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Deliverable D1.1

Requirements Capture Framework

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Task(s):	**T1.1 – Elicitation of user requirements and barriers related to IoT interoperability**
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List of Definitions & Abbreviations

Abbreviation	Definition
AIOTI	Alliance for Internet of Things Innovation
AMI	Advanced Metering Infrastructure
API	Application Programming Interface
CIP	Common Industrial Protocol
COAP	Constrained Application Protocol
DDoS	Distributed Denial of Service
DER	Distributed Energy Resources
DNA	Deoxyribonucleic acid
DoA	Description of Action
DSM	Digital Single Market
EC	European Commission
EU	European Union
FTC	Federal Trade Commission
GSN	Global Sensor Network
HTTP	HyperText Transfer Protocol
ICT	Information and Communications Technology
IdP	Entities Impacted by the Project
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IoT	Internet of Things
IIoT	Industrial Internet of Things
ImP	Entities Impacting the project
IP	Internet Protocol
ISO	International Organization for Standardization
ITIL	Information Technology Information Library
M2M	Machine-to-Machine
OASIS	Organization for the Advancement of Structured Information Standards
ODVA	Open DeviceNet Vendors Association

OGC	Open Geospatial Consortium
OM	Opinion Makers
ROI	Return of Investment
SoA	Service Oriented Architecture
SoC	System on a chip
SotA	State of the Art
SUMO	Suggested Upper Merged Ontology
UCD	User-centred design
VC	Venture Capital Company
WAN	Wide Area Network
WP	Work Package
WP1	Requirements capture Framework
WP2	Standardization Analysis and VICINITY platform conformity
WP3	VICINITY Server Implementation
WP4	VICINITY Client Infrastructures Implementation
WP5	Value-Added Services Implementation
WP6	VICINITY Framework Integration & Lab Testing
WP7	On-site Deployment and Pilot Installations
WP8	Pilot Demonstration and Overall Evaluation
WSN	Wireless Sensor Network
XML	Extensible Mark-up Language

1. Executive Summary

The present document is a deliverable of the VICINITY[1] project, funded by the European Commission (EC) Directorate-General for Research and Innovation (DG RTD), under its Horizon 2020 Research and Innovation Programme (H2020).

It introduces the current state of the art for the IoT and the VICINITY vision of easy data interchange and interoperability between IoT ecosystems. Therefore, the deliverable defines the methodology to be followed in the requirement elicitation within the project: The first part of this report introduces the current state of the art for the IoT and the VICINITY vision of easy data interchange and interoperability between IoT ecosystems. Implementation of the vision will face a number of issues, which are described as a way to identify topics to be considered in the requirements capture.

The second part details the proposed methodology, based partially in the double diamond model and adjusted specifically to serve the purposes of the project, identifies several methods for interacting with stakeholders, details a timeline for the tracking and requirement management process and defines a basic structure to list requirements.

Finally, as an important part of the techniques that will be used in the process, the document then goes on to explain the nature of the requirements capture questionnaire, which is intended to be filled in by members of the VICINITY team.

A number of risks are identified which need to be considered when carrying out the requirements capture exercise.

2. Introduction

The present document is a deliverable of the VICINITY [1] project, funded by the European Commission (EC) Directorate-General for Research and Innovation (DG RTD), under its Horizon 2020 Research and Innovation Programme (H2020).

This deliverable has the scope of describe the State of the Art (SotA) for IoT interoperability as well as its challenges and concerns.

[ISO/IEC1] has currently the following definition: "*IoT is an enabling technology that consists of many supporting technologies, for example, different type of communication networking technology, information technology, sensing and control technologies, software technology, device/hardware technology. In designing and developing IoT systems, three key technologies should be considered: (1) system technology; (2) communications technology; and (3) information technology. In a different perspective, IoT systems are composed of physical objects and virtual objects where both objects together mean "things" in "Internet of Things." The physical and virtual objects together collect, process, extract, and do electronic data interchange. They also can decide, and/or act/react to environments autonomously or upon user's request. The data and information generated by IoT systems are likely sensitive in nature; yet, data and information exchange is an essential and imperative process of IoT systems, which enable to provide various applications and services. Therefore, data/information security and user privacy is the other major technology area of importance for IoT systems. Regulations and legislative acts about security and privacy are types of laws. Additionally, reliability, dependability, and data validation and associated requirements are the other areas that the developers of IoT Systems should consider.*"

Various applications and services have been adopting and adapting IoT technology to provide innovative solutions for users, which were not possible a few years ago. There are many possible applications such as smart city, smart grid, smart home/building, smart factory, digital agriculture, manufacturing, intelligent transportation and traffic, logistics and asset/inventory management, retail transactions, e-Health, public safety, e-Learning and environment monitoring.

Although within this definition of the IoT, there is a significant focus on the edge devices, services offered by or through the cloud play just as important a role in the successful implementation of IoT capabilities. These services include data collection, brokerage and storage, data analytics, inventory management, sensor management, visualization services and monitoring, as well as device relationship management. Additional cloud services will continue to sprout up as new ways of taking advantage of the IoT are thought through and autonomous relationships are built between today's web services and IoT device middleware.

These complex systems require security controls be considered at each stage in their life-cycle and require that the supply chain of components that make up an IoT implementation are all designed and developed using security best practices. The Cloud Security Alliance IoT Working Group focuses on understanding the relevant use cases for IoT deployments and defining actionable guidance for security practitioners to secure their implementations.

[1] [ISO/IEC] Internet of Things Reference Architecture ISO/IEC 30141 WD

IoT will grow to such an extent that it will transform the data centre industry by the end of the decade. Gartner's latest comprehensive IoT forecast[2] published in May 2014 includes a list of potential challenges, some covered below:

- **Interoperability:** There are many IoT solutions on the market built on fragmented or not yet existing standards with an inaccessible information structure that often causes vendor-locks on the user side.
- **Security**: Increased automation and digitization creates new security concerns based on E2EC between the sensor and the end application distributed across different communication technologies.
- **Enterprise**: Security issues could pose safety risks.
- **Consumer Privacy**: Potential of privacy breaches.
- **Data**: A large amount of data will be generated, both for big data and for personal data.
- **Storage Management**: Industry needs to figure out what to do with the data in a cost-effective manner.
- **Server Technologies**: More investment in servers will be necessary.
- **Data Centre Network**: WAN links are optimised for human interface applications; IoT is expected to dramatically change patterns by transmitting data automatically.

According to Mobile World Congress 2016[3] millions of "things" are becoming smart with embedded sensors, data transmitters and the ability to communicate. Smart innovation is creating new business models, improving business processes, and reducing costs and risks. IoT technology is contributing to the global economy with manufacturing, health, insurance, and the financial sectors benefiting already. In the future all technology will communicate with each other, so come see how the market is quickly evolving.

The VICINITY consortium recognizes that IoT interoperability is not only about technical solutions, but also rather on consideration of stakeholders' motivations and concerns that can accelerate or inhibit the adoption of particular solutions. IoT interoperability requirements and barriers will be elicited, captured and analysed as principal drivers of the VICINITY research activities.

VICINITY definitions are in conformity with the existing IoT standards and with consideration of the state of the art achievements in the field. Optimizing the efficiency of the solutions specified by VICINITY, the consortium will carry out documentary research focusing on study of the existing, state-of-the-art IoT platforms as well as on analysis of gaps in existing IoT standards – initial approach and scope for the present document as part of **Phase One** (1): **Definition of Requirement, Standard Analysis & Framework Design.**

This **phase** (WP1 – Requirements capture Framework and WP2 - Standardization Analysis and VICINITY platform conformity) aims at establishing very early in the project the main foundation on which the rest of the project will be based. The underlying fundamental objectives to be addressed are:

- Stakeholders group requirements and user acceptance criteria.
- Further system requirements set by the extensive State of the Art analysis.
- Refinements of the application scenarios and pilot use cases based on the extracted requirements.
- Degree of availability of technological solutions and implementation feasibility.

[2] http://www.gartner.com/newsroom/id/2684616
[3] https://www.mobileworldcongress.com/exhibition/pavilions/iot-pavilion/

- Guidance for the deployment of technologies in the foreseen ICT demonstrations.

Iterative development will be applied under the project's UCD approach with participation of end-users and relevant stakeholders in all phases to continuously guide and validate project results.

2.1. Relation to other Tasks and Deliverables

During the first phase of VICINITY (WP1 and WP2), the aim is to establish as early as possible the main foundation for the project on which the rest of the project will be based.

The requirements extracted and analysed in WP1 along with the standards analysis (WP2) will provide the basis upon which the detailed system architectural framework will be **built** (WP3 - VICINITY Server Implementation, WP4 - VICINITY Client Infrastructures Implementation and WP5 Value-Added Services Implementation), **tested** (WP6 - VICINITY Framework Integration & Lab Testing) and **deployed** (WP7 - On-site Deployment and Pilot Installations) for final **demonstration** (WP8 - Pilot Demonstration and Overall Evaluation).

2.2. Deliverable Structure

The results of the work performed for the deliverable is organized in the following chapters:

Chapter 2 – Approach describes the IoT Concept and its State of the Art to, finally list the most relevant Challenges and Concerns.

Chapter 3 – Survey Methodology details how VICINITY will manage the requirements collected from stakeholder groups.

Chapter 4 – Questionnaire describes the rationale and methodology to structure questionnaires and process the answers.

Chapter 5 – Activities for preparation survey defines the most relevant activities performed in the preparation of the surveys.

Chapter 6 – Risks and Opportunities describes these aspect for IoT and details in VICINITY Approach

Chapter 7 – Conclusions details the deductions resulting from the development of the deliverables.

Annexes – Shows VICINITY **IoT User Requirements** and **Barriers** template, the example template and the **Service Design**.

3. Approach

3.1. Concept

In recent years, there has been growing change in the mode people and businesses access and use Internet - changes that began with desktops and continued with the mobile devices. Such rapid growth that can be considered today as massive because it is not more only related to people's work or entertainment devices but also because it involves any device that can be connected and managed using Internet: **The Internet of Things** (IoT).

IoT is now a buzzword that requires a clear definition in the context of the activities during the execution of the project Vicinity. Accordingly, concepts of IoT that has a widely suitable like the provided by ISO/IEC4 and Wikipedia are used:

[ISO/IEC4] has currently the following definition: "*IoT is an enabling technology that consists of many supporting technologies, for example, different type of communication networking technology, information technology, sensing and control technologies, software technology, device/hardware technology. In designing and developing IoT systems, three key technologies should be considered: (1) system technology; (2) communications technology; and (3) information technology. In a different perspective, IoT systems are composed of physical objects and virtual objects where both objects together mean "things" in "Internet of Things." The physical and virtual objects together collect, process, extract, and do electronic data interchange. They also can decide, and/or act/react to environments autonomously or upon user's request. The data and information generated by IoT systems are likely sensitive in nature; yet, data and information exchange is an essential and imperative process of IoT systems, which enable to provide various applications and services. Therefore, data/information security and user privacy is the other major technology area of importance for IoT systems. Regulations and legislative acts about security and privacy are types of laws. Additionally, reliability, dependability, and data validation and associated requirements are the other areas that the developers of IoT Systems should consider.*"

And Wikipedia describes The Internet of Things (IoT)[5] as "*is the network of physical objects like devices, vehicles, buildings and other items which are embedded with electronics, software, sensors, and network connectivity, to enable these objects to collect and exchange data. IoT enables sensed objects controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems. Direct results of this integration are improved efficiency, accuracy and economic benefit; when IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.*"

[4] [ISO/IEC] Internet of Things Reference Architecture ISO/IEC 30141 WD
[5] https://en.wikipedia.org/wiki/Internet_of_Things

3.2. State of the Art

Over the past few years fundamental changes has evolved in the way people access Internet – it started with desktops and soon shifted to mobile devices. However, the world has not been waiting long to see it grow into something huge. Internet intelligence is now knocking at the door of homes, cities, and businesses – the IoT.

Only a few years ago, awareness of IoT was managed by a relatively small group of designers, developers and enthusiasts, who envisioned a globe populated by billions of 'things' - or devices and objects - connected to the Internet, all collecting data to mine and leverage.

However, awareness of IoT has increased multi-fold and almost any human activity will the beneficiary of all these connected 'things': until 2015, solution providers faced having to work out exactly how and where they could make money from the IoT[6]. Now, starting 2016, it is seen an increased awareness and the start of deployment of IoT within the enterprise: meaning solution providers will have to not only understand how and where the IoT fits into their offerings, but understand exactly how they are going to deploy such offerings.

There is still a long way to go for stakeholders where the IoT is concerned, but 2016 will see solution providers having to take a few necessary steps starting to define their place in the IoT services opportunity[7].

Stakeholders need to understand that an IoT strategy is part of an overall Internet strategy to assist customers in optimizing multitudes of data to their advantage. Moreover, solution providers will have to be ready to handle not only the torrent of data flowing from their infrastructure and their associated connected devices, but also the increased complexity of network traffic.

Operating models focusing on hardware and embedded software will help companies thrive in many high-tech segments, but they may not be well suited to IoT customers. A more appropriate organizational structure for the IoT would emphasize a multimarket sales approach and a greater reliance on channel partners, such as distributors, as part of the go-to-market strategy. This arrangement is well suited to the IoT's fragmented market, which contains very different companies, including many small businesses, with unique needs. Other possible areas for improvement include the following:

- **R&D**: The move from customized chips to a platform approach should occur as soon as possible, but this does not always entail massive internal changes. Instead, companies may be able to license another player's intellectual property to build a platform—for instance, for image processing—thereby gaining access to new technologies without increasing development costs.
- **Investments**: Rather than making a limited number of large portfolio bets under the direction of a business-unit lead, companies should investigate numerous applications in diverse markets. This approach will help companies avoid the common mistake of allocating most funds to core products, rather than using them to develop new applications.

[6] http://www.channelnomics.com/channelnomics-us/analysis/2390102/2015-top-10-emerging-threats-number-4-the-cloud-and-the-iot

[7] http://www.channelnomics.com/channelnomics-us/analysis/2441374/hype-or-hot-wheres-the-iots-business-market

- **Change management**: If management wants employees to cultivate new capabilities or develop innovative products, they may need to revise their key performance indicators. For example, companies should provide incentives that encourage R&D to develop chip platforms that are appropriate for several verticals, such as connected cars and industrial automation, rather than optimize integrated circuits for a single vertical. Likewise, leaders that want to focus on mergers or other outside alliances must help companies recognize their importance by encouraging such partnerships more aggressively.

VICINITY's survey, interviews, and research will show that executives are optimistic about the IoT and its potential to transform the industry. More important, they will recognize its ability to help society as a whole. The exact form that this change will take is still uncertain, as is the point at which IoT will be widely adopted. It is clear, however, that almost all markets will play a major role in its ascent. Those companies that take action now, while the IoT is in its early stages, stand to gain the most.

Furthermore, introducing IoT to companies is undeniably rewarding, but it does not go without challenges. Understanding the risks, nearly 54% of mobile developers invest their efforts in creating IoT technology. Smart Home and Wearables are the most popular IoT areas currently targeted by developers. It is expected that by 2019 there will be 1.9 billion smart home devices on the market with revenue of $490 billion. See below for the most popular areas of IoT tech application:

Figure 1 – Most Popular areas of IoT[8]

[8] http://www.ip-watch.org/2016/01/13/opportunities-and-challenges-that-the-internet-of-things-creates/

Three key ways to bring IoT benefits to a company are the following:

- **Companies will be able to create smarter products to beat their competition**

People expect much more from their devices than a decade ago, and businesses are constantly looking for ways to make things easier for their customers and IoT assists them. The point is that businesses will be competing even more severely to invent more connected, useful and smarter products and they already have access to the technology that can implement it.

- **Smarter data collection and management**

IoT is targeting not only devices, but also sensors that can be attached everywhere and record necessary data. For example, network-connected sensors (e.g. smartphones) can inform doctors about the health status of their patients. Collected data would allow businesses to get information that is more specific on how their products are used, how they break down and what is expected from them in the future.

- **Business model change and smarter progress tracking**

Companies can monitor the efficiency of development processes with better accuracy and this is possible due to IoT. The progress of every employee can be tracked based on various criteria. Moreover, IoT technology will lead to increased automation and reduced need for manual labour.

3.2.1.IoT Domains

By bringing together the physical world of real objects with the virtual world of ICT systems, IoT has the potential to change significantly both the enterprise world as well as society. Some examples are:

- Smart Home with no energy waste, or with interactive walls to display useful information, pictures of art, videos of faraway friends or relatives.
- Productive business environment where offices become smart and interactive, where factories relay production-related data in real-time, or documents are integrated in the workflow.
- Smart Cities, where productive areas, retail, residential and green spaces will coexist and enhanced by IoT technologies.
- Efficient logistics environment where safety and environmental concerns are embed ubiquitously into the process.
- Smart health based on nonintrusive monitoring systems that prevents serious illness by adjusting the environment and selecting appropriate drugs and diet.
- Intelligent transportation systems where public and private transportation interacts, choosing the best path to avoid delays and congestions, and where multimodal transport is smooth and easy.
- Retail environment providing a buying and healthy experience to consumers while the products are traced continuously.

However, different communities understand differently the term IoT, especially because IoT is not a only technology but represents the convergence of heterogeneous - often-new - technologies pertaining to different engineering domains. What is needed in order to come to a common understanding is a domain model for the IoT, defining the main concepts and their relationships, and serving as a common lexicon and taxonomy and thus as a basis for further scientific discourse and development of the IoT. Having such a domain model is also

helpful in designing concrete IoT system architectures, as it provides a template and consequently structures the analysis of use cases.

At least seven key markets have the potential to support the exponential growth of IoT:

- **Building & home automation**: Innovative solutions to monitor and control intelligent buildings and smart homes to enhance security and reduce energy consumption and maintenance costs.
- **Smart cities**: Reduce cost and resource consumption with products for lighting, surveillance, centralized & integrated system control and more.
- **Smart manufacturing**: Tools, software and hardware that ease and accelerate design time for smart manufacturing integration.
- **Wearables**: Highly efficient ultra-low power solutions to be put on the body.
- **Healthcare**: Quality and accessibility of digital products that are revolutionizing the health and fitness industries.
- **Energy**: Innovative technologies for a wide range of option to reduce oil, gas and energy consumption.
- **Transport & mobility**: optimised use of transport infrastructure in order to create interoperability with vehicles, parking, urban space management, smart homes and big data in order reduce climate footprint and pollution
- **Enterprise Systems domain** – back-end enterprise / corporate systems.

The relationship between these domains illustrated in Figure 2 – High-level domain design for IoT architecture:

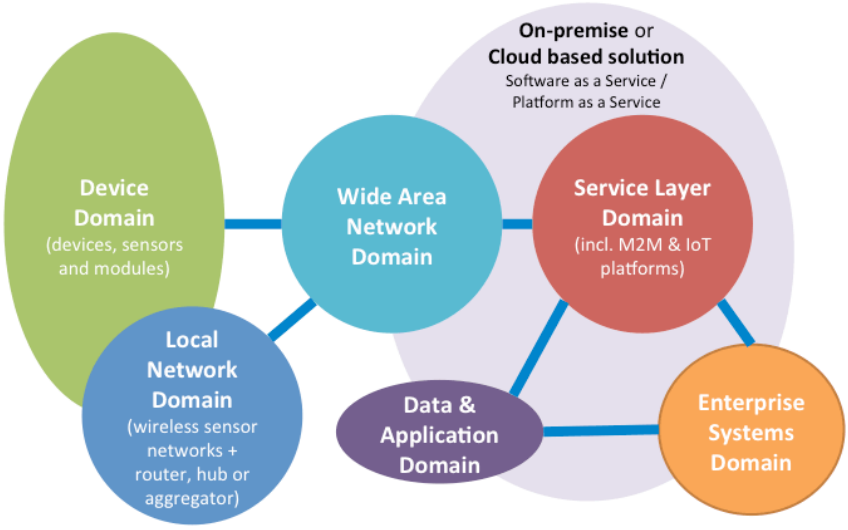

Figure 2 – High-level domain design for IoT architecture
[Source: Machina Research, 2015 [8]]

Each domain is comprised of a specific set of products, services and skills. Within IoT, the configuration of these domains may change from use case to use case. Given this characteristic, one of the crucial considerations for enterprises is to identify the tools and enablers that make implementing IoT solutions across these domains as easy and simple as possible.

3.2.2.Application

At least six key markets have the potential to support the exponential growth of IoT:

- **Building & home automation**: Innovative solutions to monitor and control intelligent buildings and smart homes to enhance security and reduce energy consumption and maintenance costs.
- **Smart cities**: Reduce cost and resource consumption with products for lighting, surveillance, centralized & integrated system control and more.
- **Smart manufacturing**: Tools, software and hardware that ease and accelerate design time for smart manufacturing integration.
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IoT products and solutions in each of these markets have different characteristics.

3.2.3.IoT Architecture

An IoT reference architecture constitutes a major advancement towards the modelling and development of an automation system made up of smart production and network devices and service able to interact with each other in a more automated and autonomous way.

As described by **The Alliance for Internet of Things Innovation** (AIOTI[9]), the IoT approach to embedded systems has as baseline virtual and physical model interlinked and supported by self-organizing properties of the Internet protocols. Several functions and resources offered by embedded devices (a subset of smart objects or things), can be encapsulated into virtual objects that are invoked or made available to a variety of applications and services, which contend to access and use the things i.e., their physical and virtual resources.

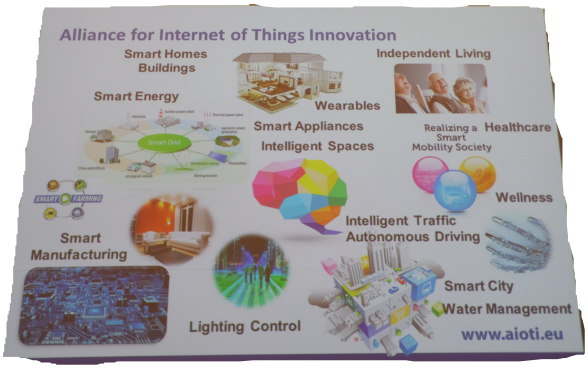

Figure 3 – Alliance for Internet of Things

IoT architecture must also conceive a set of functional elements able to support devices and application services in improving their responsiveness and adaptability to a dynamic and flexible environment, which facilitates the development and adoption of IoT-aware or IoT-enabled applications.

Following up the work presented in the FP7 Funded project IoT@Work[10], the IoT architecture depicts in a set of key functions decompose into a layered structure. This ensures a clear decoupling of concerns that enhances flexibility in multiple dimensions:

- **Flexible business models**: many stakeholders and many applications can co-exist on the same infrastructure in a secure way.

[9] https://ec.europa.eu/digital-agenda/en/alliance-internet-things-innovation-aioti
[10] https://www.iot-at-work.eu/data/D1.3_IoT@Work_Architecture_final_v1.0-submitted.pdf

- **Flexible Infrastructure:** Enabled by decoupling resources and physical issues from applications. Because changes can be kept locally, repair, enhancements and life cycle management of the whole production becomes easier.
- **IoT style semantic infrastructure**, complemented by powerful communication services and intelligent message processing, allows easier changes of the run time logic and thus enables future enhancements or optimizations.

These functional groups roughly gather a group of technologies targeted to meet functional requirements at each abstraction layer. The IoT-centred architecture defined within the context of automation systems, requires special focus on those functional parts that should deliver reliable and secure communication, which is required by some automation applications, for instance.

3.3. Challenges and Concerns

A generally known rule defines that new opportunities lead to always-new challenges. IoT will most probably throw its new adopters into dealing with the new concerns.

In the nascent industry of the internet of things, the presence of multiple communication technologies and the absence of universal standards mean interoperability is one of the most critical and complex aspects of future of the market. As major players seek to secure profits in the Internet of Things, the industry has developed in silos. This has resulted in creating complexity in combining solutions and slowing down the time to market for application makers. This will be of major concern to all players in the IoT market as they seek to find value.

IoT will grow to such an extent that it will transform the data centre industry by the end of the decade. Gartner's latest comprehensive IoT forecast[11] published in May 2014 includes a list of potential challenges, some covered below:

- **Interoperability:** There are many IoT solutions on the market built on fragmented or not yet existing standards with an inaccessible information structure that often causes vendor-locks on the user side.
- **Security**: Increased automation and digitization creates new security concerns based on E2EC between the sensor and the end application distributed across different communication technologies.
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According to Mobile World Congress 2016[12] millions of "things" are becoming smart with embedded sensors, data transmitters and the ability to communicate. Smart innovation is creating new business models, improving business processes, and reducing costs and risks. IoT technology is contributing to the global economy with manufacturing, health, insurance, and

[11] http://www.gartner.com/newsroom/id/2684616
[12] https://www.mobileworldcongress.com/exhibition/pavilions/iot-pavilion/

the financial sectors benefiting already. In the future all technology will communicate with each other, so come see how the market is quickly evolving.

World.News (2015)[3] published a survey that says: "*hundreds of multinational corporations, start-ups and SMEs in the space, IoT Nexus found that 77% of respondents saw* ***interoperability as the biggest challenge facing the internet of things****"*[13]. Indeed, current IoT landscape is rather consisting of numerous isolated islands than of a global continent.

Flexibility and scalability of IoT systems in terms of seamless adaption and integration of heterogeneous sensors, physical devices, services, or even various ERP and/or production applications, has been achieved by domain-specific standardization at different layers. The enablers for interoperability include standardised communication and data exchange protocols as well as underlying knowledge/semantic data structures representing entities and resources that are handling throughout the IoT system levels[14].

Figure **4** – Standards and IoT shows the maturity level of existing standards by category including connectivity standards.

[13] http://m2mworldnews.com/2015/02/25/10901-77-percent-of-iot-professionals-see-interoperability-as-the-biggest-challenge-facing-iot/
[14] Dario Bonino, Christoph Grimm, Dimitrios Tzovaras: Proceedings of 3rd Vocamp„ Energy using and producing Products (EupP) and it's Management", TU Kaiserslautern, June 2013

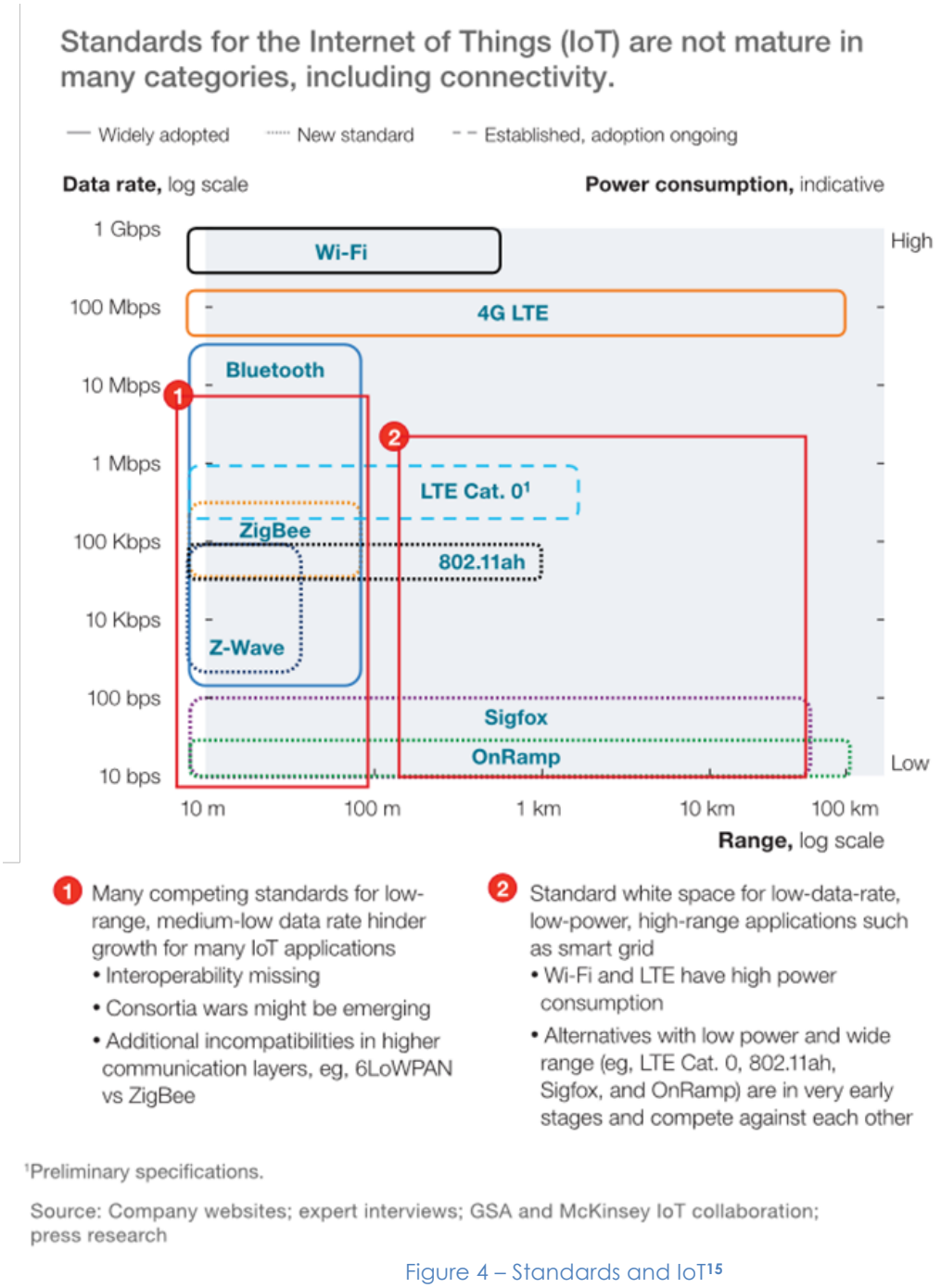

Figure 4 – Standards and IoT[15]

[15] http://www.mckinsey.com/insights/innovation/internet_of_things_opportunities_and_challenges_for_semiconductor_companies

4. Survey Methodology

ICT research and innovation will be confronted continuously and iteratively with the stakeholders' group different requirements and the overall effectiveness of the investigated approaches. To this end, the involved stakeholders and end users of the developed system will be at the core of the project in all its phases starting from the definition of the requirements and the specifications up to the validation and assessment of the benefits of the proposed solutions. The Stakeholder Advisory board will also be involved in this process providing valuable and important feedback.

Figure 5 – Phases of VCINITY's methodology

The project activities are linked with market research, technology assessment, user evaluation, new business modelling and sustainability planning for the project exploitable products. It is therefore crucial that a clear and well-structured methodology is developed for the project. The overall approach and methodology is illustrated in the figure 5 and consist of the following four interrelated phases;

The first phase of VICINITY includes WP1 and WP2, aiming to establish as early as possible the main foundation for the project on which the deliverable will be funded. The underlying fundamental objectives are:

1. stakeholders group requirements and user acceptance criteria,
2. further system requirements set by the extensive State of the Art analysis,
3. refinement of the application scenarios and pilot use cases based on the extracted requirements,
4. degree of availability of technological solutions and implementation feasibility,
5. guidance for the deployment of technologies to the foreseen ICT demonstrations.

As mentioned previously, end-users and relevant stakeholders will participate in all phases and the extracted requirements and standard analysis will help building the system architecture.

4.1. Requirements elicitation methodology

Requirements' gathering is an essential part of any project and project management in order to fully understanding what the project will deliver to its success.

A requirement is "*a statement about an intended product that specifies what it should do or how to do it*" [Mifsud[16]]. For requirements to be effectively implemented and measured, they must be specific, unambiguous and clear.

[16] Mifsud, 2013, Requirements Gathering: A Step By Step Approach For A Better User Experience

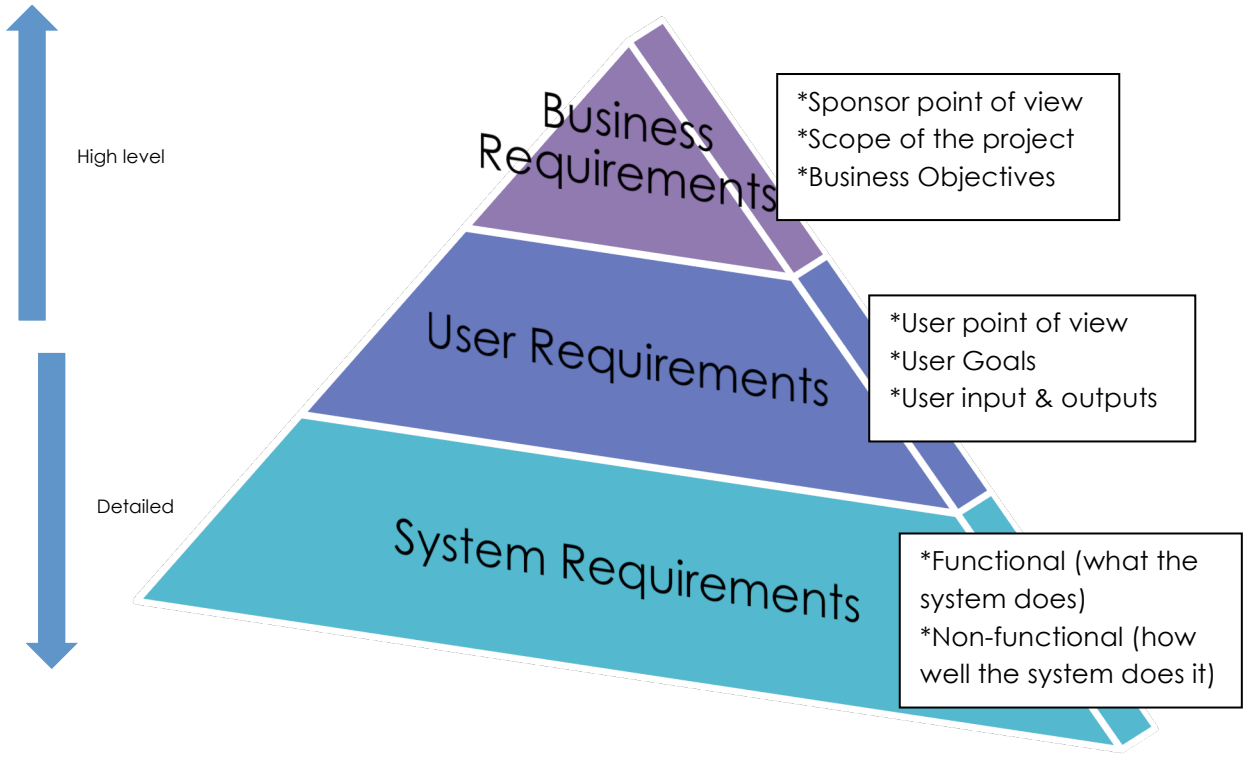

Figure 6 – Diagrammatic representation of the different types of requirements (Source: SatheesPractice[5])

In an ideal world, one would simply gather data related to user needs, analyses it and then elicit the user requirements. However, this is a very simplistic view. In the real world, user requirement gathering is an iterative process whereby each of the above steps influences the other. For example, when trying to set a particular user requirement, you realize that it is not very clear if the user really wants what you think they want. Therefore, you may opt to gather more data as a means to clarify this ambiguity. In addition to this, you will realize that the requirements themselves evolve as stakeholders interact with the prototypes that you develop based on your initial requirements gathering. What follows is a practical 3-step approach on how to gather data from your users and convert this data into system requirements.

At this early stage, do not restrict your definition of users to the actual users of your system. Instead, widen it to include a sample that represents each stakeholder.

According to Jenny Preece and Helen Sharp[17], data gathering can be done using the following conventional techniques:

- **Interviews** – good for getting people to explore issues. Semi-structured or unstructured interviews are often used early on to elicit use-cases. In the context of establishing requirements, it is equally important for development team members to meet stakeholders and for users to feel involved. This on its own may be sufficient motivation to arrange interviews
- **Focus Groups** – are ideal for establishing a consensus view and highlighting areas of conflict and disagreement during the requirements activity. On a social level, it also helps for stakeholders to meet designers and each other, and to express their views in public. It

[17] Interaction Design: Beyond Human-Computer Interaction

is common for one set of stakeholders to be unaware that their understanding of an issue or a process is different from another's even though they are in the same organization. **Workshops** can also be organized as meetings for stakeholders of the verticals, and later on horizontal issues related to interoperability

- **Questionnaires** – may be used for getting initial responses that can then be analyzed to choose people to interview or to get a wider perspective on particular issues that have arisen elsewhere. Or the questionnaire might be used to get opinions and views about specific suggestions for the kind of help that would be most appreciated. Questionnaires should be paper-based or web-based structured forms having an instruction for filling in the questionnaire. A disclaimer should normally be included[18]. Phone calls may be used to find relevant stakeholder to be followed up by other techniques
- **Direct Observation** – of participants in their natural setting is used to understand the nature of the tasks and the context in which they are performed. Sometimes trained observers who record their findings and report them back to the design team carry out the observation, and sometimes the observation is carried out by or with a member of the design team.
- **Indirect Observation** – Diaries and interaction logging are used less often within the requirements activity. Interaction logging on an existing system may be used to provide some data about how a task is performed currently, but the information is too tightly coupled with details of the existing computer support to be particularly helpful if a completely new system is planned.
- **Studying Documentation** – manuals and other documentation are a good source of data about the steps involved in an activity and any regulations governing a task. Such documentation should not be used as the only source, however, as everyday practices may augment them and may have been devised by those concerned to make the procedures work in a practical setting. Taking a user-centered view of development means that we are interested in the everyday practices rather than an idealized account.
- **Researching Similar Products** – by observing and analyzing similar products, it is very easy to establish the requirements of your own product
- **Public consultation** – can be used to collect the opinions of stakeholders and interested parties including EU citizens and private and public organizations in order to gain *quantitative* evidence on the related issues of interoperability.

Interviews are ideal in order to gather data from smaller groups while questionnaires are ideal to gather data from a geographically spread user base. Other forces that come into play are the nature of the task, the participants, the analyst, the resources that are available and a multitude of other factors. Thus, you may find yourself combining more than one of the above techniques in order to be able to interpret unclear data.

The sequence of these techniques could gain the necessary public opinion. In accordance with Regulation 45/2001, all personal data collected through a survey should be kept securely and would ultimately be destroyed. In addition, the respondent should be free to give her name and/or organization.

Requirements are statements about an intended system that specify why methodology is important, what the system should do, how the system will perform on user premises and where/when it will be put into practice.

[18] Disclaimer: "Please note that this document has been drafted for information and consultation purposes only. It has not been adopted or in any way approved by the European Commission and should not be regarded as representing the views of the Commission. It does not prejudge, or constitute the announcement of any position on the part of the Commission on the issues covered. The European Commission does not guarantee the accuracy of the information provided, nor does it accept responsibility for any use made thereof"

The methodology for requirement elicitation in VICINITY is partially based in the double diamond model (more information can be found in the ANNEX III: Service Design of this document). In order to gather as much detail as possible and to identify precisely the requirements, the requirement elicitation process is going to use several of the techniques described above.

The next sub-sections, will describe the management process of the requirements, depicting a timeline for the whole process and will define the structure of the requirements, listing the different elements of which each requirement must be composed. The stakeholders engagement, the most important key to reach successful results, is basically covered in this deliverable and will be further detailed both in D1.2 and the rest of deliverables of WP1 as well as part of the task T9.4 Stakeholders engagement.

Being the questionnaires on of the most important parts of the elicitation process, it will be extensively detailed in section 4 of this document.

4.2. Tracking and management requirements

The requirements obtained from each phase of Working Package 1 will be tracked and managed iteratively within WP1 through the following deliverables:

- D1.1 Requirement Capture Framework in Month-2 (Elicitation phase)
- D1.2 Business drivers, barriers, value-added services in Month-6 (Refinement phase)
- D1.3 Pilot sites operational requirements in Month-9 (assessment phase)
- D1.4 Business requirements in Month-12 (business phase)
- D1.5 Technical requirements in Month-12 (implementation phase)
- D1.6 Architectural design in Month-15 (final assessment phase).

Their status needs to be checked in each iteration about their definition until a final assessment is done. Possible changes will be managed in any point of the process. The timeline below shows the *Overview of the requirement management process within WP1*.

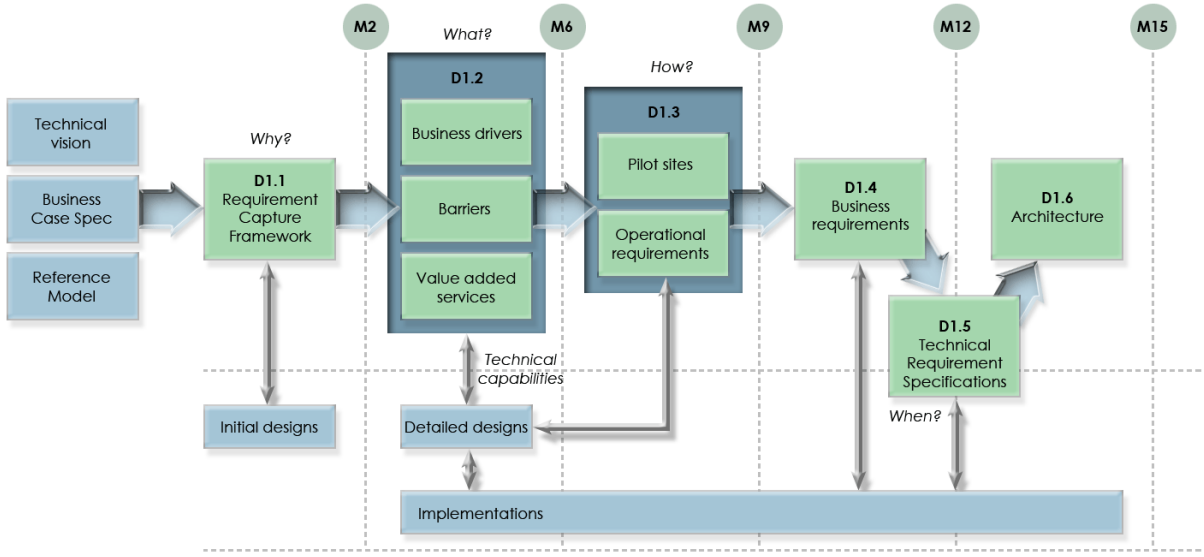

Figure 7 – Overview of the Requirement Process

Further system requirements set by the extensive State of the Art analysis will be performed in D1.2, D1.3 and D1.4.

As per the VICINITY project itself, the process performed in WP1 will result in the first initial requirements, which are included in the project definition phase. This set of initial requirements will be the starting point of the general requirement management process as it can be seen in the next figure:

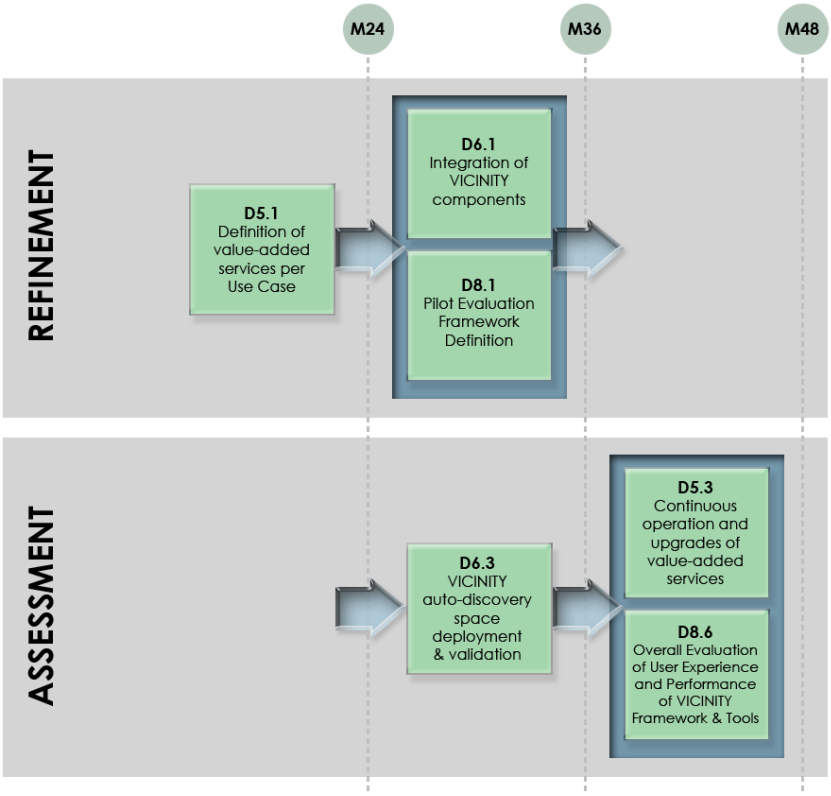

Figure 8 – Requirement Management Process

Starting with the first definition (internally refined and assessed in WP1), the requirements will be refined as part of the sub-stacks T5.1, T6.1 and T8.1 and will be finally assessed in tasks T5.3, T6.3 and T8.6.

The deliverables result of these tasks can be seen in the figure above and will use data from initial design to detailed design, lab testing and real-life demonstrations.

4.3. Categorization of the requirements

A basic structure of the requirements is shown in the table below. The VICINITY partners are in charge of gathering them in order to structure and represent the requirements.

The result will be shown in a table like:

Table 1 – Requirements itemization

Req. ID	Stakeholders	Source	Title	Description	Status	Source details

For each requirement, the following elements will be listed:

- **Requirement ID**: a unique identification per requirement.
- **Stakeholder**: describing the (categories of) stakeholders which the requirement is relevant to.
- **Source**: where the requirement is coming from.
- **Title**: a short sentence describing the requirement.
- **Description**: a few lines of text describing the requirement.
- **Status**: The status of all requirements. This status will be "verification" initially and will change over time to "refinement", "assessment", etc.
- **Source details:** a reference to a document/deliverable.

The detail of the requirements will be developed in D1.2; therefore, the current deliverable shows only the structure to be followed. Another point is, are we going to define different types of requirements, (for example business requirements and functional and non-functional requirements)?.

The requirements can be split in different categories, such as functional requirements and non-functional requirements.

Functional requirements specify the software functionality that the developers must build into the product to enable users to accomplish their tasks, and thereby satisfying the business requirements. Functional requirements states what the system must do and is a "shall" statement. Examples are:

- Business rules
- Transaction corrections, adjustments
- Administrative functions
- Authentication
- Audit tracking
- External interfaces
- Certification requirements
- Reporting requirements
- Historical data
- Legal / Ethical / Regulatory requirements

Non-functional requirements define the system's quality characteristics. As a rule of thumb, non-functional requirements generally end with "ity", although not all of them:

- Scalability
- Capacity
- Availability
- Reliability
- Recoverability
- Maintainability
- Serviceability
- Security
- Regulatory
- Manageability
- Environmental
- Data Integrity
- Usability
- Interoperability
- Performance

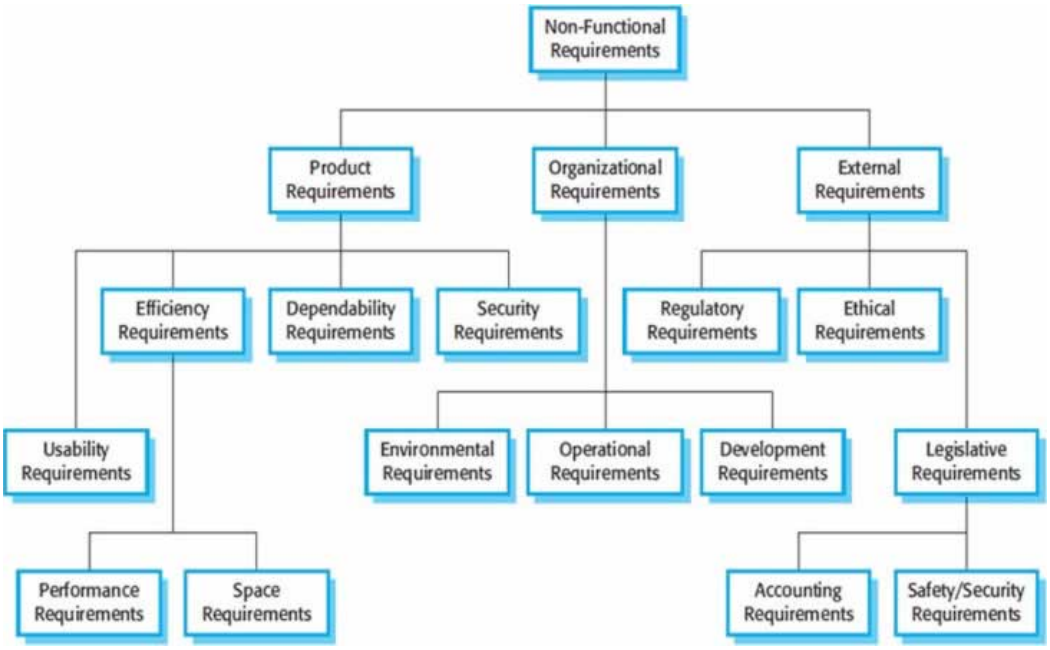

Figure 9 – Diagrammatic representation of relations between non-functional requirements (Source: Robinsce [7])

4.4. The stakeholders group

There are likely to be many profitable IoT niches within the fragmented market, and companies will need to identify the most promising ones that represent a fit with their capabilities. The use of a platform approach to cover multiple niches will be important, since R&D costs may otherwise be prohibitive. When companies are selecting the right niches, one of the most important considerations is their own expertise. Stakeholders that have strong ties to consumer-electronics companies and possesses full-system-integration capabilities might best focus on wearables and smart-home devices, developing silicon, software and algorithms, and device-level designs. They could also potentially provide server-side software, connectivity gateways, and associated infrastructure. By contrast, a company with specific expertise with high-reliability integrated circuits and security might be well suited to provide full IoT solutions for medical applications.

Table 2 – Identification of Stakeholders will be used to identify, describe and classify relevant stakeholders based on the following types:

- Entities Impacted by the Project (IdP)
- Entities Impacting the project (ImP)
- Opinion Makers (OM)

Table 2 – Identification of Stakeholders

	Health Care (Assisted living)	Energy	Mobility	Smart Cities
R&D Institutions				
Industry				

Product Manufactures				
Civil Society				
Commerce				
Government Services providers				
EU institutions				
Technology Integrators				
IoT services providers				
Other				

The Stakeholders Advisory Board (SAB) is going to play an important role in the requirements elicitation process and validation. This body will be part of the stakeholders group identifying current and future IoT interoperability challenges and barriers as well as be included in the validation activities to be carried out in the refinement and assessment phases of the process.

The SAB, along with some of the partners of the VICINITY consortium can help in the identification of relevant stakeholders and will assist and advice the consortium about potential VICINITY customers.

5. Questionnaire

5.1. The rational of requirement questionnaires

As part of the elicitation of requirements, the use of questionnaires is an important part in order to gather them in a structured way. The partners, involved in the requirement capture process, will use these questionnaires as guidelines for interacting with stakeholders for requirement capture. The stakeholders are not intended to provide immediate answers to the questions but to initiate a discussion on the relevant topic were they could freely express their opinions. The answers to the questions will be filled in by the partner organizing the interactions with stakeholders as a summary of the discussion on the topic.

5.2. Methodology for definition of questionnaires

The questionnaires will be defined to take into account the following:

- **VICINITY objectives and concept**: Questions will be defined to validate the VICINITY project objectives and concept by stakeholders such as:
  - Do you see realistic to share certain of your capacities with other actors? (Energy load control options, parking spaces, etc.)
    - Do you operate more autonomous units (buildings, DER locations, etc.) sharing certain capacities?
      - Are these units close to each other or are they remote?
      - Are there capacities shared remotely?
    - What motivators could enable to share your capacities with other entities?
    - What are the principal obstacles of sharing your capacities with other entities?
    - What kind of benefits might be sufficient to achieve collaboration with entities operating similar subjects in your neighbourhood?
- **Planned VICINITY pilots**: The plans for pilot demonstrators will be shared with stakeholders to capture their feedback.
- **Questions related to the product envisioned as outcome of the VICINITY project**: Questions related to products listed in chapters 1.3.6 (Positioning of the project) and 2.2.1.1 (VICINITY Exploitation Strategy & Business Plan) of the VICINITY DoW.
- **Partners' expertise and experience**: Specific questions are expected being raised by partners based on their experience and expertise.
- **Study of the state of the art solutions and other documents:** The corresponding questions will be aiming to target the weaknesses of the existing approaches and technology solutions such as:
  - Which solutions do you use at your domain?
    - What standards are they based on? Are they proprietary?
    - What are the strongholds of those solutions?
    - What are their weaknesses?
    - What kind of desired features are not provided by the solutions you use?

5.3. The grouping of questions to separate questionnaires

The questions will be organized into six different groups. There are four groups for the IoT verticals studied by the project (buildings, energy, health and transportation) and two groups for horizontal aspects related to all verticals (security & privacy and legal & ethics). All the six questionnaires are described in **Table 3 - The questionnaires used at requirement elicitation**. Leading partners, disposing with the appropriate expertise, manage each of these questionnaires. Leading partners will manage the preparation of questionnaires for the particular topics and will be responsible for the collation of answers collected by other partners (see 5.5.).

Although the primary aim of the questionnaires is to elicit requirements by stakeholder interaction, they will also be used to capture relevant information from the study of lessons learnt on past and ongoing projects.

Table 3 - The questionnaires used at requirement elicitation

Vertical Topics		Leading partner
Buildings	The aim of the questionnaire will be to capture stakeholders' views on connecting buildings into virtual neighbourhoods. Motivations and barriers toward shared business processes (supported by interoperable IoT) among building will be mapped. Moreover, potential links toward other IoT verticals will be questioned. Here are few examples of horizontal cooperation between the IoT verticals: • links toward energy to map the potential of building facilities to increase the controllable load in the grid, • links toward transportation to jointly manage the available parking spaces in the neighbourhood of the building, • links toward health vertical for buildings of medical and social purposes, A further important aim will be to identify the potential business cases and value added services in the field reviewing them with stakeholders.	TINYM

Vertical Topics		Leading partner
Energy	The aim of the questionnaire will be to capture stakeholders' views on enhancing current capacities by connecting distributed renewable energy systems into larger ecosystems by reducing the redundancies and gaps that are present in the operations and management of small-scale solutions. Motivations and barriers of collaboration approaches will be elicited and recorded. Moreover, potential links toward other IoT verticals will be questioned, given the transversal nature of energy relevance for these components. Here are few examples of horizontal cooperation between the IoT verticals: • consideration of charging plans of e-vehicles from the transport domain to avoid unexpected sharp load peaks during rapid charging of e-vehicle batteries, • retrieval of occupancy information from building domain over a period of time to better predict the consumption of those buildings, • improved HVAC operations through active forecasting of multivariate criteria, • improved capacity for demand side management strategies through more accurate predictive modelling, • market participation, through various energy services provision, of distributed energy resources-fed community microgrids, powered by IoT. A further important aim will be to identify the potential business cases and value added services in the field reviewing them with stakeholders.	ENERC

Vertical Topics		Leading partner
Health	The aim of the questionnaire will be to capture stakeholders' views on the motivations and constraints of the exchange of health related data among different systems. The domain shall be deeply studied from a privacy & regulatory perspective taking into account the extreme sensitivity of the health domain. A few examples: • Consideration of transport, parking and building infrastructure to access housing and being relevant for security, legal and ethical issues. • Retrieval of occupancy information from building domain in order to predict time-efficient access. • Improved capacity from healthcare workers by having all real-time occupancy and personal data in beforehand. A further important aim will be to identify the potential business cases and value added services in the field reviewing them with stakeholders.	GNOMON

Vertical Topics		Leading partner
Transportation	The aim of the questionnaire will be to capture stakeholders' views on connecting ICT facilities of different operators/owners in the transportation domain. Selected aspects, such as interoperability of smart parking will be addressed with stakeholders as well as connections to other domains as mentioned in the description for verticals for buildings and energy. Specific relations to the health vertical will be addressed to assure preference in ride and parking for health related vehicles. Connected vehicles will form the world's largest set of mobile sensors, which have the potential to be a powerful big-data source. Many novel uses will be found for this source of data, but these novelties brings uncertainty. It may be challenging to find stakeholders who already have a clear view of the potential value of this dataset, but their requirements will need to be understood if the benefits are to be realised. Parking, airports and railways are all areas of transport where low-power connected devices can provide financial benefits for organisations and convenience for consumers, e.g. Connecting parking spaces usually hard to find or keep track will improve city and transport services, reduce costs and protect the environment. A further important aim will be to identify the potential business cases and value added services in the field reviewing them with stakeholders.	HITS

Horizontal Topics		Leading partner
Security & Privacy	In a global IoT ecosystem, there are a large number of various systems, devices and services. The personal motivations behind these assets are complex and might be even malicious. The questionnaires on the topic of "security & privacy" will be dedicated to capture trust issues that are present in the ecosystem. It is planned to seek stakeholder views on assuring trust to devices and data they provide. The goal will be to understand what makes the things trustful by stakeholders (E.g. here we understand trust rather as an attitude of human being than definition from the field of trusted computing). Another exposed concern related to IoT is the breaching of privacy of personnel affected by IoT assets. For this reason, the appropriate concerns of stakeholders will be elicited and recorded.	BVR

Horizontal Topics		Leading partner
	It will be reasonable to grant access for authorized third parties to some data collected within a system, whereas some data may need to keep secret. Different classes of user may need to be given different access rights. The management of access rights for third parties exercising control is even more important. Different classes of user will need to be given absolutely defined rights to access various controls within the system. A major concern is that these access points must be robust against cyber-attack, which may prevent some essential interactions, or may overload the target system, such that the access controls might need to be overridden. The owners of these systems will have strong requirements that their systems must be fully protected. The potential users of data held within currently closed ecosystems will be keen to have easy access to that data. These two classes of stakeholders will have conflicting requirements, which must be understood and balanced.	
Legal & Ethics	The studied IoT verticals must comply with specific regulatory frameworks that will be addressed in the corresponding questionnaires. Here we will address generic requirements such as EU and national regulations on data protection. Another specific question will be related to ethics, which is also often discussed in relation to the ubiquitous presence of sensing devices (such as IoT). Ownership of data within a system is unclear in many instances. For example: car makers claim that they own all data within the vehicle's on-board control systems. Drivers will have some right to the protection of personal data contained within their system, but may not have rights to access these data. Negotiation will be needed to allow third parties to access information within these ecosystems. There must be a positive business case for the car makers to allow closed ecosystems to be opened, or they will only provide this if required by law.	CAL

5.4. The structure of the questionnaire

The questionnaires will be kept in simple spreadsheets with the same attributes (columns) for each group of questions. These attributes will be the following (Table 4):

- **Issue Id**: A unique identifier for each question/issue.
- **Issue/Question**: Short description of the targeted issue or question.
- **Detailed description**: Description of the rational of the question with potential examples (e.g. why we are asking that).

- **Answer**: The answer of the stakeholders. The answer will be filled in by the corresponding partner as an extraction of the consensus that was reached when stakeholders were discussing the given topic.
- **Explanation (optional)**: Explanation may be provided in cases when the relation of the answer to the question is not straightforward.
- **Source ref.**: The stakeholder (not necessarily by name but at least with the organization he/she represents as well as his/her position in that organization). Recording of the sources is aimed to strengthen the credibility of the recorded information.

Table 4 – Example of collated answers in questionnaire

Issue Id	VICINITY-PRIV-00100
Issue/Question	What issues regarding data sharing has to be addressed – for instance in managing security or privacy?
Detailed description	Data exchanged between agencies often includes personal data. Directive 95/46/EC and Regulation 45/2001 define how those personal data should be processed. What issues needs to be addressed during data processing (collecting, transmitting or storing)? What other legislations or regulations need to be addressed regarding such data processing (e.g. local implementations of the Directive)?
Answer	The establishment as well as the range of measures in the field of personal data protection should be agreed and unified by the participating agencies.
Explanation (optional)	Directive 95/46/EC and Regulation 45/2001 define provides that the processing of personal data is possible under the following conditions: the transparency, the access to one's own data and the possibility of objection, the legal basis, the legitimate purpose of the processing and its proportionality. In order to prevent the misuse of personal data, several system laws stablish precaution measures protecting personal data: • accuracy and currency of personal data, • notification of individuals about the processing of personal data, • use of the same connecting codes, • storage of personal data, • transmission of personal data, • protection of personal data of deceased individuals and • insurance of personal data. Measures for protection of personal and field data between the countries sometimes differ. In Slovakia, every legal body or public authority processing personal data by any means has to have a valid security project documentation, in which all the internal rules and steps are documented to ensure that the project comply with directives. There is no such request in Slovenia, but retrospective surveillance is expected. However, for example, the Slovenian Personal Data Protection Act has more detailed requirements as Directive 95/46 / EC in the following points:

	• security of personal data (requires the traceability of the processing); • protection of sensitive personal data; • biometrics (preliminary assessment of the supervisory authority); • video surveillance; • interconnection of personal databases in the public sector (preliminary assessment of the supervisory authority).
Source ref.	• Regional force agency (Slovakia) • Security Experts (Slovenia) • National force agency (EU Member state) • Information Commissioner (EU Member state)

5.5. Collection and processing of Stakeholders answers

Stakeholders' views will be collected in a variety of ways, including:

- Partners will invite stakeholders to workshops to discuss the identified questions and issues. Each partner will handle the questions belonging to its expertise with higher priority.
- By attending meetings organized by other projects or organisations (such as those participating in IoT European Platforms Initiative IoT-EPI) where a presentation by one of the partners may stimulate discussion. Alternatively, a partner may ask questions at such a meeting in order to identify useful stakeholders and to flush out their views.
- Informal meetings: face-to-face or by telephone.
- Each partner (taking part of the activity) will analyse at least one finished or ongoing project for its lessons learned and extract answers for questions that are relevant for the given project.

Each partner, participating in Task 1.2 will be involved at the elicitation of answers for questions of each questionnaire (e.g. not only those falling under their expertise). Once the questionnaires are filled with answers, they will be collated by leading partners (see leading partner column in the **Table 3 - The questionnaires used at requirement elicitation**). While leading partners are collating the stakeholders' answers for different areas, they will take special care to emphasis the common observations (through countries and IoT domains) as well as the particularities identified for a specific IoT domain or for a specific geographic location. The resulted list of answers will then serve as base for the deliverable D1.2 (Stakeholders' drivers and barriers) that represents one of the key documents of the VICINITY project.

6. Risks and Opportunities

Enterprises and users alike must be prepared for the numerous issues of IoT. Listed below are seven of the many risks that will be inherent in an IoT world, as well as suggestions to help organizations prepare for the challenge. The most relevant are the following:

- **Understanding the complexity of vulnerabilities**

Understanding where vulnerabilities fall on the complexity meter - and how serious of a threat they pose - is going to become a huge dilemma. To mitigate the risk, any project involving IoT devices must be designed with security in mind, and incorporate security controls, leveraging a pre-built role-based security model. Because these devices will have hardware, platforms and software that enterprises may never have seen before, the types of vulnerabilities may be unlike anything organizations have dealt with previously. It's critical not to underestimate the elevated risk many IoT devices may pose.

- **IoT vulnerability management**

Another big challenge for enterprises in an IoT environment will be figuring out how to patch quickly IoT device vulnerabilities -- and how to prioritize vulnerability patching. Because most IoT devices require a firmware update in order to patch vulnerabilities, the task can be complex to accomplish on the fly.

Also challenging for enterprises will be dealing with the default credentials provided when IoT devices are first used. Oftentimes, devices such as wireless access points or printers come with known administrator IDs and passwords. On top of this, devices may provide a built-in Web server to which admins can remotely connect, log in and manage the device. This huge vulnerability can put IoT devices into attackers' hands and requires enterprises to develop a stringent commissioning process.

- **Identifying, implementing security controls**

The concept of layered security remains to be seen how well enterprises can layer security and redundancy to manage IoT risk. The challenges for enterprises lie in identifying where security controls are needed for this emerging breed of Internet-connected devices, and then implementing effective controls.

- **Fulfilling the need for security analytics capabilities**

The variety of new Wi-Fi-enabled devices connecting to the Internet will create a flood of data for enterprises to collect aggregate, process and analyse. While certainly organizations will identify new business opportunities based on this data, new risks emerge as well. Organizations must also be able to identify legitimate and malicious traffic patterns on IoT devices.

- **Modular hardware and software components**

Security should be considered and implemented in every aspect of IoT to better control the parts and modules of Internet-connected devices; and it should be expected that attackers will seek to compromise the supply chain of IoT devices. Where possible, enterprises should proactively set the stage by isolating these devices to their own network segment.

Additionally, technologies such as microkernels or hypervisors can be used with embedded systems to isolate the systems in the event of a security breach.

- **Rapid demand in bandwidth requirement**

As more devices connect to the Internet, network traffic will continue to grow. However, the increased demand for Internet will potentially raise business continuity risks: If critical applications do not receive their required bandwidth, consumers will have bad experiences, employee productivity will suffer and enterprise profitability could fall.

6.1. VICINITY impact

The most important factors influencing the achievement of desired VICINITY's impact are the following:

6.1.1. Legal environment

Task 1.1 is investigating the legal feasibility of the selected innovation options with the involvement of stakeholders. Moreover, study of the appropriate regulations will be carried out by task 1.3. The results of these activities will be considered in by the VICINITY business requirements (D1.3). The goal is a coherence of the technology with the identified legal limitations.

6.1.2. Privacy concerns

One of the key features of the VICINITY concept is the full preservation of user's privacy. The platform user can decide which of his IoT asset is accessible to which another VICINITY user. User's sensitive data remains always stored at user's premises and can be shared only upon users' approval along the edges of VICINITY neighbourhood network. VICINITY added value services will collect only anonymised data assessing IoT characteristic as well as crowd behavioural patterns. Platform security and privacy features will be assessed in T1.3 and described in D1.3, then verified in T6.4 and reported in D6.4.

6.1.3. Commercial barriers

VICINITY understands the complexity of commercial ecosystem around the IoT. Therefore valid business cases for the related commercial entities will be investigated by T9.4 in order to engage them to convince their clients to join the VICINITY platform.

6.1.4. Standardization

VICINITY understands the need to standardise the interfaces and protocols used by IoT assets, so that a vendor-independent marketplace can be created. T2.2 will analyse the standardisation environment and choose appropriate standards bodies where the contribution of the results of the project will have the most impact on European and global standards.

7. Conclusions

According to Mobile World Congress 2016[19] millions of "things" are becoming smart with embedded sensors, data transmitters and the ability to communicate. Smart innovation is creating new business models, improving business processes, and reducing costs and risks. IoT technology is contributing to the global economy with manufacturing, health, insurance, and the financial sectors benefiting already. In the future all technology will communicate with each other, so come see how the market is quickly evolving.

The VICINITY consortium recognizes that IoT interoperability is not only about technical solutions, but also rather on consideration of stakeholders' motivations and concerns that can accelerate or inhibit the adoption of particular solutions. IoT interoperability requirements and barriers will be elicited, captured and analysed as principal drivers of the VICINITY research activities.

The present document details the fundaments, techniques and processes to be followed along the requirements elicitation in the VICINITY project. The basic structure of the requirements defined in this deliverable, will be further detailed in the next deliverables of the WP1, adjusting it to the necessities based on the different groups of stakeholders. The VICINITY consortium will populate this structure with information gathered from stakeholders, using the different techniques identified in this document.

Further deliverables in this WP (such as D1.2) will detail more precisely the different groups of stakeholders. It will use this methodology, refining and adjusting parts of it to the specific information given by their stakeholders and will assess and present the results of these activities, forming the first set of requirements, which will be further refined and assessed in later WPs of the project (namely WP5, WP6 and WP8).

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ANNEX I: VICINITY IoT User Requirements and Barriers template

The following template is an initial approach to collect and register relevant users' requirements and the barriers they identified for the deployment of IoT.

Case study name and URL or other reference – Country, Sector, Role	Importance
	0-not
Case study summary	1-less
	2-medium
1. Name of person filling out the form and your role in the project	3-high
2. What stage is the project at?	
Concept? Pilot? Roll out?	
3. What is the population of your community?	
Up to 1.000? Between 1.000 and 5.000? Over 5.000?	
4. What are the key purposes the project aims to fulfil? (Healthier citizens, economic growth? Less pollution?)	
5. What are the key systems involved in the project? (Building, Housing, Energy, Health, Mobility, Transport)	
6. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)	
7. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure …..)	
8. Who are the key stakeholders i.e. organisation, business, agency, citizen ... and what are their roles?	
9. What role does technology play?	
10. What is the scale of the project today (citywide, district, neighbourhood, building, citizen)?	
11. What are the regulatory requirements and terms being used that are related to devices, communications and content?	
12. Have there been any issues about ICT technical interoperability i.e. collaboration between systems? If so, what were they? How have they been solved?	
13. Have there been any issues around technical interoperability which are not related to ICT? If so, what were they? How have they been solved?	
14. Have there been any issues around managing the relationships between	

project partners? If so, what were they? How have they been solved?	
Different strategic priorities? Different business processes? Information sharing? Other?	
15. Have there been any issues regarding data sharing – for instance in managing security or privacy or in the use of different terminology? If so what were they? How have they been solved?	
16. Have there been any problems in gaining the initial or ongoing funding for the project? If so, what were they? How did you solve them?	
17. Have you been able to measure the cost/benefit of your project? If you did this, what methodology did you use?	
18. Have there been any other issues about interoperability/ integration/ ethics/ informed consent?	
19. Are there any aspects of the project where good practice guidelines, certifications schemes or standards would have helped?	
20. Have you been able to use only standard, non-proprietary technologies in your project?	
Yes? No? If not, was this because: a) There was no standard, non-proprietary technology available? b) The standard, non-proprietary technology was not as good as, or was more expensive than, the proprietary one c) Pressure from your commercial partners?	
21. Can we contact you to follow up on any of these issues?	
22. Email address/ Phone number	

ANNEX II: Example template

Source: Alan D.Duncan, 2014, Analytics & Reporting Requirements Template

ORIGINATING REPORTING REQUIREMENT	The statement of need for the business user to produce reporting output • E.g. a statutory obligation, an information request from a government department, a standing commitment to a peer-group forum, or internal reporting specification. This may be a reference to an originating document, memo or specification.
REPORTING PURPOSE	Business purpose or outcome supported by the report; why is the report needed?
REPORTING REQUIREMENT AUDIENCE	Who is requesting the reporting output?
UNSW REPORTING OWNER	Who is the nominated UNSW person accountable for producing the reporting output?
DATA STEWARD(s):	Who else is actively involved in administering the data sets and preparing the associated reports?
SOURCE DATA INPUTS	What data is required to fulfil the requirement? Where does this data originate from?
REPORTING DELIVERY METHODS & DATA UPDATE PROCESSES	What process is followed to produce the required reports? What steps are involved? (Include any details of manipulation that may be applied to source data)
EXCEPTIONS, CONSTRAINTS & EXCLUSIONS	Are there any exceptions or constraints that limit the scope of report delivery? Is there are any data that explicitly won't be included?
DETAILED DATA DEFINITIONS & BUSINESS RULES	Define any specific terms, calculations or business logic that are used within the report.
REPORTING DOCUMENTATION	What documentation exists for this reporting process? E.g. minutes, design documents, updates to metadata repository etc.
OTHER RELEVANT REFERENCE	What other principles, guidelines and reference materials relate to

MATERIALS	this requirement? (e.g. legislation, regulation, policies and standards)
IDENTIFIED DEPENDENCIES	Pre-requisites etc. that need to be satisfied before the report can be prepared.
RELATED UNSW BUSINESS PROCESSES	Identify other existing UNSW processes impacted by the delivery of the report.
OTHER INFORMATION & NOTES	Please include any further information that you consider of relevance.

ANNEX III: Service Design

Conventional analysis of gathered market and company data based on charts, figures and statistics do not reveal the user's individual needs, feelings and desires. What they do is to provide useful insights to be integrated in the research process.

As such, the methodology called service design uses a different approach to collect, organize and prepare data. Although every designer has a slightly different approach and different design The methodology presented in chapter 3, 4 and 5 will still be relevant, but within a different context – and based on other kind of facts and with sources. Specialists also have their own ways of working, but there are some general activities common to all designers. The Design Council has developed the "Double Diamond" model to illustrate this.

Services are not developed by and for programmer and integrators – they are developed for the end users. The services aim to offer increased quality of life, simplified living and more efficient use of the resources that are available as information streams and knowledge about use and contexts.

Service design[20] "*is a form of conceptual design which involves the activity of planning and organizing people, infrastructure, communication and material components of a service in order to improve its quality and the interaction between service provider and customers. For this purpose service design uses methods and tools derived from different disciplines, from ethnography (Segelström et al., Ylirisku and Buur, 2007, Buur, Binder et al. 2000; Buur and Soendergaard 2000) to information and management science (Morelli, 2006), and interaction design (Holmlid, 2007, Parker and Heapy, 2006). Service design concepts and ideas that are typically portrayed visually, using different representation techniques according to the culture, skills and level of understanding of the stakeholders involved in the service processes (Krucken and Meroni, 2006, Morelli and Tollestrup, 2007). Service design may inform changes to an existing service or creation of new services.*

Service design is the specification and construction of processes that deliver valuable capacities for action to a particular customer. Capacity for action in Information Services has the basic form of assertions. In Health Services, it has the basic form of diagnostic assessments and prescriptions (commands). In Educational Services, it has the form of a promise to produce a new capacity for the customer to make new promises.

Service design can be both tangible and intangible. It can involve artifacts and other things including communication, environment and behaviors.

Several authors (Eiglier 1979; Normann 2000; Morelli 2002), though, emphasize that, unlike products, which are created and "exist" before being purchased and used, services come to existence at the same moment they are being provided and used. While a designer can prescribe the exact configuration of a product, s/he cannot prescribe in the same way the result of the interaction between customers and service providers (Holmlid, 2007), nor can s/he prescribe the form and characteristics of any emotional value produced by the service.

[20] https://en.wikipedia.org/wiki/Service_design

Consequently, service design is an activity that, among other things, suggests behavioral patterns or "scripts" to the actors interacting in the service. Understanding how these patterns interweave and support each other are important aspects of the character of design and service (Holmlid, 2012). This opens up more degrees of freedom to the customer and for employees to adapt to the customers' behavior."

Divided into four distinct phases, the "Double Diamond" model looks like this: Discover, Define, Develop and Deliver.

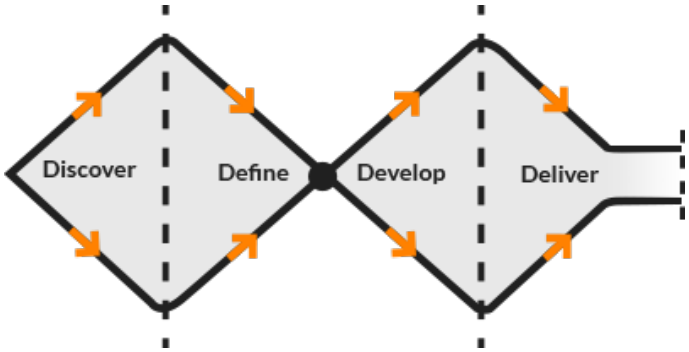

Figure 10 – The double diamond phases

The model maps how the design process passes from points where thinking and possibilities are as broad as possible to situations where they are deliberately narrowed down and focused on distinct objectives.

Overview of the double diamond phases

Discover	The start of a project is a period of discovery, gathering inspiration and insights, identifying user needs and developing initial ideas. The first quarter of the double diamond model covers the start of the project. Designers try to look at the world in a fresh way, noticing new things and seeking inspiration. They gather insights, developing an opinion about what they see, deciding what is new and interesting, and what will inspire new ideas. Specific methods include: market research, user research, managing and planning and design research groups. Objectives • Identify the problem, opportunity or needs to be addressed through design. • Define the solution space. • Build a rich knowledge resource with inspiration and insights.
Define	The second quarter represents the definition phase, in which designers try to make sense of all the possibilities identified in the Discover phase. Which matters most? Which should we act on first? The goal here is to develop a clear creative brief that frames the fundamental design challenge to the organization. Key methods during the Define phase are: project development, project management and project sign-off. Objectives • Analyze the outputs of the Discover phase. • Synthesize the findings into a reduced number of opportunities.

	• Define a clear brief for sign off by all stakeholders.
Develop	The third quarter marks a period of development where solutions are created, prototyped, tested and iterated. This process of trial and error helps designers to improve and refine their ideas. Key activities and objectives during the Develop phase are: brainstorming, prototyping, multi-disciplinary working, visual management, development methods and testing. Objectives • Develop the initial brief into a product or service for implementation. • Design service components in detail and as part of a holistic experience. • Iteratively test concepts with end users.
Deliver[21]	The final quarter of the double diamond model is the Deliver phase, where the resulting product or service is finalized and launched. The key activities and objectives during this stage are final testing, approval and launch, targets, evaluation and feedback loops. Objectives • Taking product or service to launch. • Ensure customer feedback mechanisms are in place. • Share lessons from development process back into the organization.

Wikipedia[22] also detail that *"Together with the most traditional methods used for product design, service design requires methods and tools to control new elements of the design process. These will typically be information such as the time and the interaction between actors. (Morelli 2006), who proposes three main directions, proposes an overview of the methodologies for designing services:*

- *Identification of the actors involved in the definition of the service, using appropriate analytical tools*
- *Definition of possible service scenarios, verifying use cases, sequences of actions and actors' role, in order to define the requirements for the service and its logical and organizational structure*
- *Representation of the service, using techniques that illustrate all the components of the service, including physical elements, interactions, logical links and temporal sequences*

Analytical tools refer to anthropology, social studies, ethnography and social construction of technology. Appropriate elaborations of those tools have been proposed with video-ethnography (Buur, Binder et al. 2000; Buur and Soendergaard 2000), and different observation techniques to gather data about users' behavior (Kumar 2004) . Other methods, such as cultural probes, have been developed in the design discipline, which aim at capturing information on customers in their context of use (Gaver, Dunne et al. 1999; Lindsay and Rocchi 2003)."

A number of different activities are involved in harvesting knowledge about the user needs and specifications:

21 http://www.designcouncil.org.uk/sites/default/files/asset/document/Design%20methods%20for%20developing%20services.pdf

22 https://en.wikipedia.org/wiki/Service_design

- Interviews, questionnaires, polls and participatory workshops as described in chapter 3 and 4.
- Conventional consumer study methods that mainly reveal their explicit and known needs (as opposed to tacit & hidden needs).
- Personas
- Empathy maps
- Ethnographic studies
- Context mapping
- Mental models
- Customer journey maps
- Service blueprints
- Rapid mock-ups
- Storytelling and storyboarding
- Role plays, social games & experience prototyping

All of these activities will provide VICINITY with more information about what aspects are being valued and needed, what approach to use, and also about views and opinions, concerns and limitations that otherwise may not be reflected properly in in textual questionnaires.

Methodology Service Design 2014

In VICINITY, a proposed approach is to base knowledge on collaborative activities using the latest version of the Service Design standard. Conventional consumer study methods mainly reveal their explicit and known needs (as opposed to tacit and hidden needs). This will typically involve activities like interviews, questionnaires, polls and participatory workshops. The use of personas has been adapted in consumer studies, and combined with conventional methods, new aspects of the users needs and content of service can be explored.

Closely linked to personas, empathy maps are a quick way for describing a customers thinking, hearing, seeing, saying, feeling and doing towards a particular topic/product/service/experience.

- Ethnographic studies
- Context mapping
- Mental models
- Customer journey maps
- Service blueprints
- Rapid mock-ups
- Storytelling & Storyboarding
- Role plays, social games & experience prototyping

In VICINITY, field studies or "shadowing" (observation and note taking, photo shooting and videotaping) may be one way of identifying what problems the platform really has to solve. Learning about people's behavior in a particular context and the way they interact with products and services in their everyday life's and in natural environments may help in defining what kind of data that should be exchanged, how the information should be shared, how to best achieve the desired results and other aspects of integrating the VICINITY mind of thought into other components. Ethnographic studies help to uncover hidden needs and recurrent behavioral patterns which users may not be aware of themselves or have difficulty to formulate and express (for ex. during workshops, interviews, questionnaires & polls).

Time and resources is an issue, direct field studies are not always an option. Service design is a methodology that is constantly evolving. The latest version was standardized in 2014:

	Steps	Relevance for VICINITY	Deadline
1	Framing		
	Context and objective	Identifying why and where the VICINITY concept is most suitable and relevant.	
	Research question	Looking into what areas needs to be examined in more detail and harvest information from relevant sources.	
2	User insights		
	Interview: user experience	How will the users access the data from sensors How can the information be seamlessly integrated in the VICINITY service?	
	Interview: Actors map	Who are the different stakeholders and what role will they have in using the VICINITY platform.	
3	Personas		
	Persona dimensions	What extremes in positive and negative direction will users affected by smart devices exhibit when interacting with services offered through VICINITY and other platforms.	
	Persona	How to describe different kind of users of VICINITY powered services? What are their knowledge, age, interest, expectations etc.	
4	Design scope		
	Design challenge	Identifying actors that are involved or affected by the VICINITY project – both internal and external users, expert and novices, private and public sectors – and look at where there are challenges and what kind of KPIs should be met.	
	Design requirements	Looking at what kind of contexts and goals VICINITY needs to meet when it comes to physical presence, emotional values, direct and indirect activities – as well as other requirements the integration platform needs to adhere to.	
5	Ideation		
	Lotus blossom	Combining VICINITYs design requirements with inspirational examples – which may include user interface, API and integration, transparency etc.	
	Idea selection – COCD box	Sort what ideas that are feasible, what should be included – what could be included, what would extend functionality – and what should be dropped.	
6	Service concept		
	(serious play) scenario	Creating a user story, identify core activities and touch points with goals, expectations, sensors and services.	
	User's journeys	Following the user journey – from when VICINITY is installed to how devices can be configured to support and be integrated with other sensors and data sources.	
7	Protype and test		

	Test preparations	In VICINITY the test can be on a number of different areas – it can be the platform, it can be the user experience, it can be integration with other services and platforms.
	Test and evalution	After the test has been completed, an evaluation needs to be made as to whether VICINITY has managed to reach the goals. The tests can be run in several stages – both as paper copies, prototyped UX with finite responses, or as fully functional platforms.
8	Feasibility	
	Blueprint	Combining user roles with touchpoints and activities – and examine the success and failure rate where these meet. In VICINITY, this may end up being a very complex scheme.
	Roadmap	Looking the road ahead – combing with expectations, further functionality as described in the COCD box, as well as feedback from other users of VICINITY and similar integration platforms.

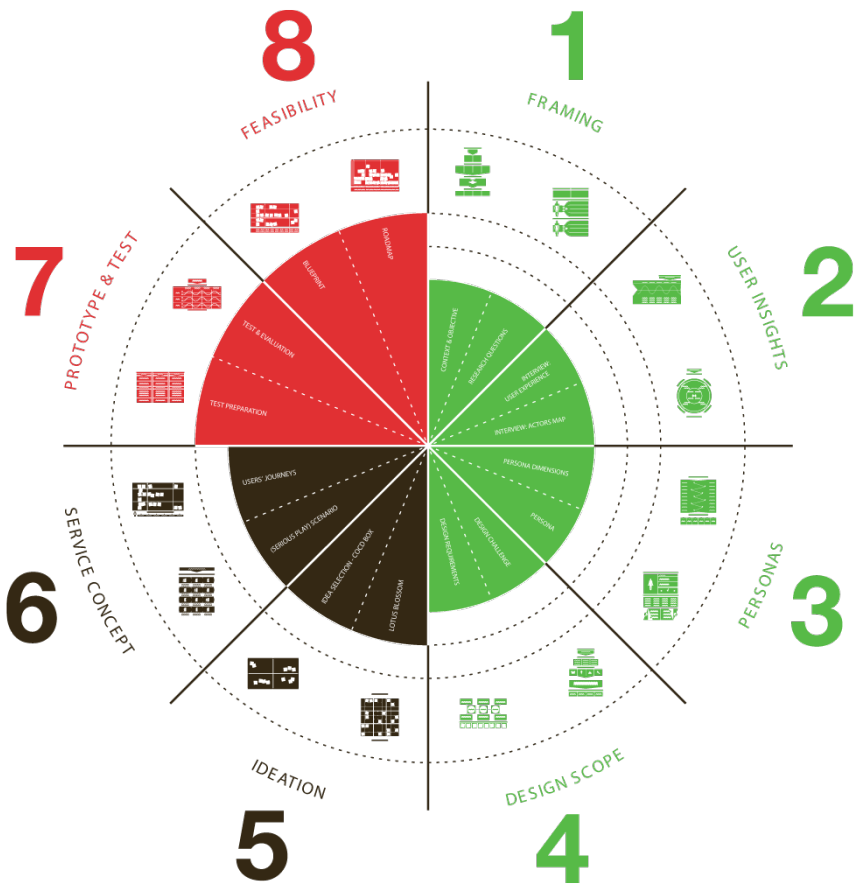

Figure 11 – Steps in service design methodology

An earlier version of the service design methodology was standardized in 2011. Although some of the components differ, the core is still the same

Service Design Toolkit 2011

Tools	Methods
• SWOT • Cause diagram • Stakeholder mapping • Touchpoint diagram • Blueprint	• Templates • Observation • Interview • Focus group • Diary • Perception • Vision & scope • Scenarios • Test • Design briefing

In order to get the necessary information from and about stakeholders, a number of options were implemented:

Stakeholders

Topics	Diagram - topics	Relevance for VICINITY	Deadlines
Framing – context and objectives	Objective of the service – which service will you develop or improve? For whom?	What do VICINITY mean for the end users? Who are the real end users?	
	Objectives of the organization – how does this fit with the objectives of the organization	VICINITY will not be just one entity, it will a joint effort from a consortium.	
	Needs in the market – which demands or needs will you meet?	In VICINITY, this is already pretty well defined, but new knowledge can still be gained.	
Framing – research questions	What do you already know? Which hypothesis do you want to test?	VICINITY is based upon known challenges and needs, but there may be other factors that may affect design decisions.	
	What do you want to know? Which insights are missing?	E.g., the project does not know much about who are willing to support the platform and how well it is going to be received.	
	Users – concrete questions. Which types of users do you want to interview	There may be necessary to look at more distinct user groups and identify what makes them relevant for the project.	
	Facts – who, what, where, how?		
	Objectives – why?		
	Emotions – how did you feel?		
	Ideas – how can this be improved		
	Employees and other stakeholders – concrete questions. Which types of employees and interested		

	parties do you want to interview?
	Facts – who, what, where, how
	Objectives – why?
	Emotions – how do you feel?
	Ideas – how can this be improved
SWOT	Identify strengths – internal factors that contribute to create value
	Weaknesses – internal factors that decrease value
	Opportunities – external factors that (can) influence your service positively
	Threats – external factors that (can) influence your service negatively
Stakeholder mapping	Core target group and staff involved
	Direct stakeholders
	Indirect stakeholders
Touchpoint diagram	Attract attention – how do you create awareness and attract attention for your service?
	Inform – how do you stimulate the customer to take action
	Use – how to you respond to customer needs with regard to service provision
	Support – how do you handle problems or questions during service provision?
	Maintain – how do you enter into a relationship with the customer?
Cause diagram	Core problem
	Direct causes
	Underlying causes
	Contributing factors
Interviews	Interview: parties involved Ask who was involved in the various experience phases.
	Phase
	Distant connection (for example, a service provider or supplier)
	Close connection (for example, family, friends, colleagues)
	Persona, context and objectives of the service – develop the story with activities and touch points.
Service context	Trends – which trends can your service ideas positively influence

	Internal barriers – what can be brakes within the organization
	Restrictions – within which imitations must you work
	Conditions – what must certainly be available for your service to succeed
Service promise	Values – what do you stand for as an organization
	Values – how can this contribute to the distinctive character of your future service?
	Answers – to which specific user needs do you certainly want to offer an answer?
	Most important results – what will happen if your service is a success?
Design scope – design requirements	Physical context – who? Which requirements have to do with the usage environment
	Activities – does what? What are the most important user requirements related to the activities and operations during use
	Emotional goals – why? Which requirements are related to the non-functional goals of your use
	Relational context – who? Which requirements have to do with the interactions of others?
	Objects – does what? What are the most important user requirements related to the objects implied in the service
	Rational goals – why? Which requirements are related to the functional goals of your user
	Most important requirements – which 8 requirements would make the most difference if you offered a good answer to them?

Blueprint

	Attract attention	Inform	Use	Support	Maintain
User – what does the customer do					
Touchpoints – what are the					

moments and places the customer gets into direct contact with your service?					
Service – direct contact – what do your staff actually do?					
Service – back office – what do your staff actually do					
Means and process – what else is involved					

User insights: Interview – user experience

Phases in the experience	Ask the user or employee to describe his or her current experience. First, ask what the different steps are and then detail the user experience
Emotional scale	Satisfied
Emotional scale	Unsatisfied
Why's	Ask, for the most positive and the most negative experiences, how the user or employee felt and what he or she thought. Get to the bottom of the underlying reasons. Don't hesitate to ask follow-up questions.

Service concept: User's journey

Steps	Beforehand: Notice, understand, be triggered	Using the service: Decide to use, first use, further use, help with problems	After use: Building relationships, stimulation/re-use, end of use.	
Users: need – what does the user want?				
Users: activities – what does the user do?				
Service provision: touch point – how does the user come in contact with the service				

Service provision: Answers – how are the demands of the user answered? (What does the employee do? What does the website do? Etc.)				

Persona

Name		
Occupation		
Other	Other elements that has an influence on your service	
Service attitude -	Is your persona someone who figures everything out on his or her own?	• Do it yourselfer • Advice seeker • Delegator
Description	Describe your persona. Describe who they are in the context of the (future) service. What are his or her objectives, both rational and emotional?	
Motivating	What can make your use happy when using the service?	
Demotivating	What can deter your user from using the service?	

Examples of relevant case studies

Case: Older citizens

Co-designing public services for older residents in Buckinghamshire

In recent years, local authorities have been encouraged to embed a culture of engagement and community empowerment in the development and delivery of services. This process of involving the community in decision-making at all levels is set to bring about a transformation in the relationship between community, elected members and authorities.

The briefing

In recent years local authorities have been encouraged to embed a culture of engagement and community empowerment in the development and delivery of services. This process of

involving the community in decision-making at all levels is set to bring about a transformation in the relationship between community, elected members and authorities.

Engine was asked to facilitate the development of a best practice methodology for the engagement of local authorities, elected council members and service providers and users. The methodology, which came to be known as SHAPE: Services Having All People Engaged, was modelled through a live programme of work that concentrated on residents of the county in the 50+-age range.

One of the key characteristics of co-design projects is their complexity when it comes to managing expectations and establishing objectives that will be focused enough to yield tangible results, and flexible enough to keep people with different interests engaged. Our project began with the broad intention of improving access to transport and health for elderly residents of Bucks. However, no specific service was identified that would address this issue.

The Approach

To help Bucks engage their residents and community in the development of services, Engine demonstrated a co-design process to show how tacit insights could be drawn from residents' needs and experiences and translated into efficient and effective services.

Engine developed this into a best practice methodology, using service design research, tools and methods to explore the problems and opportunities in the day-to-day lives of older residents, and used the insights to help elected members, residents, officers and service providers to co-design ideas and propositions to meet those needs.

The methodology, which came to be known as SHAPE: Services Having All People Engaged, also addressed the organizational challenges around how a local authority and its delivery partners plan the process of engagement and organize themselves to benefit from that process to see real and sustainable change. Engine approached this by balancing SHAPE to reduce complexity through managing expectations and establishing clear and focused objectives with tangible results and be flexible enough to adapt to changes and ranges of involvement by keeping people with different interests engaged.

The methodology was demonstrated through the programme of work that would improve how 50+ residents could access health and social care services from all over the county, taking into account times, availability and public and private transport. The teams all worked together to generate, organize and plan the development of the service, with clear input from residents throughout.

The process

The project involved a concentrated programme of work over a period of 4 months. The main activities took place during and in-between a set of workshops that involved a wide group of participants. The whole process involved nearly 40 people from county and district councilors and officers, health professionals, voluntary groups and community representatives.

To begin with, participants were set the challenge of going on a bus journey to one of the local hospitals and to document their experiences in words and pictures. This was the starting point for a workshop dedicated to exploring the problems and opportunities from the users perspective.

From the start, elected members, residents, officers and service providers had to work together, having equal status within the group, to generate ideas and arrive at consensus. Once agreement was reached within the group, the task of designing a service that would meet everyone's needs and desires could begin.

The result

The outcomes were twofold. HealthConnect is a service development proposal designed to improve access to health and social care services in Buckinghamshire. It is also a response to the way people with limited accessibility, especially in rural areas, find journeys to and from the doctors particularly stressful, time-consuming and expensive.

Case: Better health

Designing for the social challenges of better health

The Southwark Rise project was set up in partnership with Engine as a platform for developing a multi-disciplinary, cross service approach for connecting strategic policy making with the everyday lives of families in the borough. Working with a core team of policy strategists, Engine was asked to explore two related and complex areas: childhood obesity and the challenges of creating better life chances for children from the most deprived backgrounds.

The briefing

Exploring new ways of working

Southwark is one of 33 boroughs in London. The Southwark Alliance provides a multitude of services to their 278,0000 residents.

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The project was carried out with a view towards enabling Southwark policy makers, through the transfer of skills and knowledge to:

- Build a more complete picture of the complex lives of families living with economic hardship and become smarter in the way they identify and act on opportunities to support their residents.
- Generate a 360 view of families' lives in Southwark.

Painting a rich and useful picture of the challenges faced by the most disadvantaged families is not easy. It was important to understand topics such as employment, health, community, faith, and relationships in concert. To generate a deeper understanding of these interrelated topics we employed design ethnographies to study eight families in the borough.

The process

This qualitative approach encouraged open and natural dialogue and enabled us to gain access to day-to-day lives using comfortable (home) environments, extended engagement periods and objective observation. Informal stimulus materials helped to unearth perceptions of support, mindsets towards staff and services and permit conversations around sensitive or complicated issues inherent to health and family.

Collaborative service development with service users and health experts

Building on insights revealed through design ethnographies we moved to the conception of preventative health services that can support Southwark families in addressing the challenges of childhood obesity.

Through a series of collaborative design workshops, we lead an action research programme involving a design team of 20 parents and frontline Council staff interested in the topic of childhood obesity as a dimension of public health.

Design activities challenged team members to look at problems as opportunities and supported them to generate services that involved new partnerships and approaches. A series of unexpected services were developed, evaluated, refined and modelled using tools such as service sketching, idea templates, customer journey mapping, desktop prototyping and voting. This revealed underlying values related to provision, desired service journeys and considerations for new and existing touchpoints.

The result

From the many service ideas and propositions emerged a series of key areas of support around health. The image of a remarkably different notion of health support was defined, one that shifts the emphasis from providing support by health professionals to providing platforms that let residents support themselves in different ways such as:

- Support the exchange of information and experiences between people.
- Support individuals to create tailored solutions for themselves through resources that allow them to organize, manage and deliver themselves.
- Support the creation of new, combined and informal service roles.

These insights have provided the basis of the Southwark Alliances (Local Strategic Partnership) new work programme, which forms its approach to Total Place.