy-japan-and-eu-assessment-common-challenges-and-collaboration-potential

fully functional IoT. This is inline with the 3 pillars identified in the IoT Staff Working Document in order to advance IoT in Europe:

- A single market for the IoT: IoT devices and services (thus including data) must be able to connect seamlessly and on a plug-and-play basis anywhere in the European Union (EU), and scale up without hindering from national borders;
- A context of thriving IoT Ecosystems: new products and services in selected lead markets such as Industrial IoT, and the existence of open platforms across vertical silos, helping developers' communities to innovate and not causing lock-in situations for users;
- A human-centred IoT: European values must find their application for the IoT to empower citizens rather than machines and corporations, driven by high privacy and security standards and notably through a "Trusted IoT" label.

On the other side of the Atlantic, US Congress has introduced the Developing Innovation and Growing the IoT (DIGIT) Act to facilitate planning and coordination among government and private entities to support expanded use of the IoT.

The initiative considers that advances in technology could mean using the IoT to create life-improving developments for everything from health care to transportation to energy management to smart cities. The strategy aims to incentivise the development of the IoT, prioritise accelerating IoT's development and deployment and ensure it responsibly protects against misuse.

The DIGIT Act forms a working group consisting of businesses, non-governmental stakeholders, and federal agencies that would issue guidance on potential regulatory barriers, current and future spectrum needs, and possible security concerns. The resolution underscores the US's commitment to nurturing innovation, but also in protecting consumers and finding solutions to societal challenges through technology driven solutions like IoT.

The strong focus in both regions on implementing a strategy on IoT offers many opportunities for collaboration and cooperation in the years to come.

Additional international cooperation partnerships are expected with further partner countries or regions. In particular, cooperation with India is highly anticipated. India has created its vision "to develop connected and smart IoT based system for our country's economy, society, environment and global needs" and is rolling out its IoT action plan. The Indian IoT policy comprises of five vertical pillars (Demonstration Centres, Capacity Building and Incubation, R&D and Innovation, Incentives and Engagements, Human

Resource Development) and 2 horizontal supports (Standards and Governance structure). International cooperation is anticipated in several areas of the IoT policy programme. For instance, in human Resources Development, it is called for bilateral cooperation programs between Indian premier institutes and institutes of other countries. Europeis expected to approach authorities and academic/research institutes in India to explore synergies and collaborations for global solutions but also local exploitation.

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