Ref. Ares(2021)4274541 - 01/07/2021

TERMINET

Project No. 957406

Project acronym: TERMINET

Project title:

nexT gEneRation sMart INterconnectEd ioT

Deliverable 2.1

TERMINET Stakeholders Requirements Analysis

Programme: H2020-ICT-2020-1
Start date of project: 01.11.2020
Duration: 36 months

Editor: CERTH

Due date of deliverable: 30/06/2021 **Actual submission date:** 30/06/2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957406

Document Control Page

Deliverable Name	TERMINET D2.1 Stakeholders requirements analysis
Deliverable Number	2.1
Work Package	WP2
Associated Task	T2.1
Covered Period	M01-M08
Due Date	30/06/2021
Completion Date	30/06/2021
Submission Date	30/06/2021
Deliverable Lead Partner	CERTH
Deliverable Author(s)	Dimosthenis Ioannidis (CERTH), Georgios Stavropoulos (CERTH), Anna Tzatzopoulou (CERTH), Dimitrios Mylonas (CERTH), Georgos Siachamis (CERTH), Chrysovalantis-Giorgos Kontoulis (CERTH), Ioannis Shoinas (CERTH), Marcello Morchio (TEI), Christos Dalamagkas (PPC), Dimitris Iatropoulos (MEVGAL), George Karagiannidis (AUTH), Sabine Koch (KI), Amelia Alvarez (SCHN), Miriam Cabrita (iSPRINT), Aristodemos Pnevmatikakis (iSPRINT), Khaled Sarayeddine (OPTINVENT), Vicky Krystallidou (AFS), Vicente Mayor (WTG), Felix Klaedtke (NEC), Rahul Bobba (NEC), Panagiotis Sarigiannidis (UOWM), Thomas Lagkas (UOWM), Konstantinos Zaralis (UOWM), Panagiotis Radoglou-Grammatikis (UOWM), Dimitris Pliatsios (UOWM), Karaiskou Chrysoula (UOWM)
Version	**1.0**

Dissemination Level		
PU	Public	X
CO	Confidential to a group specified by the consortium (including the Commission Services)	

Document History

Version	Date	Change History	Author(s)	Organisation
0.1	15/01/2021	ToC Creation	Georgios Stavropoulos	CERTH
0.6	20/05/2021	Contribution to 2.2.1.16, 2.2.1.17, and user / stakeholder requirements	Christos Dalamagkas	PPC
0.7	20/05/2021	Contribution to 2.2.1.12, 2.2.1.13 and 2.2.1.14	Dimitris Iatropoulos	MEVGAL

0.8	20/05/2021	Contribution to 2.2.1.4, 2.2.1.16 and 2.2.1.17	Marcello Morchio	TEI
0.9	20/05/2021	Contribution to 2.2.1.1, 2.2.1.2	George Karagiannidis	AUTH
0.10	20/05/2021	Contribution to 2.2.1.15 and 2.2.2.1	Sabine Koch	KI
0.11	20/05/2021	Contribution to 2.2.1.16	Amelia Alvarez	SCHN
0.12	20/05/2021	Contribution to 2.2.1.6, 2.2.1.7, 2.2.1.8 and 2.2.2.1	Miriam Cabrita, Aristodemos Pnevmatikakis	iSPRINT
0.13	20/05/2021	Contribution to 2.2.1.16 ,2.2.2.1	Khaled Sarayeddine	OPTINVENT
0.14	27/05/2021	Contribution to 2.2.1.3, 2.2.1.5	Vicky Krystallidou	AFS
0.15	03/06/2021	Contribution to 2.2.1.12, 2.2.1.13 and 2.2.1.14	Dimitris Iatropoulos	MEVGAL
0.16	03/06/2021	Contribution to 2.2.2.1	LOGOS	LOGOS
0.17	10/06/2021	Contribution to 2, 3, 4, 5, 6	Anna Tzatzopoulou, Dimitris Mylonas, Giorgos Siachamis, Valantis Kontoulis, Ioannis Shoinas	CERTH
0.18	10/06/2021	Contribution to 2.2.1.10, 2.2.1.11	Vicente Mayor	WTG
0.19	15/6/2021	Contribution to 3, 4	Dimitris Mylonas, Giorgos Siachamis, Ioannis Shoinas	CERTH
0.20	16/06/2021	Final draft for internal review	Georgios Stavropoulos	CERTH
0.21	24/06/2021	Contribution to 1, 2, 3, 4	Felix Klaedtke, Rahul Bobba	NEC
0.22	30/06/2021	Addressing reviewer's comments	Ioannis Shoinas	CERTH
1.0	30/06/2021	Minor corrections, final version and submission to EU.	Panagiotis Sarigiannidis, Thomas Lagkas, Konstantinos Zaralis, Panagiotis Radoglou-Grammatikis, Dimitris Pliatsios, Karaiskou Chrysoula, Stamatia Bibi	UOWM

Internal Review History

Name	Institution	Date
Elisavet Grigoriou	SID	25/06/2021
Vicky Krystallidou	AFS	27/06/2021
Andreas Andreadis	AFS	27/06/2021

Quality & Risk Manager Revision

Name	Institution	Date
Dimosthenis Ioannidis	CERTH	30/06/2021

Executive Summary

This deliverable intends to investigate the stakeholder requirements for the TERMINET H2020 project. This deliverable will serve as the basis, upon which the rest of the TERMINET developments will build. More specifically, WP2 deliverables (namely D2.2 – Reference Architecture and D2.3 – Use Cases description) will heavily rely on the present deliverable. Moreover, the technical work of WPs 3, 4, 5 and 6 will also refer to this document for their respective developments. Thus, it is of high importance that the requirements are defined in a comprehensive manner, and the work leading to it be as extensive as possible.

The first step towards defining the requirements, was to identify the various stakeholders and system actors as well as their roles within TERMINET, along with the various application environments, where the TERMINET solution is expected to operate. Then, to define the user requirements, a thorough strategy was devised, consisting of questionnaires that the stakeholders filled, and regular meetings between the end-users and the rest of the consortium to better understand their needs and expectations, and form the TERMINET proposal according to those. Finally, stemming from the stakeholder requirements, a set of system requirements was extracted and is presented in the deliverable. The latter is not the final set, as it will be updated while the system architecture is being finalized. The final set of system requirements will be presented in D2.2.

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Acronyms

Acronym	Explanation
AI	Artificial Intelligence
AMQP	Advanced Message Queuing Protocol
API	Application Programming Interface
AR	Augmented Reality
B2B	Business to Business
B2C	Business to Customers
BMS	Building Management System
C2B	Customers to Business
C2C	Customers to Customers
CFA-IoT-N	Control Flow Attestation for IoT Nodes
DNP	Distributed Network Protocol
DPT	Data Protection Requirements
EMS	Energy Management System
EPES	Electrical Power Energy Systems
ESCO	Energy Service Company
ESPC	Energy Service Provider
FDX	Full Duplex Transmission
FLF	Federated Learning Framework
FMGC	Fast Moving Goods Company
FR	Functional Requirement
FT-NIR	Fourier-transform near infrared
GACP	Good Agricultural and Collection Practice
GDPR	General Data Protection Law
GEM	Fondazione Policlinico Universitario Agostino Gemelli
GMP	Good Manufacturing Practice
GPU	Graphics Processing Unit
GSD	Ground Sample Distance
GSM	Global System for Mobile Communications

GYN	Gynecology
HACCP	Hazard Analysis Critical Control Point
HDX	Half Duplex Transmission
HMD	Hierarchical Message Description
HTTPS	HyperText Transfer Protocol Secure
ICT	Information & Communication Technology
ID	Identifier
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
InoFA	Internet of Food Alliance
IoT	Internet of Things
ISO	International Organization for Standardization
IT	Information Technology
JSON	JavaScript Object Notation
KPI	Key Performance Indicator
LCP	Lightweight Crypto Primitives
LoRa	Long Range
LoRaWAN	Long Range Wide Area Network
MEC	Multi-Access Computing
ML	Machine Learning
MQTT	Message Queuing Telemetry Transport
NDVI	Normalized Differential Vegetation Index
NETCONF	Network Configuration Protocol
NFR	Non-Functional Requirements
NFV	Network Function Virtualization
NG-IoT	Next Generation Internet-of-Things
NIR	Near-infrared
NVMe	Nonvolatile Memory Express
OCP	Open Compute Project
OPC_UA	Open Platform Communications Unified Architecture

PLA-L	Platform Layer
PLC	Programmable Logic Controller
PROMs	Patient-Reported Outcome Measures
QoS	Quality of Service
R&D	Research & Development
RES	Resilience Requirements
RFID	Radio Frequency Identification
RL	Reliability Requirements
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SDN	Software Defined Networking
SEC	Data Security Requirements
SFP	Small Form-factor Pluggable Transceivers
SPMO	Strategy Project Management Office
SSD	Solid State Drives
TERSPEC	TERMINET-Specific Requirements
UAV	Unmanned Aerial Vehicle
UR	User Requirement
US	Usability Requirements
VCPUs	Virtual Central Processing Units
vMEC	Virtualized Multi-Access Computing
VPN	Virtual Private Network
VR	Virtual Reality
XAI	eXplainable Artificial Intelligence
YANG	Yet Another Next Generation (data modeling language)

1. Introduction

1.1 Purpose of the Deliverable

This document describes the stakeholders' requirements analysis of the TERMINET project. It provides a documentation of the functional and non-functional requirements for the different use cases carried out in the project. It also includes some ethical aspects, guiding the development of the TERMINET components, with additional references to some external and technology requirements. Through this deliverable, a survey for each use case is carried out with the formation and utilization of a questionnaire answered by TERMINET end-users and stakeholders. Along with this process, valuable information was obtained in order to form project user requirements, which will determine and influence the system requirements and the whole architecture of the system. Therefore, this document aims to describe the 1) general methods used and the results of the process for gathering and analysing the end-users, 2) stakeholders' requirements and 3) defining the final user requirements and the tentative set of system requirements. The multiple dimensions of the TERMINET project have been considered in combination with the requirements list in order to accomplish the proper development of project architecture.

1.2 Relation with other Deliverables and Tasks

The current document constitutes the input for the following deliverables of the WP2, which are related to project reference architecture and pilot/demonstration scenarios. Additionally, it will guide all project technical work packages that follow, considering the clarification of what TERMINET's partners should implement, how, and to what extent. This deliverable is the base for the formation of the project architecture and for use case descriptions. It will be utilized by the partners involved in the technical work packages (WP3, WP4, WP5 and WP6) in order to clarify and implement all project components. In other words, Deliverable 2.1 constitutes the base of the TERMINET's pyramid on which all the following deliverables, tasks and components of the project will be based and from which all the necessary information related to the user/system requirements and the architecture details will be obtained.

1.3 Structure of the Document

Deliverable D2.1 is divided into six main sections. More specifically, Section 1 is the introductory part of the document and provides an overview of its structure and purposes. Section 2 gives an overall and analytical description of the project's scope and challenges and defines the stakeholders, the system actors and the roles that exist in the project based on the use cases. Additionally, except for the naming conventions and the terminology, it provides an outline of the main operation modes. The TERMINET system consists of components, corresponding to the main functionalities that the system will offer its end-users, as well as the application environments in which it will be deployed. Subsequently, Section 3 first describes the methodology and the various methods that were followed for gathering and analysing user requirements in the given context of the TERMINET project. Then, it continues by analytically describing the questionnaire that was given to the project stakeholders and finally analysed the different outcomes of it. These outcomes led to the specification and the definition of the TERMINET user requirements. The definition and the prioritized list of the TERMINET stakeholders' requirements are

presented in Section 4, based on their importance. In Section 5, the functional and non-functional requirements of the project are presented in a series of lists of user requirements and general requirements. Finally, Section 6 provides some concluding remarks. This document concludes with an annex including the questionnaire that was used in the scope of the user surveys.

2. TERMINET Overall description

2.1 Project Scope and challenges

2.1.1 Project Scope

Since the appearance of the Internet of Things (IoT), a new way for systems and devices to communicate arose. Due to IoT connotation, smart devices and sensors, wearable devices and intelligent embedded apparatuses are able to not only to connect to each other but also to communicate and exchange data and information without human intervention. The Internet of Things operates through a variety of different heterogeneous technologies, platforms and devices which they collaborate in order to produce, collect, process, manage, analyse and provide data to the stakeholder. Over the years, the IoT sector is growing rapidly, and new systems and smart proposals have emerged, such as efficient edge devices with connectivity and operating capabilities, focusing on the ability to collect, process and provide real-time data at the edge of the network or in other words next to the end-user. Nevertheless, today's cloud computing and IoT systems are created and designed in order to support non-real-time services, and at the same time, they are very costly. Privacy and security issues concerning the storage and the process of personal data, the centralization of data computation and the time-consuming and high-cost services are some of the main issues that current IoT and Cloud computing systems have to face. On the other hand, next-generation solutions and systems require and stand in need for low latency and ultra-fast analytics in order to exploit advanced cutting-edge technologies and smart applications with embedded intelligence, connectivity, and processing capabilities. Concerning the above issues, a new cost-effective approach in which IoT systems will be closer to the data sources and in this way, they will provide faster services, high-level security and viable applications is crucial to be considered.

The number of connected IoT devices worldwide has become enormous (50 million devices in 2020), and with the passage of time, this number will continue to increase extremely. In essence, these devices are heterogeneous apparatuses such as smart phones, gateways, actuators, nodes and computing systems that have to connect and communicate with each other. The heterogeneity and complexity of these devices, their enormous number and the increased demands in data sharing make the process of their connection and configuration extremely difficult, and the deployment of an IoT system in large-scale environments becomes a very toilsome task. The traditional ways for connecting, managing and configuring such a vast number of devices is no longer efficient and viable, and a new interoperability approach of Next-Generation IoT applications support is needed more than ever in order to alleviate and manage effectively the increased complexity and the enormous number of connected devices.

Additionally, every organization's digital transformation depends on some non-negotiable principles such as the implementation of smart applications for customers, the improvement of user experience and the utilization of complicated analytics tools for monitoring useful data and predictive procedures. For these processes, Artificial Intelligence (AI) constitutes an efficient and effective way that can be used in the IoT domain in order to implement and deploy smart services. Although the rapid evolution of the Artificial Intelligence field, predictive mechanisms and strategies are needed in order to predict future events and actions that will be vital (e.g. maintenance predictions and actions for machineries preservation). Due to effective and robust cooperation between IoT and AI fields, organizations and companies will be able to

obtain an unprecedented quality of insights with detailed and real-time information for their customer's preferences and trends, employees, suppliers and partners and how all of them interact with the IoT assets. It is obvious that a new approach for AI and IoT integration is more than needed in order to establish a more secure environment where multiple IoT ecosystem instances are trained by data coming from all IoT infrastructures, without actual data exchange and with a security by design concept. In addition, IoT and digital technologies, in general plays a vital role not only in digital businesses' development but also in their business model innovation, which is extremely important to sustain the competitiveness of both large and small enterprises. For this reason, smart IoT devices, novel hardware and software concepts, user-friendly applications and market oriented intelligent IoT devices are some of the main current scopes of the Information Technology industry. Business model innovation will play a crucial role for further market exploration, as it will give added value to IoT organisations to fit with the environment, although it seems that the IoT ecosystem will be a vital key factor for new market offerings, opportunities and business layers due to the digital transformation and digital technologies usage. In order to create associated infrastructure accompanied by an expanding knowledge base, novel and intelligent IoT devices are required. Intelligent IoT devices, operating at the edge, requires reducing the amount of data sent to the cloud through effective data streaming in a middleware layer between the IoT infrastructure and the IoT cloud services. However, the deployment of such intelligent and novel IoT devices seems to depend on moving the intelligence and the decisions to the point of interest in order to better serve the end-user, while at the same time optimising the use of novel IoT devices by adopting efficient AI schemes and concepts.

In the same tenor, in order to visualize important insights of their operational technologies and at the same time to foster new business oriented IoT uses cases, businesses exploit additional efficient tools such as Augmented Reality (AR) and Virtual Reality (VR). Sectors like agriculture, healthcare, energy, transportation and manufacturing become more and more interested in the ability to view their physical and virtual environments either. Industries related to critical infrastructure (e.g. power grid, remote robotic-enabled surgery etc.) could greatly benefit from training IoT applications that use AR and VR solutions, a fact that indicates, even more, the importance and necessity of these technologies to be adopted by the existing IoT ecosystems. The fact that cooperation between AR/VR systems and IoT environment has not been already adequate relies on the requirements for low latency, flexibility, and AI support that industrial automation and the virtual representation of IoT environments have. For this reason, a coherent framework is needed, where cutting-edge AR/VR tools will be supported and will be able to interact and be utilized from modern IoT systems and applications.

Last but not least, the concept of the Digital Twin can offer a revolutionary and powerful tool in the hands of businesses in the way of digital transformation and predictive maintenance. A Digital Twin is the virtual representation of an asset such as a real device, node, control unit, station, or an engine, where the physical asset sends data back and forth to its digital 'twin', and by this way, a dynamic digital model of this asset is formed. The virtual view of often high-value equipment or device is very important for businesses and can lead to reduced costs, reduced downtime, extremely efficient predictive maintenance and new product opportunities. When it comes to critical infrastructure management, with high-cost devices or even more with human lives in jeopardy in case of some maintenance failure, then the necessity and importance of Digital Twin usage become explicit. It is obvious that Digital Twins' proper operation

depends on the efficient and fast data management and exchange between devices (sensors, cameras, etc.) and IoT assets. Traditional IoT environments are not able to support such concepts since they suffer from low latency and lack of flexibility and in general, they are not able to feed the Digital Twins with real-time information.

Based on the aforementioned remarks and extensive scientific and market research, the project nexT gEneRation sMart INterconnectEd ioT (TERMINET), aims to provide a novel next-generation proposal architecture in order to address all of the above issues and offer a new dimension on the IoT domain. This architecture will be based on cutting-edge technologies such as multi-access computing (MEC), Software Defined Networking (SDN) and virtualization for next-generation IoT and, at the same time, will introduce new, smart IoT devices in order to achieve low-latency and implement specific use cases based on the market. TERMINET aims to enhance the final user' services by bringing the decisions to the point of interest and in a more efficient and accurate way. This will be achieved by reducing the complexity of connecting a vast number of heterogeneous devices through a flexible SDN-enabled middleware layer, applying distributed AI at the edge by using accelerated hardware and sophisticated software to support local AI model, training using Federated Learning. Designing, developing, and integrating novel, intelligent IoT devices such as smart glasses, haptic devices, energy harvesting modules, smart animal monitoring collars, AR/VR environments, and autonomous drones to support new market-oriented use cases are also between project scopes. Additionally, in this way, TERMINET will foster AR and VR contextual computing by demonstrating realistic results based on the use cases that will take place by using cutting-edge IoT-enabled AR/VR applications. Furthermore, through TERMINET, a decentralized and distributed blockchain framework will be designed and implemented in order to support supply chain maintenance and optimization within an IoT-driven system, and at the same time, vertical security by design methodology will be applied, which will satisfy all the privacy and trust requirements of the NG-IoT architecture. Finally, TERMINET aims to provide new business models and standardization activities for the IoT ecosystem. Through six proof-of-concept and realistic use cases, TERMINET will validate and demonstrate the above scopes and goals with real data from modern IoT domains.

2.1.2 Project Challenges

Concerning the continually increasing demand of the market for NG-IoT solutions and the emergent need for synergies between IoT and AI technologies in order to provide low latency and intelligent systems with real-time data procedures, new challenges have arisen. The view of TERMINET project in regard to the challenges it intends to address is presented below.

TERMINET aims to develop an NG-IoT reference model capable of real-time solutions. In this scope, the concept of multi-access edge computing (MEC) will be employed in order to move decisions to the point of interest and serve better the end-user. However, the high level of heterogeneity in the IoT environment and the large-scale IoT paradigms constitutes constraints for MEC, as it cannot support them due to its lack of scalability. For this reason, TERMINET will exploit Software Defined Networking (SDN) and virtualization technologies to provide a new SDN-enabled, virtualized Multi-access Computing (vMEC) reference architecture. More specifically, SDN technology will provide a spherical view of the edge nodes to the MEC servers so as to assist with the offloading decisions, while virtualization technologies will be

used in order to enable the on-demand deployment of vMEC servers, nodes and gateways. New signalling schemes will be designed and utilized so as to limit the communication overhead, focusing on the synchronization of MEC services.

Additionally, the integration of multiple communication and computing technologies with NG-IoT is one of the key factors for enabling NG-IoT in large-scale environments. Scalability and interoperability of new generation IoT solutions are one of the most critical aspects, especially when it comes to large-scale deployments. TERMINET will integrate a novel-SDN-enabled middleware layer that will be responsible for connecting IoT devices from different vendors, and for addressing the interoperability challenge. It will examine the usage of SDN-enabled gateways for device-to-device communication. These gateways will be connected with virtual switches based on Network Function Virtualization (NFV) technologies in order to provide the connection between different networking technologies. Simultaneously, an OpenFlow-based SDN controller will be placed in every node in order to control SDN-enabled gateways and virtual switches and increase the flexibility and the efficient management of the IoT devices by handling large amounts of data in an effective way.

Another challenge for the TERMINET project is to address the limitations of current IoT systems concerning their centralized nature. Today's IoT systems follow the centralized client-server model, where all devices have to be connected and authenticated via a central point. The NG-IoT systems cannot compromise with such constraints if they want to achieve high scalability and security standards. Due to the decentralized model, NG-IoT systems will be able to offer low-latency communications and increased scalability and security, as the processing takes place at the network edge nodes near the users.

Furthermore, TERMINET aims to deploy an architecture in which the data stays with the user, reducing the data transmission and storage in a central IoT platform. This will be accomplished through development of a distributed Federated Learning Framework (FLF), where model training is distributed across a number of edge nodes enabling privacy by design and efficiency in terms of training and processing requirements. Within FLF, the edge nodes use their local data to train the advanced machine learning model required by the core AI machine located at the IoT platform. The edge nodes then send the model updates instead of the raw data to the core AI machine for aggregation.

Market-oriented use cases implementation and examination are one of the core objectives of TERMINET project. Due to use cases implementation, several novel and intelligent IoT devices are more than necessary to be designed, developed and integrated. Due to the six use cases there will be used a variety of new smart IoT devices such as (1) advanced analytics over IoT-collected data from crop and herd environments, AR smart glasses and sensor-equipped Unmanned Aerial Vehicles (UC1), (2) e-health wearables, predictive analytics, and block chain technology to monitor the medical status of patients and provide personalized treatment (UC2), (3) autonomous building that conducts AI-assisted energy consumption optimization over large amounts of data, collected from various IoT sensors deployed throughout the building- (UC3), (4) IoT devices for monitoring every aspect of the supply chain, from the factory to the end customers- (UC4), (5) advanced machine learning algorithms to enable remote surgery training scenarios for multiple participants through the use of VR technologies (UC5), (6) Smart glasses and haptic sensors are used to assist in the maintenance process of critical infrastructure, supported by predictive analytics (UC6).

Subsequently, achieving the highest levels of data security and protection by applying vertical security by design methodology is a critical challenge for TERMINET. Meeting the privacy-preserving and trust requirements of the NG-IoT architecture should be one of the project's main priorities. TERMINET can be characterized by its dependence on the distributed learning technologies and, therefore, to the large amounts of user data that are moving between the system's components in order to obtain proper functionality. In addition, the main volume of the data is gathering, resides and be processed at the edge points of the IoT system. That means that the risk of data violation is very high, and many threats and vulnerabilities should be considered and addressed. In order to face these issues and at the same time to keep the accuracy of the models at high levels, TERMINET will utilize attestation techniques with strict user data encryption and trust management and device authentication services. Among the assets of IoT infrastructure, there will be specific relations and trust hierarchies that will be specified due to the examination of each use case paradigm. Sophisticated crypto primitives will be used, such as Lightweight Crypto Primitives (LCP) and Control Flow Attestation for IoT Nodes (CFA-IoT-N), in order to achieve the aforementioned goals and to identify the suitable features and security requirements to design and integrate the ideal security model for each use case.

The utilization of novel IoT enabled AR/VR applications by businesses can visualize critical insights about their operations and, in this way, enhance their functionality and efficiency. Three out of the six use cases in TERMINET will utilize such AR/VR applications so as to exploit and demonstrate the generated results and examine the effectiveness, efficiency and user experience that these AR/VR contextual computing will offer. Meanwhile, these applications require extremely low end-to-end latency in order to increase user experience and achieve high performances. Providing the necessary means of supporting tactile IoT capabilities for supporting new low latency, human-centric services is another challenge for TERMINET. This can be done with the deployment of advanced technologies and specific frameworks such as network slicing, Network Function Virtualization (NFV) and RINA, in order to obtain ultra-reliable and near-real-time connectivity.

Moreover, the design and implementation of the digital-twins concept in order to enrich the IoT industry and provide a new dimension in predictive maintenance and supply chain optimization constitutes one more TERMINET's goal. Digital twins are a revolutionary technology for industrial businesses and can be used for the maintenance of critical equipment in synergy with Federated Learning and predictive analytics models, which are based on different types of production and sales data and allows real-time operation monitoring. In general, one of TERMINET's primary goals is to provide novel disruptive business models while fostering standardization activities for the IoT ecosystem. This challenge requires extensive exploitation for potential market sectors that may be interested in the project results and, at the same time, a revenue prediction model. It is important to specify the regulatory barriers that will arise and the key factors that will enhance the adoption and sustainable growth of TERMINET in the market. Finally, the prototypes that will be developed and used in the project will be enclosed (e.g. FLF, SDN-enabled vMEC, NG-IoT Applications, Services Hub etc.). Based on the project results and lessons learned, TERMINET standardization activities will include compliance with the General Data Protection Regulation (GDPR) by meeting all the stipulated requirements and recommendations for certification will be formulated.

2.2 Stakeholders, system actors and roles

2.2.1 Stakeholders based on the use case scenarios

The following stakeholders are defined in accordance with the use cases and by taking into consideration the answers to the questionnaires provided by the partners involved in them.

2.2.1.1 Non-profit organizations (Use Case 1)

Ethical and sustainable farming is a major priority of this use case of the TERMINET project. The interaction of this use case with the civil society organizations is twofold: i) The views of the corresponding stakeholders will be deeply considered in the design and implementation of this use case, while ii) the actions made within this use case will be of high interest for civil society organizations. The latter is due to the fact that the positive impacts of the strategies that will be showcased in this use case will strengthen the voice of organizations that give a fight against poverty, hunger, environmental pollution, animal exploitation, etc.

2.2.1.2 Service providers (Use Case 1)

The results of this use case will be of high interest for agricultural service providers in the area of smart farming, including agricultural and farming services that provide information, consulting, equipment, and supplies to the agricultural industry. Examples include government agricultural extensions, crop brokers and shippers, meat packers, produce distributors and wholesalers, and veterinarians. Especially, the results of this use case will be important to the providers of equipment, market, regulatory, and farming services.

2.2.1.3 Real economy actors along the agrifood value chain (Use Case 1)

A Value Chain is the pathway of processes that a product follows as it moves from the primary producer to the final consumer. Agrifood Value chain infers a flow of information and incentives between all people involved. The added value of the product increases at each point, hence using the term Value Chain. For Use Case 1, meat and dairy are the main production systems. Real economy actors involve farmers, research/training institutes, meat packers, catering professionals, sales outlets and consumers [1].

Transparency throughout the supply chain is a prerequisite for the modern consumer. The meat and dairy industry cannot ignore these modern market demands that require full access to information at all stages. A growing trend that contributes to this is sustainable consumption. The consumer is more interested and concerned with the origin of the meat and dairy products, the process until the sale of the product, but also its impact on the environment. In order to keep all meat and dairy processing issues clear and

transparent, it is important to have consistently available information on traceability, product specifications and quality.

The above will be supported by the cluster of the InoFA (Internet of Food Alliance) that American Farm School coordinates. InoFA innovation cluster is an effort to connect all the links of the agri-food chain and those who provide materials and services to it under a common umbrella based on high technology and the Internet of Things. In this sense, the flow of products in the supply chain creates a parallel flow of information which is born at the point of primary production (e.g. field) and is constantly enriched until its final consumption. The purpose of the cluster is to create synergies between the participants and civil society to develop new digital products and services that will lead to the improvement of the applied processes by all the links of the supply chain. This technological upgrade, in turn, will help it meet the modern challenges of the circular economy, food traceability, environmental footprint, and nutritional values.

2.2.1.4 Network operators (Use Case 1, Use Case 6)

A Network Operator is a provider of wired and wireless communications services that owns or controls the infrastructure necessary to sell and deliver services to other Network Operators and end-users.

2.2.1.5 Farm owners (Use Case 1)

Animal husbandry is a basic socio-economic agricultural activity. Livestock contributes substantially to regional rural development and the preservation of the rural social economy. It also exploits areas, especially those that are impossible to exploit differently. The modern livestock farmer seeks for new technologies to maximize production, while at the same time maintains sustainability. Though Digital Livestock Farming, farmers can improve production and reproduction increase animal welfare and reduce the environmental impact. Simultaneously, advanced digitalization technologies offer the farmer the potential to become more transparent and thus fostering increased consumer trust. More specifically, the farmers involved in the project manage both intensive and extensive livestock systems. The first farm engages free grazing beef cattle while the second farm with sheep for both dairy and meat production. AFS acting both as a farmer and as an innovation facilitator will transfer the obtained knowledge to the farmer cooperatives that the two pilot farms belong to.

2.2.1.6 Medical Personnel (Use Case 2)

The mission of healthcare professionals is to treat patients maximizing the efficiency and effectiveness of the medical care provided. By combining data gathered from different sources from within the clinical setting (e.g., different departments) and outside of it (e.g., Real-World Data collected in the home environment of the patients), medical personnel obtains a holistic view of the patient context. This view facilitates a personalized approach to the individual patient. Furthermore, the content and means for a discussion between members of the medical team (e.g., from different medical specializations) at any

moment of the care path should be provided. This provision allows for collaborative decision-making on the optimal care path for each individual patient, thereby reducing hospitalization time and improving patient satisfaction.

2.2.1.7 Health systems (Use Case 2)

Health systems are facing severe economic challenges due to demographic changes and an increase in the prevalence of chronic diseases. More than ever before, it is of paramount importance to manage resources efficiently, for example, by finding the optimal care path for each individual patient that results in the minimum number of hospitalization days.

2.2.1.8 Healthcare organizations (Use Case 2)

Healthcare organizations want to be recognized for the quality of care they provide. The satisfaction of the patients is a key factor as, in cases where there is freedom of choice, it dictates which healthcare organization the patient will choose to receive the medical care. Longer hospital stays often result in in-hospital complications, which in return result in higher resources consumption and reduced patient satisfaction.

2.2.1.9 Citizens / Patients (Use Case 2)

Every citizen might, unfortunately, become a patient, but if so, wishes to be a patient for the shortest period possible. Once a situation is detected that requires medical assistance, a patient wants to receive the best treatment in the shortest time-span possible. Hospitalization days bring negative consequences for the daily life of the patients, compromising personal and professional life.

Patients might be affected in a positive way if care professionals' life-long learning leads to better provision of care. This might be the case when novel surgery methods and other medical techniques can be easily spread to a broader group of care professionals and medical students using distributed VR technology.

2.2.1.10 Public Sector (Use Case 3)

Energy efficiency is consolidated as one of the great challenges in public buildings. When it comes to energy efficiency, the public sector must play a strong role in setting an example for the public. The public sector must lead by example when it comes to investments, maintenance and energy management of its buildings, facilities, and equipment. Energy efficiency is a valid strategy for the entire public administration to solve the problem of scarcity of public funds and contribute to reducing the serious problems of energy and climate.

TERMINET solution can be useful to all those who are interested in saving energy and in advancing in the acquisition of more efficient habits and behaviours in the use of energy in Public Buildings, but it is especially aimed at:

- Heads of Departments, Services and Sections of Local and Regional Administrations
- Responsible for maintenance of public buildings
- Administration staff, in general

2.2.1.11 Facilities managers / Building owners (Use Case 3)

Energy management in smart buildings represents between 20 and 30% of the operating costs of a building.
Managing, operating and updating systems for minimizing energy use can allow achieving high economic savings in the life of a building and guide it towards the concept of an intelligent building.
To meet this objective, constant supervision is essential to guarantee the reduction of energy use, CO2 emissions and environmental impact, providing measurable values for building owners, occupants and society.
The objective of our interest group is to provide energy services to its clients' thanks to the implementation of the Building Management System (BMS) and Energy Management System (EMS), where objectives are set to measure the progress made, analyse and interpret the information provided by these systems, and improve the knowledge and commitment in energy aspects of all employees in order to make decisions that allow optimizing the operation of the facilities and achieving the desired energy objectives.

2.2.1.12 Manufacturers with complex supply chain (Use Case 4)

The main purposes of all manufacturers are the satisfaction of their customers, the monitoring of customer needs, the ability to gain advantages against competitive companies, efficient and accurate forecast for their production. These factors lead to more complex supply chains in order to satisfy those needs. The complexity of the supply chain applies to the need for inter-connectedness and inter-dependencies through all the processes of the supply chain [2].

MEVGAL, as one of the largest dairy industries in Greece, is in constant need and search of a proper and accurate way to manage and monitor the whole supply chain because of the fact that most of the products must depart from the factory ten to twelve days, at most, after their production date in order to exploit the maximum advantage of their life-span due to the volatile demand patterns, the perishable nature and the short life span of most of the products. Inability to establish and practice a proper way to manage and monitor the supply chain translates to production problems and a decrease in profit.

2.2.1.13 Personnel in complex supply chains (Use Case 4)

Personnel in complex supply chain is mainly employed in two sectors.

- **Functional integration** aims at linking more efficiently elements of the supply chain, namely, to ensure that suppliers closely meet the requirements of customers in terms of costs, availability, and time.
- **Supply chain management** applies to management, coordination, forecasting and monitoring of every stage of the production flow, from purchasing the raw materials to the delivery of the final product to customers.

MEVGAL's personnel working on supply chains are looking for better communication and connection of all the stages of the supply chain in order to optimize the inventory management systems, improve the factory's responsiveness to customer requirements and better efficiency.

2.2.1.14 Customers (Use Case 4)

A customer is a person or company that receives, consumes or buys a product or service and can choose between variety of goods and suppliers. The main goal of all companies is to attract customers and make them purchase what they have on sale. In general, customers are considered the backbone of a company [3].

Depending on their legal entity and type of transaction, customers can be categorized as follows:

- **Business to customers (B2C)**
- **Business to business (B2B)**
- **Customers to business (C2B)**
- **Customers to customers (C2C)**

Customers' expectations, such as needs for faster deliveries, wider varieties of products and services and more customer-oriented experiences, are skyrocketing nowadays due to the rapid development of technology and vaster range of choices customers are offered. These factors force companies to support more unique orders through their supply chain, requiring the better collaboration of the employees, more efficient inventory management, better communication with suppliers and deeper understanding and monitoring of the supply chain.

In order to satisfy customer needs, MEVGAL's factory must meet the demand coming from the customers, who are identified as stores and representative agents, who must also meet the demand coming from their customers (super-markets, food stores, catering clients etc.).

2.2.1.15 Medical Universities (Use Case 5)

Medical universities perform research and education activities in the areas of life science, medicine, healthcare and related areas. The ultimate aim of a medical university is to contribute knowledge that enables better and sustainable health for the global population.

Research comprises basic experimental research to patient-oriented and nursing research, but also integrated fields like medical education, medical informatics, medical management and medical ethics.

Education comprises academics education at undergraduate, graduate and post-graduate levels, but also continuing education of different professionals working in the health care sector.

2.2.1.16 Manufacturers (Use Case 6)

Manufacturers are businesses that create and sell technology products to retail customers and/or other businesses. The revenues of manufacturers depend mainly on the sales of the produced goods. Therefore, manufacturers need to take all the necessary actions to preserve and expand their market share by maintaining good relations with the existing customers and embedding trust to current and potential new customers. In this context, manufacturers:

- Provide supplementary technical material for enabling customers to understand and exploit the full capacities and functionalities of the supplied product.
- Provide the necessary safety guidelines for ensuring personnel safety and preventing any impact on business operations.
- Develop and provide training material that facilitates efficient transfer of knowledge to technical personnel and ensure successful execution of complex operation tasks (e.g., maintenance, commission/decommission of devices, etc.).
- On-demand support in the event of a significant failure. In such cases, manufacturers may need to visit the remote site or perform inspection either remotely or physically.

Considering the above points, manufacturers need to ensure that they provide adequate technical material and support, aiming to decrease inspection and support costs, while the provided supporting material (e.g., AR-enabled instructions) facilitate the adoption of even more complex products by the market stakeholders.

Depending on the market where the manufacturer is active, more specific categories of manufacturers can be outlined. For example, in more detail:

- A Telecom Manufacturer, such as Ericsson, is a company that offers products and services, such as hardware, software and infrastructure in information and communications technology for Network operators. Example of such products are the Small Form-factor pluggable transceivers (SFP) modules, which are used by high-capacity switches to convert the optical to electric signal and vice versa. More specifically, an SFP manufacturer is a manufacturer of optical communication components and subsystems, including optical transceiver modules and optical components for various ICT applications. SFP manufacturer usually includes Research & Development (R&D) and manufacturing facilities.
- Manufacturers for energy and automation solutions provide industrial equipment for power stations and substations. Control devices, such as Remote Terminal Units (RTUs), are used for remote telemetry and for enabling the interfacing analog instruments with computerized Supervisory Control and Data Acquisition (SCADA) systems. RTUs are used as a primary source of real-time data or as communication gateways.

2.2.1.17 Maintenance Administrators and Engineers (Use Case 6)

Maintenance administrators are specialized personnel who oversee all operations related to maintenance. Common duties include monitoring the supplies and scheduling regular or urgent maintenance operations. The maintenance administrator holds a significant role in ensuring the safe and proper operation of the industrial facilities and infrastructure since they undertake the monitoring and implementation of the maintenance schedule.

A more specific example of maintenance regards all the tasks involved to keep a network up and running is called Network Maintenance. Network Maintenance includes the following responsibilities:

- Monitoring network engineering performance and ensure system availability and reliability
- Configuring and installing various network devices and services (e.g., routers, switches, firewalls, load balancers, Virtual Private Networks (VPN), Quality of Service (QoS))
- Performing network maintenance and system upgrades, including service packs, patches, hot fixes and security configurations

Network Maintenance can be driven directly by the Network Operator or can be sub-contracted to specialized companies. In either case, the administration and maintenance tasks are supported at various levels, from basic help desk (Tier 1) to in-depth technical support (Tier 2) to expert product and service support (Tier 3).

Considering the variety and the geographical dispense of the owned equipment, the maintenance of adequately specialised teams of engineers, and the schedule of technical visits on remote sites, maybe a significant overhead.

Consequently, maintenance administrators would be benefited from solutions that can estimate upcoming faults on the infrastructure so that maintenance administrators can be prepared and timely allocate the necessary human resources. Moreover, maintenance engineers can improve their specialisation on cutting-edge equipment by using innovative technologies, like AR/VR apps, which can provide intuitive guidelines and efficiently convey technical knowledge, thus, strengthening the maintenance teams [4].

2.2.1.18 Energy Providers (Use Case 6)

Energy service providers are involved in a broad range of energy-related activities that fall into the categories of supply, trading, aggregation and retail. The aim of these stakeholders is to provide energy services to their customers. Energy providers can be distinguished in the following categories based on the services they provide:

- **Retail energy providers:** They provide energy to customers based on a contract. The energy can originate from the energy providers' power plants or relevant markets.
- **Energy Service Providers (ESPC) /Energy Service Company (ESCO):** They offer services regarding energy-efficiency insights and management. They can be part of a project that aim to improve energy efficiency and provide savings and reduced costs through monitoring and management.

- **Aggregator:** Aggregators are new entities in EPES that act as the middleman between consumers and the other Energy-related organisations [5]. Their main objective is to aggregate multiple customers forming a cluster which in turn use to negotiate the purchase of electricity with energy providers.
- **Energy trader:** Their main objective is to move energy from the production point to where it is needed.

2.2.2 System actors and roles

2.2.2.1 Actors and Roles based on the Use cases

Table 1 Categorization of involved partners

Partner	Farm and live-stock Owner	En-ergy Pro-vider	Manufac-turer	Dairy Prod-ucts Pro-ducer	Telecom-munica-tions company	Healthcare Organiza-tion	Medical Univer-sity	Tech-nology Provider
PPC		√						
SCHN			√					
TEI			√		√			
AFS	√							
MEVGAL				√				
KI							√	
WTG								√
AUTH								√
FINT								√
OPTINVENT			√					√
iSPRINT								√
FPG						√		
TECN								√
i2CAT								√
CERTH								√
UOWM								√
8BL								√
ALT								√
LOG								√

Table 1 presents the partners involved in the use cases and provides details about their personnel and their roles. Based on the provided information, the following roles have been identified.

Personnel involved in smart farms use case scenario

- Farmer
- Veterinarians
- Agronomists
- Researchers with expertise in the area of Internet-of-Things technologies for smart farming
- Manufacturer of Smart glasses and provider of mobile solutions (Android applications) for the agriculture field

Medical Personnel

- Doctors
- Surgeons

Roles in medical education

- Teachers
- Medical students
- Nursing students

Personnel in complex supply chains

- Workers

Personnel in critical Infrastructure

- Maintenance engineers
- Remote maintenance, logistics

2.3 Application environments

2.3.1 User-Centric Devices in Smart Farming

The environment of Use Case 1 is two farms located at a long distance between them. TERMINET envisions the extension of the smart farming market during its lifecycle. What is expected is to enhance the sustainability of smart agriculture, boost production and minimize risks related to the livestock and the crops.

2.3.2 Pathway of Personalised Healthcare

The environment of Use Case 2 is a hospital. The goal of TERMINET is related to a more personalized treatment for patients and aims towards a better healthcare system and patient satisfaction. It will also improve medical education provided to healthcare practitioners.

2.3.3 Smart, Sustainable and Efficient Buildings

The environment of Use Case 3 is a smart building. In smart buildings, optimizing energy consumption is a major issue, as it enables them to become truly smart. In TERMINET, this will happen via distributed AI techniques, such as Federated Learning.

2.3.4 Prediction and Forecasting System for Optimising the Supply Chain in Dairy Products

The environment of Use Case 4 is an industrial environment. Via TERMINET, a predictive and forecasting toolkit will be created and used to optimize scheduling, save money and labour time and ultimately, increase productivity while decreasing miscalculations. Also, human expertise will be employed to achieve better results.

2.3.5 Group Training Surgery Using VR-enabled IoT Technologies

The environment of Use Case 5 is on medical and nursing education as well as continuing education and training of clinical staff. A virtual training environment will be set up using VR capabilities and will aim to both train and enhance the entire learning experience of participants.

2.3.6 Mixed Reality and ML Supported Maintenance and Fault Prediction of IoT-based Critical Infrastructure

The environment of Use Case 6 is Infrastructure maintenance and monitoring. By utilizing mixed reality technologies, along with the Digital Twin and predictions of future maintenance and tasks, TERMINET will reduce operational costs, as well as the workload of people needed for maintenance and monitoring, while the general operational overhead will be reduced.

2.4 Operation modes

TERMINET consists of the following operation modes, which also outline the functionalities offered to the end-user by the system:

1. **Data gathering,** which is split into two different levels, based on how data is being gathered: device and sensor level. In TERMINET, data can be gathered from sensors, usually when they are originating from industrial environments and from devices such as smart wearables and AR/VR glasses if sensors are not applicable.
2. **Data collection/data storage,** which is happening at the edge nodes of TERMINET. It is necessary for this data to be protected from unauthorized access, hence there will be privacy by design in the storage systems used. Furthermore, for the Federated Learning process, data do not need to leave the node's premises. Therefore, there is no danger from intercepting data sent for model training. Lastly, because of the decentralized blockchain framework, data written to the ledger are immutable, ensuring data integrity.
3. **Data transmission,** which will send data through the cloud continuum in order to train models locally, aggregate them to a global model and distribute results. Also, simulation data, expert data injection

and other similar functionalities will be sent to the edge devices that will follow certified and secure protocols for transmitting data in an IoT system, such as Message Queuing Telemetry Transport (MQTT), HyperText Transfer Protocol Secure (HTTPS) and so on.

4. **AI Learning,** which will be based on Federated Learning Framework (FLF) and will be a central piece for the distributed intelligence of TERMINET. AI models will be trained locally at the edge and then fused at the PLA-L of the project. Then, there will be the possibility to personalize the provided models by utilizing meta-learning methodologies, such as Model Agnostic Meta-Learning, in order to reach a high model quality in few training iterations. Finally, GDPR and relevant laws regarding data management will be followed to ensure that all data processing operates on a legal basis.
5. **Network control,** which will be enabled via SDN technology, by establishing an SDN-enabled scheme for communication, configuring SDN-controllers, gateways and switches, while supporting the dynamic adaptation and configuration of the SDN controller, based on user needs and requests from the TERMINET upper levels.
6. **Orchestration,** which will provide optimization mechanisms for resource management during runtime, as well as the edge service lifetime management through the entire cloud continuum. Also, heterogeneous platform services and applications with diverse QoS requirements will be placed, with bindings developed for open-source and state-of-the-art orchestrators.
7. **Applications and services,** which will be the highest level included in TERMINET. It will contain a plethora of applications and services, such as a User Panel with a KPI Manager, Reports and Visualisations, Energy Consumption Manager, a dashboard. 5G will be enabled and used, providing low latency, high scalability and high performance for TERMINET's applications and services. Thus, AR/VR frameworks will be possible to be implemented, as well as predictive analysis via Digital Twins and other intelligent IoT devices.

3. Stakeholder's requirements investigation

3.1 Methodology

There are a lot of methodologies to use when eliciting requirements. The one followed here is the Volere methodology [1], considering the relevant legal frameworks issued from both the national and the EU side, as well as the use cases described by the stakeholders and the user needs.

For that, a four-phase process was used to analyse and specify the TERMINET requirements, which are the following:

1. **Project objectives document**: This is the first phase in which the project's objectives, outcomes and impact are described.
2. **Stakeholders' requirements gathering**: This is the second phase in which background information about the stakeholders/users and processes takes place. According to Preece and Sharp, in their book "Interaction Design: Beyond Human-Computer Interaction" [6], data gathering can be done using the following methods: use-cases scenarios, observations, interviews and questionnaires, etc.
3. **Requirement analysis and evaluation**: Is the third phase which encompasses tasks that include determining the needs or conditions to meet for running a new project, taking account of the possibly conflicting requirements of the various end-users, analysing, and documenting, validating and managing stakeholder requirements. Once the user requirements are gathered (phase 2), potential techniques for analysing stakeholder needs are "brainstorming" (taking into consideration guidelines and standards), "presentation scenarios", "prototyping" etc. [7].
4. **User and General requirements specification**: This is the final phase in the general process for stakeholders' requirements analysis.

3.2 Methods for stakeholders' requirements gathering

Different requirements identification methods can be applied in parallel to complement each other to yield more effective results for the identification of the requirements [8]. This section presents the methods used for identifying the stakeholders' requirements for the TERMINET project, collecting information as follows:

1. **Meetings**: Meetings with the stakeholders were held in order to receive information about their views, needs and requirements, both Functional and non-Functional ones.
2. **Questionnaires**: A set of written questions to all stakeholders is given in order to further support the requirements gathering process.

3.3 TERMINET questionnaires

The current questionnaire designed and shared with all TERMINET's stakeholders in order to further support the requirements gathering process. It constitutes an initial approach to collect and register relevant users' requirements and the barriers they identified in their environment for the deployment of TERMINET's IoT ecosystem. The questionnaire consists of a set of written questions through which the delineation of each organization is attempted, by making an outline of their profile, their expectations and goals, their weaknesses or strengths and some other useful information.

Regarding the delineation of each organization profile, there are questions about the general purposes which each organization aims to fulfil, daily key systems that are involved in the organization's activities and a general description of the basic infrastructures and community facilities involved in their operation if any. In the same context, there are questions related to the amounts of unstructured data that is used and to what extend and also about the experience that each organization may have with cloud-based solutions for data hosting. The role of technology, the declaration of key stakeholders and the description of their human-machine interfaces concerning their complexity are also included in each organization profiling. Moving on, there are questions about potential issues that each organization may have faced related to ICT technical interoperability, management of relationships between departments or cooperative organizations, data sharing and any other issue related to interoperability, integration, ethics etc. and how they solved them. Furthermore, each organization's representative who fills the form is called to answer about any regulatory requirements and terms being used that are related to devices, communications and content and any possible aspects of their projects where good practice guidelines, certifications schemes or standards would have helped. Finally, through the questionnaire, an attempt is made, in order to have a general description of each organization key goals as their operating pillars and their purposes which aim to gain throw the TERMINET project in combination with their needs for evolution and improvements, such as the acquisition of real-time applications and services.

3.4 Analysis and results

USE CASE 1

UC1 validates, demonstrates and assesses key aspects of the TERMINET platform in one of the most popular IoT ecosystems, smart farming. American Farm School (AFS) is one of the main actors in this case study and, Filippos Papadopoulos, the director of SPMO, filled out the questionnaire. Strategic Project Management Office (SPMO) coordinates an innovation ecosystem with demonstration farms, a LoRaWAN telecommunications network and a vertically integrated cluster (Internet of Food Alliance). According to his answers, through TERMINET, AFS aims to reduce its environmental footprint and achieve traceability & efficiency in agricultural production. Farms, packing/processing, distribution and retailers are the main actors and processes that are involved in AFS's day to day activities, and at the same time, there are not any key infrastructure or community facilities that there are involved. The main stakeholders around AFS are the real economy actors along the agrifood value chain, technology providers, service providers (consultants), Universities and civil society organizations. Concerning the role of technology, digital

technologies are the integrating factor for AFS processes. Big amounts of unstructured data are gathered from fixed sensors (LoRa network, animal tracking sensors and weather stations), data ownership and lack of knowledge on LoRaWAN & cloud security are some of the data-sharing issues that AFS faces. Even if AFS has a 2-year experience working with IoT infrastructure, there are some features that are missing from their current IoT systems such as real-time alarm management, review & control of daily communications, review & control of energy values of gateways, radio noise & interference check (to move into urban environments), roaming, automation/Industry 4.0, integration of rural-urban operations. The ICT technical interoperability issues concern AFS's cloud (Microsoft Azure) with proprietary clouds of technology providers, and simultaneously, AFS representative argued that private network would be interested in exploring the possibility of going public. Issues around managing the relationships between different departments or with other organizations AFS closely work with have emerged. Disruption of the balance of power between links of the value chain due to big amounts of data transferred, obstacles to integrating retailer internal processes with digital traceability systems and information sharing across the links of the value chain or between competitors in the same link are some of these problems. Additionally, "accuracy decay" tests in field conditions and testing/calibration of agricultural IoT equipment would be good practise guidelines or even necessary in order to avoid potential issues of integrating digital tech with GACP & GMP certification. Managing in an integrated manner fixed sensor (set at ½ or 1-hour intervals) with vehicle tracking indicates the necessity for (near) real-time applications or services. Finally, some useful information gained from the questionnaire concerns some specific characteristics of AFS and its environment. AFS's competitors use IoT solutions partly, and the interfaces used by AFS cannot be characterized as user friendly. Moreover, AFS personnel are quite comfortable in using cloud-based solutions for hosting organization data, but there are some concerns about security and pricing.

USE CASE 2

This use case will venture to facilitate the exchange of information between hospital departments. Specifically, the aim of this case study is to develop more efficient and personalized treatments by facilitating the exchange of information between hospital departments and utilising medical knowledge from various sources. The pilot site is the hospital (wards and clinics) Fondazione Policlinico Universitario Agostino Gemelli (GEM), and it is located in Italy, as noted by Andrea Damiani (Head AI strategy, R&D). The organization envisions to improve the efficiency of healthcare delivery (e.g., by reducing hospitalization time) and patient quality of life. By participating in the TERMINET project, the organization expects to experience an improved communication level between different specialists. At the same time, a raised patient awareness level and improved qualitative communication between patient and doctor are also expected.

Technology is already used in day-to-day activities, and a number of IT solutions exist in the hospital. There is a need to improve interoperability and exchange of information between different settings inside the hospital. The key stakeholders affected by such systems are citizens, other healthcare organizations and Health Systems. Also, they are experienced with working with IoT infrastructure as they have four ongoing protocols using IoT's; related to COVID-19 patient monitoring during radiotherapy treatment, PROMS

assessment in GYN patients during radiotherapy and COVID-19 infection monitoring in patients with HIV. An app is used to monitor Adverse Drug Reactions after COVID-19 vaccine sub ministration.

An ICT technical interoperability issue noted is that different IT systems need to establish continuous communication in order to exchange timely information. Either they are enabled by design to do that, or an integration process needs to be put in place at a later time. This is especially true when heterogeneous data sources (structured, unstructured, processed images, omic etc.) are needed for some research task. This issue is usually solved by building one or more integration layers to project data from sources to data marts, where they are made available to data scientists. Also, the organization does not have traction with big amounts of unstructured data in the setting that is addressed by this project. Though in other projects, they frequently encounter unstructured data such as Histopathology reports, Radiology reports, surgical reports, and many others for which text mining is often necessary.

Relationships between different departments may be affected by different strategic priorities. Guidelines harmonisation is sometimes needed when the same disease is assessed by different specializations. Specific interdisciplinary groups are appointed to deal with this issue. Also, for information sharing, there are two different levels. Inside a hospital, there can be different data collection procedures with different formatting and terminological systems. All these issues need to be fixed before any research effort is initiated. Between different institutions, all the above apply, and the data exchange issues related to privacy and data property should also be kept in consideration.

Data sharing is another issue worth mentioning. As a general policy, patient data are not allowed to leave the Hospital, even in (pseudo-) anonymized form. The general solution is Federated Learning, which is developed locally and put in place for many multi centric studies. When special permissions are given and positively evaluated by the Ethical Committee, pseudonymized data are allowed to leave the hospital for research aims. The organization has specific experience on terminological systems and semantic preservation across data sources, which is indeed a problem, but with feasible solutions. Note that all their projects are approved by the Ethical Committee after close scrutiny and are conducted under rules approved by our Data Protection Officer, in full respect of good practice guidelines, official clinical guidelines, national and E.U. rules. For cloud-based solutions, special permission is needed from the Hospital Ethical Committee. Full certifications of adherence to GDPR are needed, and the cloud should be physically located in E.U. under E.U. jurisdiction.

It is worth mentioning that the organization would use only standard, non-proprietary technologies in their projects, but there are cases that this might not be the best option. Such cases occurred when there was no standard, non-proprietary technology available. Proprietary solutions were developed for extracting information from clinical images and for Federated Learning algorithms because the needed level of customization was not available. Also, in other projects mentioned above, proprietary technology (Healthentia) was used because it offered the right level of personalization that was needed for the use cases and it was not available in standard products.

For their human-machine interfaces, they adhere to the eXplainable Artificial Intelligence (XAI) paradigm, under which human - machine interfaces should make the user aware of the meaning of the AI solution(s)

underlying the model in use. This includes user friendliness and clear explanations, in terms suitable for the average user of the interactions with the system.

USE CASE 3

Use case 3 aims to transform a legacy building into a Smart Building, providing mechanisms (sensors, learning models, and IoT platforms) to improve energy consumption, as noted by Vicente Mayor, who is R&D Project Manager in WTG. Their organization aims to achieve comfort and energy efficiency, while their everyday activities include energy-related issues and IoT Platforms. This Use Case involves an existing building in Algeciras, and the key stakeholders are the Centro Tecnológico de Algeciras, who is the building owner and Wellness TechGroup, who is the Pilot provider. The WTG organization is an IoT provider for Smart Cities acting on the competitive IoT market, and they are also comfortable with cloud-based solutions for hosting data. By participating in the TERMINET project, the organization aims to achieve an integral platform to provide IoT capabilities to a non-smart environment.

Technological elements can be used as a form of data acquisition and processing mechanism, so utilizing sensors in the building, the energy efficiency can be improved. Note that for that purpose, IoT applications need to control and monitor devices in a timely manner, as close as possible to real-time. The key infrastructures include an electricity infrastructure, an energy generation system (thermal solar and photovoltaic solar system) and the air conditioning systems of the building.

USE CASE 4

UC4 is oriented around the Prediction and Forecasting System for Optimizing the Supply Chain in Dairy Products. MEVGAL S.A. is a private company located in Northern Greece which produces and markets a full range of products such as milk, yoghurts, and various types of soft, semi-hard and hard cheese. MEVGAL S.A. is actively involved in a number of researches and technological development projects in constant pursuit of innovation, and in this context, they joined the TERMINET project as one of the main actors. Konstantinos Georgakidis (MEVGAL's Production Support Department) and Dimitris Iatropoulos (MEVGAL's Junior Project Manager) filled out the questionnaire from which the following information was gained.

According to their answers, the main goals which MEVGAL aims to fulfil through TERMINET are to optimize its supply chain and to increase its productivity, the reduction of wastage, its economic growth with a simplification of the processes and finally, the improvement of forecast accuracy. MEVGAL's day to day activities include daily production schedules, according to their needs, forecasting and, orders and the key stakeholders of MEVGAL's actions are its personnel and customers apart from the owners. The role that technology plays is crucial, as most of the actions in the supply chain are monitored, from the production of the milk up until its distribution or its products. The amounts of unstructured data used are big since many production systems that produce data such as production orders, sales data, route data, production sensors data (temperature, control, process data etc.) run daily. Concerning the regulatory requirements and terms being used from MEVGAL that are related to devices, communications and content, these are

Device safety of use, Communications Security, Security and Data Protection. ICT technical interoperability issues like a collaboration between systems have been solved through the usage of appropriate s/w services or export suitable files from one system and import to another. Other issues related to ethics, integration and informed consent or technical interoperability issues that are not related to ICT have not emerged yet. MEVGAL is experienced in working with IOT infrastructure as some of their systems have IoT capacity as part of the control production system (i.e. ACMON Data etc.) and according the questionnaire's answers, smart forecasting is a feature that is missing from MEVGAL's current IoT systems. ISO 9001 certification has been utilized and helped MEVGAL to set procedures for every crucial aspect of their work. Throw TERMINET project, MEVGAL expects to have a tool that will produce and get better in time of the forecasting of certain product codes and via AI technologies to make forecasting more accurate and predictable over time. Finally, MEVGAL uses user-friendly interfaces and proprietary technology as their systems are crucial for their operations and in FMCG, they need very quick response time in a problem that only proprietary technology could usually offer. The necessity for (near) real-time applications and services are obvious and, regarding MEVGAL's representatives, their competitors use IoT solutions as well.

USE CASE 5

The following information concerns the answers to the questionnaire filled out by Dag Eklund, the project leader of Alteruna, which is the technical expert of use case 5. The respective use case goes into the implementation of enhanced VR training sessions by utilizing the ALTER TeamSimulator and the capabilities of the TERMINET platform towards keeping doctors' lifesaving skills sharp. TeamSimulator is a virtual reality training software for medical staffs and universities. Nurses, doctors and students can train specific surgery and treatments the site or over the internet. It supports both skills and team training. The key purposes Alteruna aims to fulfil due to this project is to provide better training for health care professionals and students, which will lead to less harm to patients and finally to healthier citizens. Health care and education are the key systems involved in Alteruna's day to day activities and, to this scope, Universities (such as KI) and hospitals which are the key stakeholders, are some of the community facilities that will participate in the enterprise. Electricity and communication networks will be the key infrastructures while the technology will play a crucial role for Use Case 5 implementation as mobile reality equipment is required. Concerning the regulatory requirements and terms being used that are related to devices, communications and content, the application doesn't require CE approval. In the case of user data collection and storage, there will be compliance with GDPR. According to Dag Eklund, there are no sensitive content and user data stored in the context of this project yet, so neither no issues regarding data sharing. It is worth mentioning that concerns have been raised from customers concerning storing user data. Moving on, content/screen casting in closed hospital networks was a technical interoperability issue not related to ICT, which was resolved by setting up internal networks. Furthermore, there are a few issues with virtual reality such as tired eyes, nausea, inability to have a stereoscopic view, etc., that should be addressed. For this reason, guidelines and standards will be appropriate, and certifications may be useful for certain training applications. According to Alteruna's representative answers, low latency is the reference point of TERMINET which can lead to a high-quality virtual reality experience and help to avoid

the aforementioned issues and obstacles. The ability to observe and manage users through a device management application will be important as well. Moreover, Alteruna is able to use only standard, non-proprietary technologies in their project and their operations require (near) real-time applications and services. Finally, concerning Alteruna's human-machine interfaces, consumer friendly and intuitive APIs are used, even if Virtual Reality is complex technology. Specifically, Alteruna employs consumer virtual reality equipment from Oculus/Facebook.

USE CASE 6

"Mixed Reality and ML Supported Maintenance and Fault Prediction of IoT-based Critical Infrastructure" is the general scope of UC6. PPC, which constitutes a main involved actor in this Use Case is the dominant energy provider in Greece, and its representative, Marios Valsamakis (Electrical Engineer, Inspector and Head of Electrical Testing and Measurements Subsection of TRSC/PPC), filled out the questionnaire. Along the TERMINET project, PPC aims to increase the efficiency of maintenance tasks (in terms of success rate, the accuracy of the performed tasks and task duration – including minimum errors). In addition, PPC aims to centralize the monitoring of critical infrastructure and be informed about possible upcoming faults, leading to cost savings and increased availability. The key systems involved in PPC's day to day activities constitute energy-related equipment, including generators, PLCs, RTUs, as well as networking equipment like switches, routers, and servers. Concerning the community facilities and key infrastructures which are implicated, those are power stations on the one hand and RTUs, PLCs, servers, virtualized infrastructure and network switches on the other hand. The manufacturers that provide the infrastructure under maintenance and the engineers that perform maintenance tasks can be characterized as the key stakeholders of the PPC environment. Technology plays a crucial role for PPC's proper functionality as it facilitates data management and access to historical data, enables remote access and transmission, studies tendencies and predicts possible future events and assists engineers to detect faults and guide them via mixed reality through complex tasks. Moving on, PPC's workflows involve known and structured data, however, the various workflows (e.g., monitoring different type of assets) introduce multiple, totally different data structures. At the same time, PPC operates some IoT equipment that uses common communication protocols (e.g., Modbus, MQTT). Regarding the ICT technical interoperability issues, custom software must be developed to collect and store IoT data flows, resulting to additional effort and lack of scalability and concerning the data-sharing issues, data-sharing is restricted since health status from generators, actuators, and critical devices should remain confidential. Therefore, this information is disclosed only to authorized personnel. According to PPC's representative, they have not been able to use the only standard and non-proprietary technologies in internal projects, mainly because the proprietary solutions are already established in the business workflow, are more trusted by the management, and there is no strong incentive to move to non-proprietary and standard solutions. In other words, the proprietary solutions are more established and trusted in the market. Furthermore, it is worth mentioning that PPC's competitors already use IoT solutions, and PPC's existing human-machine interfaces are complex and inflexible, meaning that they cannot be easily adapted to the various data structures. Finally, personnel of PPC are comfortable storing data in the cloud if non-disclosure agreements have already been taken place (e.g. Data indicating faults at a specific time should remain private).

In addition to the above, Amelia Alvarez, who is a Schneider Electric Project Manager (SCHN), participates in this Use Case. Schneider Electric provides energy and digital automation solutions for efficiency and sustainability. Schneider Electric combines world-leading energy technologies, real-time automation, software and services into integrated solutions for homes, buildings, data centres, infrastructure and industries. Their aim is to make process and energy safe and reliable, efficient, and sustainable, open, and connected. The key systems involved in their everyday activities include Electric substation controllers / Remote Terminal Unit (RTU), while the involved facility is a Power Plant. Their key infrastructure is electricity based. Note that RTUs operate on an embedded real-time operating system, and thus, controllers running on the RTUs are real-time services.

The key stakeholders are utilities that acquire Schneider Electric's RTUs, manufacturers of equipment or systems that are going to be integrated with their RTUs, and engineers that perform the installation and maintenance tasks. The aim of Schneider Electric in this Use Case is to enable its technology to facilitate data management and access to historical data, enables remote access and transmission, studies tendencies and predicts possible future events, and last but not least, assists engineers to detect faults and guide them via mixed reality through complex tasks.

The organization has previous working experience with the development of an embedded prototype of an IoT interface under the scope of another R&D project, which included a limited set of IoT protocols (i.e. MQTT, AMQP, OCP UA), but not with IoT infrastructure itself. The TERMINET project will assist in validating the technologies that they will deploy. As far as the data structure is concerned, RTUs handle databases specifically designed for the customer. Those data are sent as structured data using a previously selected communication protocol. Also, the Data sharing policy is not handled by Schneider Electric but by the customer that installs the RTU, as the RTU just handles the information that is defined for the customer database. User interfaces are user friendly, and their complexity is dependent on the complexity of the RTU configuration for the custom installation to be controlled.

Ericsson's vision and purpose are "Empowering a more intelligent and sustainable connected world by relentlessly innovating networked technologies that are easy to use, adopt and scale". The everyday activities of the company involve Optical Transport equipment as part of the Ericsson Radio Access Network for 4G and 5G connectivity, as stated by Marcello Morchio, who is an Electronic Engineer, System Manager in Optical Solutions and Fronthaul in the Ericsson R&D Italy (TEI).

Their activities involve community facilities such as Radio access network is spread between radio antennas in outside towers in indoor locations and telecom operator central offices. Optical transport network includes distribution nodes and cabinets located on poles, strands, curbs or underground in manholes. The key infrastructures are Antennas, telecom infrastructure, physical and virtualized servers, and network components. In general, the key stakeholders include business and individual mobile users, network roll out and maintenance teams, network integrators, city planners, network operators. For the scope of TERMINET UC-6, the direct stakeholders are network maintenance teams and network operators, and integrators. Involved technologies in the UC-6 can assist in reducing optical network maintenance cost by predicting possible failures on SFP modules and allowing planning of maintenance actions.

As telecom manufacturers, the company usually provides the network infrastructure, either fixed or mobile, for the IoT networks. In this case, we consider the components of the network itself as sensors, and thus as IoT devices, generating performance data to be correlated with configuration data. SFP modules are used in many kinds of network products that have their own Operation and Management workflow. Integration of collection and processing of common data across different managed elements is a challenge. The current solution is a cross-platform data collection to cover many hardware maintenances services, the challenge is to exploit that platform for advanced Use Cases such as predictive maintenance. The reference standards, with regard to SFP modules, are maintained by SNIA "Storage Networking Industry Association" [9]. It is worth mentioning that data sharing is restricted since health status from optical modules and critical devices should remain confidential. Therefore, this information is disclosed only to authorized personnel and managed according to local data protection rules.

With their participation in TERMINET, the organization aims to address the challenge of exploiting exploit the data platform for advanced Use Cases such as predictive maintenance, coping with the need of avoiding data spread beyond the regulatory constraints. As far as human-machine interfaces are concerned, there are many types of interfaces and presentation pipelines in the network management realm, with different level of complexity and targeted to different types of users. Their usage is intuitive, provided the right competence level of the user. Lastly, the organization expresses its comfortability of storing data in the cloud, but there are constraints about cloud being propriety of our customers for some data types and ours for others.

4. Stakeholders requirements definition

4.1 Requirements elicitation and prioritization approach

After gathering the results of the meetings and questionnaires that were described in the previous section, the next phase of the approach aims in the definition of the requirements alongside an evaluation regarding their importance. To achieve this goal, a relevant analysis was performed that lead to the definition of a number of requirements associated with the use case scenarios.

The following requirements form the core of the project and will steer the research efforts during the development of the TERMINET system. It is evident that elicitation and prioritization should be aligned and in accordance with the needs and goals of the specified use cases resulting in the end to the functional and non-functional requirements of the TERMINET system that has been envisioned.

To this end, the requirements identified in the meetings with involved parties and with the use of questionnaires were further analysed and prioritized, defining and using an importance value for each one of them. The values used to signify the importance of the requirements fall into three labels “High”, “Medium”, and “Low”. The derived importance level is based on the frequency of occurrence of the requirement, its broadness and interdependencies and the impact it poses for the successful implementation of the Use Cases scenarios.

4.2 Prioritized requirements

ID	UR1
Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Edge Node
Rationale:	The edge node is required to map TERMINET functionalities and deployed IoT devices to current WTGs infrastructure, and also to provide edge computing capabilities.
Requirement description:	TERMINET should integrate with WTG's Edge Node (one per monitoring entity, e.g., floors, buildings...), enabling the Smart Building to integrate high IoT heterogeneity (e.g., protocols, network interfaces), and also to provide edge computing capabilities.
Originator:	Wellness Tech Group
Priority:	High
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR2
Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Reduce energy consumption of the Smart Building
Rationale:	Energy efficiency
Requirement description:	The main goal is to reduce energy consumption at the building, turning it into a Smart Building. TERMINET should combine AI models, automation and visualisation tools to enhance energy efficiency from the data gathered from deployed sensors.
Originator:	Wellness Tech Group
Priority:	High
Fit criterion:	Energy efficiency increased by 25% (minimum) compared before vs after TERMINET deployment
Supporting Materials:	-

ID	UR3
Requirement Type:	User
Relevant Use Case:	UC5
Short Title	Reliable communication between IoT device and intelligence layer
Rationale:	In order to minimize deviation between the IoT device state and intelligence layer application state.
Requirement description:	The scenario will be captured in real-time from the IoT device by exchanging events and positional data of objects in the virtual environment. To reduce the gap of the current situation reflected on the edge node in relation to the IoT device, a high amount of data has to be synchronized continuously.
Originator:	Alteruna
Priority:	High
Fit criterion:	Measured packet-loss below 4%
Supporting Materials:	-
ID	UR4

Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Controlled video stream from edge node application to the application layer.
Rationale:	In order to observe and control a virtual reality session (from an HMD/IoT device) in real-time from the application layer.
Requirement description:	The main goal is to reduce energy consumption at the building, turning it into a Smart Building. TERMINET should combine AI models, automation and visualisation tools to enhance energy efficacy from the data gathered from deployed sensors. The application controlling selection of the current view within the virtual environment must be highly responsive. The application will be used to observe and examine surgery training sessions in virtual reality and must therefore provide high-quality video and audio in combination with low input lag. Input will be sent from the application to the software module running on the edge node, which in turn selects an appropriate camera as a rendering target.
Originator:	Alteruna
Priority:	High
Fit criterion:	To test input lag from the device management window and to ensure that latency should be below 40ms for controlling the viewpoint. The quality of video stream to ensure that bitrate is according to specifications/requirements.
Supporting Materials:	-

ID	UR5
Requirement Type:	User
Relevant Use Case:	UC5
Short Title	GPU pass-through on edge nodes
Rationale:	In order to offload traffic and reduce latency.
Requirement description:	The software module deployed will need an Nvidia graphics card in order to encode and broadcast video and audio streams to client browsers.

	In order to only exchange positional data between the edge node and the participants in the virtual reality training session, the edge node has to be context-aware and able to derive a video stream (reflecting the virtual environment) and broadcast to device management window applications.
Originator:	Alteruna
Priority:	High
Fit criterion:	Test input lag from device management window and ensure latency is below 40ms.
Supporting Materials:	-

ID	UR6
Requirement Type:	User
Relevant Use Case:	UC2
Short Title	Unique matching of individual patient data sources
Rationale:	A user must be uniquely identifiable across the databases. A doctor must have access to all information available from one unique patient.
Requirement description:	No matter their entry node in TERMINET, a patient must be identifiable as the source of the data across all TERMINET nodes. TERMINET must know that a patient with some Gemelli ID is the same person as a participant with some Healthentia ID.
Originator:	Innovation Sprint
Priority:	High
Fit criterion:	Validate in pilots
Supporting Materials:	-

ID	UR7
Requirement Type:	User
Relevant Use Case:	UC2

Short Title	TERMINET can leverage the existing Gemelli infrastructure
Rationale:	The IT infrastructure of the Gemelli hospital cannot be altered. Any new technology needs to integrate with existing networks.
Requirement description:	The TERMINET instance will be independent of the IT infrastructure of Gemelli. It will use resources provided by Gemelli and its network infrastructure.
Originator:	Innovation Sprint
Priority:	High
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR8
Requirement Type:	User
Relevant Use Case:	UC2
Short Title	Only authorized healthcare personnel can identify patients.
Rationale:	Given the sensitivity of the medical information, it is of utmost importance to know which data was/is being shared, by whom and to whom.
Requirement description:	Only healthcare professionals will be able to match a patient ID with the patient.
Originator:	Innovation Sprint
Priority:	High
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

ID	UR9
Requirement Type:	User
Relevant Use Case:	UC2

Short Title	Number of TERMINET edge nodes needed
Rationale:	One of the aims of TERMINET is to facilitate transferring of models between departments. This model transfer should not go through the hospital infrastructure.
Requirement description:	There shall be one edge node per participating department of the Gemelli Hospital (4 departments: radiology, Oncology, Pathology and Surgery).
Originator:	Innovation Sprint
Priority:	High
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

ID	UR10
Requirement Type:	User
Relevant Use Case:	UC2
Short Title	Data visualization tool combining Real-World Data and clinical data for intergroup evaluation
Rationale:	One of the pains experienced by the stakeholder is that there is no way to facilitate the exchange of information during the Intergroup Evaluations. The Intergroup combines experts from four hospital departments – Pathology, Radiology, Radiation Oncology and Surgery – and discusses specific patient cases in order to decide on the next steps in the care path of the patient. The visualization tool is the front-end of the TERMINET technology, and therefore, it is of utmost importance for the evaluation tasks.
Requirement description:	*TERMINET shall deliver a visualization tool (e.g. dashboard) that displays several types of medical information (e.g. medical history, patient care path and guidelines from different specialities) of a single patient that is the subject of the Intergroup evaluation. This visualization tool will be used during face-to-face and virtual meetings of the Intergroup.*
Originator:	Innovation Sprint
Priority:	Normal
Fit criterion:	Evaluate/Validate in pilots

Supporting Materials:	-

ID	UR11
Requirement Type:	User
Relevant Use Case:	UC2
Short Title	Secure and private data exchange
Rationale:	At the moment, the medical data of a patient is very fragmented between hospital departments. This means that when a patient is referred by a department, there is no or minimal information available about the medical history.
Requirement description:	*TERMINET shall facilitate exchange of data from the two sources (Healthentia and Generator).*
Originator:	Innovation Sprint
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR12
Requirement Type:	User
Relevant Use Case:	UC2
Short Title	Combine medical guidelines of relevant medical specialties
Rationale:	Each medical speciality often has different guidelines for how to address specific symptoms. This means that the care path of the patient within the hospital is often influenced by the first and consequent order of medical professionals that receive the case. This leads to delays. Intergroup evaluation with access to different guidelines (ideally unified guidelines) would address this pain.

Requirement description:	In the visualization tool, when viewing information about a specific patient, the tool shall provide all medical guidelines related to the patient's symptoms.
Originator:	Innovation Sprint
Priority:	Normal
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

ID	UR13
Requirement Type:	Functional
Relevant Use Case:	UC6
Short Title	RTU gathering maintenance data provided by substation sensors or devices
Rationale:	By satisfying this requirement, the RTU will act as an IoT gateway, allowing the conversion of complex industrial protocols and raw analogue signals to interoperable and flexible IoT protocols (e.g., MQTT).
Requirement description:	In case any of the information provided by substation devices or sensors are of interest for substation maintenance tasks to be developed in UC6, the information needs to be collected by the RTU using: - Substation Standard Industrial Protocols such as Modbus, DNP 3.0, IEC 104, IEC 101 or IEC 61850 - Direct wiring to digital or analog acquisition boards of the own RTU. (i.e. a temperature sensor of the substation can be connected to the analog acquisition board) This requirement may only apply to substation devices or sensors that are actively implied in the exploitation and normal operation of the substation.
Originator:	Schneider Electric
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR14
Requirement Type:	Functional
Relevant Use Case:	UC6
Short Title	Substation RTU IoT data exchange
Rationale:	Flexible, interoperable, and secure IoT protocols should be supported by the RTU in order to be easily integrated into various IoT environments.
Requirement description:	Substation RTU will exchange maintenance data and substation information with IoT cloud using MQTT or OPC_UA protocols.
Originator:	Schneider Electric
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR15
Requirement Type:	Non-functional
Relevant Use Case:	UC6
Short Title	Substation RTU should be protected against cybersecurity attacks through IoT communication interface.
Rationale:	Substations are considered as critical infrastructures. That is why only industrial communication protocols approved for substations are used and Internet connections are generally disable for substation IED assets.
Requirement description:	The IoT communication interface must be well protected so cybersecurity attackers cannot influence on the normal operation of the substation by writing on the RTU database.
Originator:	Schneider Electric
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR16
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Interface with IoT devices using OPC_UA or MQTT
Rationale:	MQTT is a secure, and flexible IoT protocol that is based on the pub/sub communication model. The asynchronous nature of this protocol and the JSON-based data schema makes it lightweight and interoperable with various IoT systems. OPC_UA is a M2M protocol that is specialised on industrial automation, providing advanced security functionalities and a service-oriented architecture (SOA). Both protocols satisfy industry standards and are appropriate for transmitting operational data and measurements.
Requirement description:	TERMINET must be able to support the collection of IoT data using at least OPC_UA or MQTT communication protocols.
Originator:	Public Power Corporation S.A.
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR17
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	TERMINET must be able to collect IoT data using NETCONF
Rationale:	NETCONF is a modern management protocol used by network administrators and NOC (Network Operation Centre) in order to manage intermediary network devices (e.g., routers and switches). In the context of UC6, NETCONF can be used to communicate with the optical switches, in order to access the operational data of the attached SFP modules.
Requirement description:	The TERMINET platform must support the collection of operational data from IoT devices via the NETCONF communication protocol, using the corresponding YANG model of the IoT device.

Originator:	Public Power Corporation S.A.
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR18
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Labelling sensitive corporate data
Rationale:	Operational data indicating faults in the facility is considered sensitive corporate data.
Requirement description:	The user should be able to indicate specific data collections in TERMINET as sensitive. By making this indication, TERMINET must ensure secure transmission and storage.
Originator:	Public Power Corporation S.A.
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR19
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Log rotation for the IoT data
Rationale:	-
Requirement description:	The TERMINET user must be able to configure log rotation for the IoT data, based on size or time-limit.
Originator:	Public Power Corporation S.A.
Priority:	Normal

Fit criterion:	-
Supporting Materials:	-

ID	UR20
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Data Interoperability
Rationale:	UC6 will collect and store operational data concurrently from SFP modules and RTUs. The data structures between the SFP modules and the RTUs are completely different.
Requirement description:	The TERMINET platform must store and work with operational data that have various structures.
Originator:	Public Power Corporation S.A.
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR21
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Asset inventory
Rationale:	-
Requirement description:	TERMINET must provide an asset inventory for registering assets that are monitored for their health status (to be utilised for predictive maintenance). Specific and customizable attributes should be stored for each asset.
Originator:	Public Power Corporation S.A.
Priority:	Normal
Fit criterion:	-

Supporting Materials:	-

ID	UR22
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Asset inventory: Alerts
Rationale:	The operators should be asynchronously notified if a device needs maintenance.
Requirement description:	• The asset inventory must generate alert when a device needs maintenance, according to the results of the corresponding prediction models. Multiple levels of alerts should be available, depending on the prediction accuracy (if applicable) and the severity of the predicted fault.
Originator:	Public Power Corporation S.A.
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR23
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Asset inventory: Locating Engineers
Rationale:	Considering that RTUs may be placed in remote areas, it would be helpful to have an automated mechanism for notifying the nearest available engineer about an RTU that needs attention, in order to ensure immediate response.
Requirement description:	The asset inventory of TERMINET must be able to monitor and track the location of each engineer in a facility.
Originator:	Public Power Corporation S.A.

Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR24
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	QoS prioritization for real-time flows
Rationale:	Introduced to ensure smooth running of demanding but mission-critical applications that consume significant network resources (e.g., live streaming of a maintenance task to the RE)
Requirement description:	TERMINET must be able to prioritize network traffic in order to give priority for real-time applications
Originator:	Public Power Corporation S.A.
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR25
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	TERMINET Authenticator
Rationale:	Enhance security and ensure trusted communications in the IoT network.
Requirement description:	TERMINET must authenticate all IoT devices before they join the network.
Originator:	Public Power Corporation S.A.

Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR26
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Mapping QoS rules to TERMINET apps
Rationale:	QoS rules should apply to specific TERMINET apps.
Requirement description:	TERMINET must provide the option for the user to establish Quality of Service Key Performance Indicators that are mapped to specific TERMINET applications.
Originator:	Public Power Corporation S.A.
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR27
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Monitoring QoS and generating alerts
Rationale:	QoS rules must be monitored in order to intervene where possible.
Requirement description:	TERMINET must be able to monitor configured QoS KPIs and generate alerts in case they are not accomplished.
Originator:	Public Power Corporation S.A.
Priority:	Normal

Fit criterion:	-
Supporting Materials:	-

ID	UR28
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Tracking and identification of the individual animal from a distance
Rationale:	Quick and easy selection of the animals for vet treatment. Avoiding injuries
Requirement description:	Livestock identification and tracking is a process of accurately recognizing individual animals. Identification of livestock enables farmers to manage animals more cost effectively, provides better proof of ownership in areas where there is little or no grazing boundaries and assists in the recovery of animals in cases of stock theft. Tracking of animal movements also has a far-reaching impact in the areas of health, food quality management and conservation. For the extensive livestock, it is important to identify animals among the lot from a distance and have the relevant information presented real-time to the farmer. The identification for the intensive livestock can be made while the animals are inside milking parlour. Digit animal collars (GSM) can be used while for the intensive system the already placed RFID rumen bolus RFID (FDX and HDX)
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR29
Requirement Type:	User
Relevant Use Case:	UC1

Short Title	Animal Geo Tagged (Conjunction with NDVI)
Rationale:	Relate the animal's position with the most suitable area for grazing. Real-time information
Requirement description:	Grazing management - Allows the farmer to select the most suitable area. Relate the animal's position with the most suitable area for grazing with the NDVI information
Originator:	American Farm School
Priority:	High
Fit criterion:	-
Supporting Materials:	-

ID	UR30
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Normalized difference vegetation index (NDVI) – Satellite or UAV
Rationale:	Real-time NDVI form large areas (grasslands) - Grazing management - Allows the farmer to select the most suitable area ARC GIS
Requirement description:	Appropriate grazing management is an important tool in effectively utilizing land resources. Pasture biomass estimation from normalized difference vegetation index (NDVI) using ground, air or space borne sensors is becoming more widely used in precision agriculture. Utilization of satellite data for precision agriculture satellite which carries sensors for wavelengths are useful for producing vegetation indices. Nevertheless, surface information sometimes cannot be acquired because of interference by clouds, aerosols, moisture, or fog. On the other hand, Multispectral cameras on UAVs can capture data that are useful for evaluating vegetation conditions. A UAV can cover comparatively small areas but can provide data with a ground sample distance (GSD) of a few centimetres, thereby offering improved spatial resolution. All the information should be offered real-time to the farmer.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-

Supporting Materials:	-

ID	UR31
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Digital fencing, create “safe areas” and define alerts
Rationale:	Avoid overgrazing – protect animals - Digitanimal collars - GSM
Requirement description:	Virtual fencing technology has the potential to revolutionize the management of the livestock industries. The presence of a virtual fence is communicated to the animals via signals rather than through the presence of a physical barrier which can increase the flexibility of fencing options. This may result in reduced labour, improved herd management, and protection of environmentally sensitive areas.
Originator:	American Farm School
Priority:	High
Fit criterion:	-
Supporting Materials:	-

ID	UR32
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Video streaming of the animal
Rationale:	Live and quick advice from the vet to the farmer - minimise consultancy travel costs and provide immediate solutions.
Requirement description:	Disease detection systems help producers detect diseases earlier by monitoring subtle changes every day. Many of the symptoms require vet visits. Regarding the extensive livestock system where all the animals are kept outside and grazing lands are in most of the cases, far away in the mountains where physical visits are not always possible. Live streaming of cattle can give an indicator of the animal’s health condition. The vet can give

	advice to the farmer without having to travel large distances and thus minimize the vet cost for the farmer.
Originator:	American Farm School
Priority:	High
Fit criterion:	-
Supporting Materials:	-

ID	UR33
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Animal photo storage (phenotypic characteristics of the animal)
Rationale:	Photo Storage of phenotypic characteristics of the animal – data analysis for body score condition
Requirement description:	Body condition scores are often used as a critical measure of how effective feeding is on a farm. Knowing the body condition score of the animals is limiting weight loss in early lactation (transition management) and making sure that animals do not get too fat in late lactation (feed efficiency). It is necessary to observe animals on an individual level in order to assess their health and wellbeing and ensure efficient production. One of the most significant challenges to the livestock industry is its reliance upon subjective human observation for assessment, which can be as low as only a few seconds per animal each day. Photo capture and image processing and analysis can give indicators for an animal's body score conditions.
Originator:	American Farm School
Priority:	High
Fit criterion:	-
Supporting Materials:	-

ID	UR34
Requirement Type:	User

Relevant Use Case:	UC4
Short Title	Real-time monitoring of processes of the supply chain
Rationale:	Optimization of the efficiency of the supply chain
Requirement description:	Through TERMINET, monitoring devices will be applied on the factory, on the processing departments and on the packaging departments in order to real-time monitor quantities of products and raw material in the different processes of the supply chain.
Originator:	MEVGAL
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR35
Requirement Type:	User
Relevant Use Case:	UC4
Short Title	Interoperability of collected data to all permission granted users
Rationale:	Optimization of data entry and decision making
Requirement description:	Efficient communication and data exchange between the different software that are used during the processes of the supply chain (ERP, Forecasting system) and the monitoring devices that are going to be applied to the various processes of the supply chain.
Originator:	MEVGAL
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR36

Requirement Type:	User
Relevant Use Case:	UC4
Short Title	Quantification of qualitative variables (i.e. competition)
Rationale:	Application of qualitative variables to the forecasting system in order to optimize the forecasts efficiency.
Requirement description:	Data collection and development of methods for the transformation of qualitative variables to quantitative values that can be applied to the developing AI forecasting system.
Originator:	MEVGAL
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR37
Requirement Type:	User
Relevant Use Case:	UC4
Short Title	Exploitation of long- and short-term historical data from production sales (Market trends and seasonality)
Rationale:	Use of historical data in order to identify sales patterns
Requirement description:	Provision of historical sales data from MEVGAL and application of this data to the developing AI forecasting system.
Originator:	MEVGAL
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR38

Requirement Type:	User
Relevant Use Case:	UC4
Short Title	Creation of a four-week forecast every week and exchange of data with our ERP system
Rationale:	Optimization of the existing forecasting system with the determination of the forecast value through the combination of data and automated data-entry to the ERP system.
Requirement description:	Combination of all the data that have been collected during the previous requirements in order to create a weekly for four weeks forecasting value that will also be applied to the existing ERP system,
Originator:	MEVGAL
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR39
Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Artificial intelligence for energy efficiency
Rationale:	AI will be the main source to enable energy savings.
Requirement description:	It should exist an AI model to improve the energy consumption of the building based on its behaviour. The AI model could provide suggestions or predictions to enhance energy efficiency.
Originator:	Wellness Tech Group
Priority:	Normal
Fit criterion:	Reduce energy consumption of the Smart Building
Supporting Materials:	-

ID	UR40
Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Federated learning capabilities
Rationale:	In a Smart City context, data exchange should be secure (and private), and data computation should be decentralised to be efficient.
Requirement description:	Federated Learning will allow similar buildings to exchange useful information for improving energy efficiency without privacy concerns. In a future state, a federated learning framework should allow similar buildings to follow a federated paradigm, exchanging useful information for the others.
Originator:	Wellness Tech Group
Priority:	Normal
Fit criterion:	Energy efficiency data and KPIs have common order of magnitude/values in similar buildings and environments. Evidence of shared info between scenarios
Supporting Materials:	-

ID	UR41
Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Forecasting platform
Rationale:	The building owner should be able to visualize the energy prediction of the building to manually act in consequence if needed.
Requirement description:	AI results, suggestions or predictions should be visualized through a forecasting platform. Yet to be completely defined.
Originator:	Wellness Tech Group
Priority:	Normal
Fit criterion:	User will be able to visualize energy consumption and future efficiency behaviour through platform GUI.

Supporting Materials:	-

ID	UR42
Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Heterogenous IoT support
Rationale:	Not every IoT provider use the same protocols/APIs, and not every monitored device is supposed to be "smart" (legacy equipment).
Requirement description:	TERMINET should be able to handle heterogeneous IoT data coming from newly installed IoT devices and also from legacy equipment (e.g., air conditioning systems).
Originator:	Wellness Tech Group
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR43
Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Energy monitoring system
Rationale:	WTGs energy monitoring system is needed to extract energy consumption data, which will be used for direct visualisation (e.g., dashboard) and also to feed AI models.
Requirement description:	TERMINET should be prepared for WTGs energy monitoring system (WeSave, Unigate), which is needed to monitor the energy consumption and other power parameters from the wiring of the building.
Originator:	Wellness Tech Group
Priority:	Normal

Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR44
Requirement Type:	User
Relevant Use Case:	UC3
Short Title	Dashboard and IoT platform
Rationale:	Collected data should be gathered by WTGs' IoT platform (WeSave) and visualized through its dashboard.
Requirement description:	An IoT platform is needed to register IoT devices and also to gather and visualize any data collected by sensors or energy monitoring.
Originator:	Wellness Tech Group
Priority:	Normal
Fit criterion:	Evaluate/validate in pilots
Supporting Materials:	-

ID	UR45
Requirement Type:	User
Relevant Use Case:	UC6
Short Title	Issue warning when disk limit is reached
Rationale:	-
Requirement description:	The TERMINET administrator should receive a corresponding warning when the available disk space falls below a specific threshold. Consider that failing to timely expand the disk space or to delete/archive older datasets can result in loss of new information, thus, reduced observability over the facility status.
Originator:	Public Power Corporation S.A.
Priority:	Normal

Fit criterion:	-
Supporting Materials:	-

ID	UR46
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Monitor daily activity and temperature of livestock and send indicators on the animal's activity and health
Rationale:	Cross-check indicators with history records
Requirement description:	The good health and well-being of animals are essential for sustainable production. The most common form of animal behaviour assessment is visual observation. Unfortunately, day-to-day monitoring of free-grazing animals from farmers is difficult. Changes in the daily activity of the animal are often connected to disease appearance. Devices that monitor daily activity and at the same time temperature of the animal are essential can be crossed checked with history record and provide real-time information to the farmer.
Originator:	American Farm School
Priority:	High
Fit criterion:	-
Supporting Materials:	-

ID	UR47
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Monitor milk tank (temperature, fat, protein of milk)
Rationale:	Reading the data from the sensors directly possible with smart glasses in a simple interface can provide the farmer with valuable information.

Requirement description:	Butterfat content is a major component of milk. It is an indicator of nutritional quality and one of the primary factors used to determine the price that milk is sold. Both fat and protein can be used to determine feed ratios and cow health. Due to enzymatic and microbial activity, both the microbial and functional quality of raw milk deteriorates with time. Thus, constant monitoring of the nutritional content of milk is essential.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR48
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Monitor temperature and moisture of silo
Rationale:	Reading the data from the sensors directly possible with smart glasses in a simple interface can provide the farmer with valuable information.
Requirement description:	Monitoring, quality assurance and optimal conditioning of stored grain and animal feed are crucial for the quality of the products produced on the farm. Wireless sensors placed inside silos can capture multiple quality-relevant parameters (temperature, moisture, CO_2). Through direct monitoring, spoilage predictions and early warnings can inform the farmer of the current conditions of his feedlot.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR49
Requirement Type:	User

Relevant Use Case:	UC1
Short Title	Identify feedstock composition – NIR technology.
Rationale:	Information on feedstuff composition to the farmer in order to help him formulate a balanced feed ratio on the farm or buy feed from a producer
Requirement description:	Animal nutrition is crucial for the livestock production industry. Feedstuffs may differ widely in composition due to origin, fertilizer use, seasonal changes, transport or storage. For adequate feeding of livestock, farmers need information about the nutritive value of available feedstuffs. The wet chemical analyses of feed samples to determine their chemical composition are time consuming and expensive. Near Infrared spectroscopy (FT-NIR) spectroscopy provides a fast and effective solution for analysing raw materials as well as finished feeds in order to optimize the production steps and monitor the final product quality. On farm, measurements can help the farmer better utilise all nutrition material.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR50
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Thermal imaging of the mammary gland and feet
Rationale:	Early identification of mastitis and lameness Thermal camera
Requirement description:	Lameness and mastitis are infectious diseases which both result to the development of fever. Fever fights infection by helping immune cells to crawl along blood-vessel walls to attack invading microbes. This has as result the rise of the temperature at the infected area. Infrared thermography (thermal camera) can be used for early detection of mastitis and lameness by monitoring the temperature of the feet and udder
Originator:	American Farm School
Priority:	Low

Fit criterion:	-
Supporting Materials:	-

ID	UR51
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Automated irrigation – Sensors and meteorological stations
Rationale:	Improved irrigation management and water usage optimization.
Requirement description:	Irrigation is one of the most important agricultural parameters. Irrigation water management and use practices should aim to ensure both economic and environmental benefits. The water needs vary per crop and according to the meteorological conditions, as well as the growth stage of the plant. Wireless sensors measure soil moisture and other necessary physical and chemical parameters, while meteorological stations provide climate parameters. The combination of data from sensors and weather stations can be processed and, thus, decision-making can be involved in automation and scheduling irrigation.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR52
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	NDVI glasses
Rationale:	Indicator of plant stress is light absorption and reflectance
Requirement description:	NDVI is an indicator of plant stress is light absorption and reflectance. Using reflectance at specific wavelengths in the visible and near-infrared range can

	enhance the contrast between healthy and unhealthy plants. The NDVI is calculated from the visible and near-infrared light reflected by vegetation. Healthy vegetation absorbs most of the visible light that hits it and reflects a large portion of the near-infrared light. Unhealthy vegetation reflects more visible light and less near-infrared light.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR53
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Soil monitoring Fertilization
Rationale:	Automated analysis
Requirement description:	Possibility of sensors usage. Soil data analysed providing the profile of the field
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR54
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Secure data transfer to and from the farming sites
Rationale:	IoT security protocols

Requirement description:	Messages between the end devices / meters may need to be transported to the applications of utilities, energy service providers and similar organizations through a number of devices and the communication links between them. Therefore, the solution has to provide application-level, end-to-end security that provides confidentiality, authenticity, and proof of origin between the endpoints.
Originator:	American Farm School
Priority:	High
Fit criterion:	-
Supporting Materials:	-

ID	UR55
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Plant growth (image processing, crop maturity) UAV & VR/AR glasses
Rationale:	Image processing through UAV &VR/AR glasses in order to predict plant growth or crop maturity
Requirement description:	Imaging techniques have been broadening in several areas of agricultural sciences due to their ability to analyse plant temperature and colour discrepancies between distinct biological samples. Thermography can be utilized to evaluate yield development and crop maturity. Unmanned aerial vehicles (UAVs) equipped with cameras and sensors can allow rapid and non-destructive measurements. Alternatively, thermal image processing from VR/AR glasses can give the farmers real-time information about the status of the plants.
Originator:	American Farm School
Priority:	High
Fit criterion:	-
Supporting Materials:	-

ID	UR56
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Alert system
Rationale:	Issues that require immediate action might occur.
Requirement description:	Generate alerts whenever there is an issue that needs to be taken care of immediately.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	-
Supporting Materials:	-

ID	UR57
Requirement Type:	User
Relevant Use Case:	UC1
Short Title	Easy-to-use user interface
Rationale:	Provide access to all apps, data and information in one unified environment and simplify remote work
Requirement description:	All applications use a separate interface. This is not practically useful for a farmer, especially in the mountains. A user-friendly interface that integrates all applications is a farmer's requirement
Originator:	American Farm School
Priority:	High
Fit criterion:	-
Supporting Materials:	-

ID	UR58
Requirement Type:	Functional

Relevant Use Case:	UC1
Short Title	Interoperability and long-term stability
Rationale:	Long term stability of the underlying technologies is crucial
Requirement description:	Multi-sourcing is important to keep purchasing costs down. Ease of system integration is important to keep the time and the costs of deploying the system under control. These aspects call for a solution that provides standards-based interoperability. On the other hand, the standard shall allow freedom to accommodate project-specific requirements. As a large smart metering system is rolled out over several years and kept in operation for many (15-20) years, long-term stability of the underlying technologies is crucial.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

ID	UR59
Requirement Type:	Functional
Relevant Use Case:	UC1
Short Title	Remote Maintenance and diagnostics
Rationale:	Create tools for remote maintenance and diagnostics
Requirement description:	Remote maintenance: During the lifetime of the system, the firmware in the devices may need to be updated for various reasons, e.g. to add functionality or to correct any bugs. Therefore, the solution shall provide standardized and secure firmware upgrade mechanisms — also considering legal metrology requirements — to update the firmware of a large number of devices in an efficient and secure manner. Remote diagnostics: The operation of the system has to be monitored without the need for any physical interaction. Therefore, the solution shall provide a wide range of diagnostic information on the operation of the devices, including the core functionality, communication performance, and discovery of any fraudulent attempts.
Originator:	American Farm School

Priority:	Normal
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

ID	UR60
Requirement Type:	Functional
Relevant Use Case:	UC1
Short Title	Separation of application and transport technologies
Rationale:	Media agnostic application created
Requirement description:	Whereas the requirements for the functions and the use cases that the system has to fulfil are relatively stable over time, the communication technologies used to carry the messages change rapidly. For this reason, the application shall be media agnostic so that it can be used over any transport technologies emerging.
Originator:	American Farm School
Priority:	Normal
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

ID	UR61
Requirement Type:	User
Relevant Use Case:	UC2
Short Title	Transferring of ML models between hospital departments
Rationale:	Transferring of models shouldn't go through the hospital infrastructure.
Requirement description:	The models resulting from the Machine Learning shall be transferred between TERMINET edge nodes.
Originator:	Innovation Sprint

Priority:	Normal
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

ID	UR62
Requirement Type:	User
Relevant Use Case:	UC2
Short Title	Data and models always available in real-time
Rationale:	The medical team can get together at any time to discuss the case of multiple or a particular patient.
Requirement description:	Data and models should be made available to the medical team at any moment and at any place in the four departments of the Gemelli Hospital.
Originator:	Innovation Sprint
Priority:	Normal
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

ID	UR63
Requirement Type:	User
Relevant Use Case:	UC2
Short Title	Transferring of clinical data
Rationale:	The Gemelli Hospital has a system in place for the transfer of clinical data within departments. Individual clinical data must not leave the hospital infrastructure.
Requirement description:	Clinical data shall be transferred through the hospital infrastructure (TrackCare).
Originator:	Innovation Sprint

Priority:	Normal
Fit criterion:	Evaluate/Validate in pilots
Supporting Materials:	-

4.3 Summary of User Requirements

Following the results of the stakeholder's analysis and requirement elicitation and prioritization an overview of the results is presented in the next two charts. Specifically, we depict the volume of the identified requirements based on the Use Case they are derived from (Figure 1, Figure 3) and in priority the volume of requirements per priority is presented.

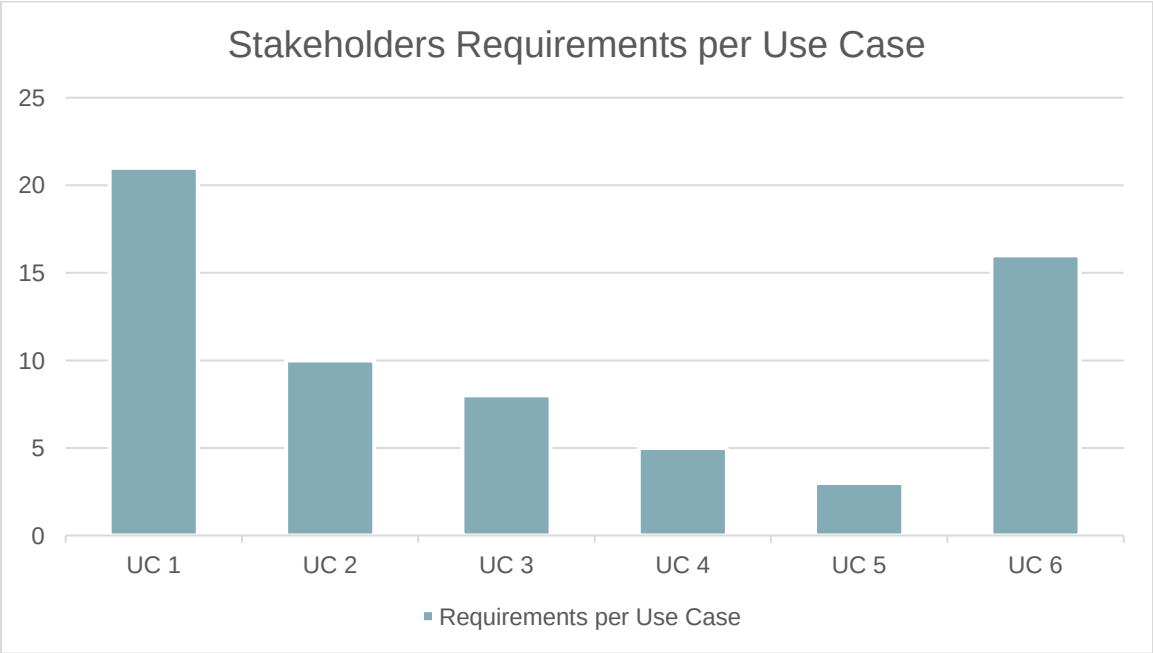

Figure 1 Stakeholders' requirements per Use Case

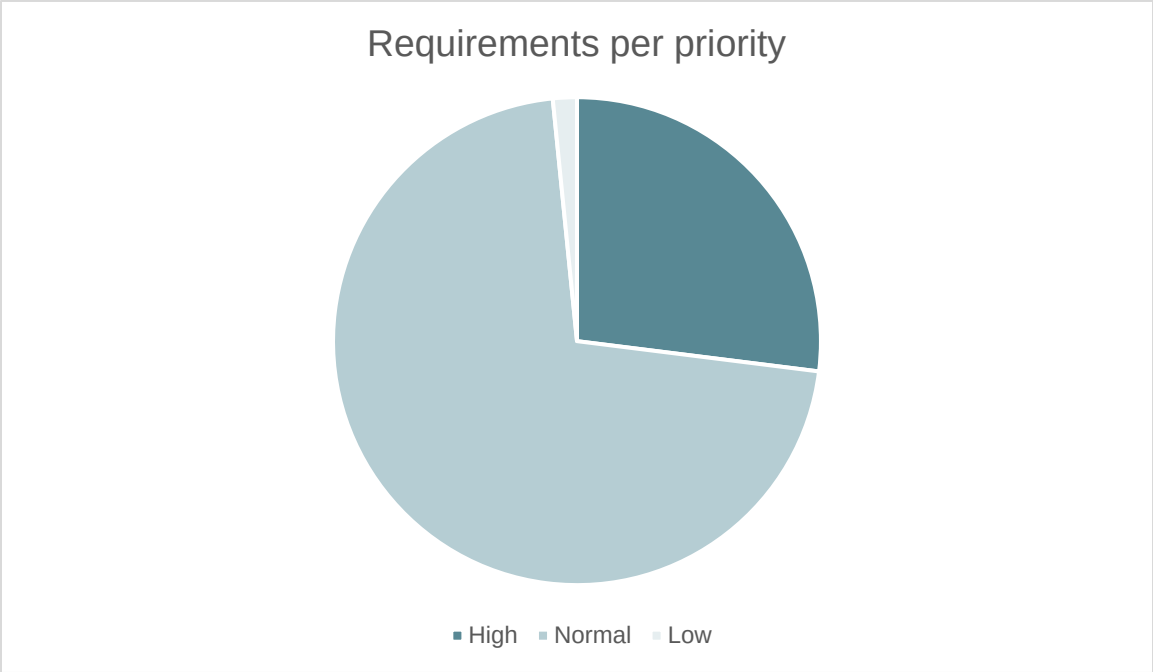

Figure 2 Stakeholders' requirements per priority

5. System Requirements

The purpose of this section is to present the requirements of the TERMINET project. The requirements fall into two main categories functional and non-functional. Functional requirements describe what the software system should do. On the other hand, non-functional requirements describe how the system should perform these certain tasks as well as restrictions that may apply. The requirements derived from the stakeholders' analysis and requirements definition presented in the previous sections.

5.1 Functional requirements

These Functional requirements represent those requirements that were obtained from the stakeholder survey and further analysed to extract requirements that describe what the TERMINET system should do. The survey comprises 39 questions (including multiple-choice questions) divided into three categories: performance and functionality, regulatory compliance and reputation, business and organisational. 19 TERMINET project partners participated in the current survey. This user-oriented approach has been used to identify user requirements that comprise both functional and non-functional requirements, as detailed below.

Finally, the user's requirements specified from the stakeholder's analysis have been further analysed and form the key requirements presented in the following sections. The functional requirements are presented in this section in Table 2. They are listed in a table with four columns: ID, which is a unique identifier to the requirement, Description holding a brief description of the requirement, Priority which depicts the importance level as derived from the user requirements above and the Relevant UR, which shows from which User Requirement it has been derived.

ID	Description	Priority	Relevant UR
FR-1	Edge node hardware codec for video compression – h.264	High	UR5
FR-2	The graphic card in the edge nodes should be Nvidia Tesla T4 GPU	High	UR5
FR-3	Accelerated computing instance - 1 GPU, 8 vCPUs, 32 GiB of memory, 225 NVMe SSD, up to 25 Gbps network performance	High	UR5
FR-4	3D environment updates per client should be in two ways Data-package per transform and object (position, rotation and scale) Approximately 50 scene synchronisable 60 frames per second equals 0.21 Mbyte per second	High	UR5
FR-5	The system should be able to process a large volume of historical data.	High	UR5

FR-6	The system should be integrated with WTG's Edge Nodes to preserve high IoT heterogeneity and provide edge computing capabilities	High	UR1
FR-7	The systems should be able to combine AI models that act upon the data gathered from the deployed sensors. Their aim will be to extract useful information about the energy efficiency status of the building and possible areas of improvement.	High	UR2, UR4
FR-8	The system should provide automations regarding enhancement of energy efficiency of the buildings. The use of AI models upon gathered data should automatically trigger corrective actions towards this goal.	High	UR2, UR4
FR-9	The system should provide a dashboard with adequate visualization tools about the data gathered from the deployed sensors, results from the AI models and action taken from the automated procedures	High	UR2
FR-10	IoT devices should be able to communicate with the intelligence layer. Large volume of data should be continuously exchanged to keep them synchronized.	High	UR3
FR-11	Edge nodes should be context aware and have video capabilities. They should be able to stream video that reflects the virtual environment and broadcast it to device management applications	High	UR4, UR5
FR-12	The user of the system that monitors a virtual reality session should be able to choose between various sources of video stream from each edge node and be to control. This will allow the users to observe and control a virtual reality session	High	UR4, UR5
FR-13	The System should be able to identify and match different data sources for a single patient and provide all available information to the doctors. More specifically TERMINET should be able to match Gemelli ID and Healthentia ID when they belong to the same patient	High	UR6
FR-14	The system should provide a dashboard with various visualization tools to display the necessary medical information of a patient subject to Intergroup evaluation	Normal	UR10

FR-15	Different data sources that hold medical data of patients should be able to communicate and exchange these data.	Normal	UR10
FR-16	The visualization tools to be used during Intergroup evaluation should provide all available medical guidelines related to the patient symptoms.	Normal	UR12
FR-17	TERMINET's RTU should be able to collect any information, important for the proper execution of maintenance tasks, provided by substation devices and sensors.	Normal	UR13
FR-18	RTU should be wired with digital or analog acquisition boards	Normal	UR13
FR-19	Substation RTU should exchange data and information with IoT cloud	Normal	UR14
FR-20	The system should be able to allow the user to mark specific data collections as sensitive corporate data. An example of such sensitive corporate data would be operational data that indicate faults in the facility.	Normal	UR18
FR-21	The system should be able to notify the user in case of data pending to be labelled in regard with their sensitivity status.	Normal	UR18
FR-22	The system should be able to allow the user to configure log rotation for the IoT data, based on size or time-limit.	Normal	UR19
FR-23	The system should be able to generate alerts when a device needs maintenance, consulting the asset inventory.	Normal	UR22
FR-24	The system should be able to monitor and track the location of each engineer in a facility, consulting the asset inventory.	Normal	UR23
FR-25	The system should be able to generate alerts in case the configured Quality of Service (QoS) Key Performance Indicators (KPIs) are not accomplished.	Normal	UR27
FR-26	The system should be able to allow tracking and identification of an individual animal from distance in order to collect them easily and quickly for vet treatment to avoid injuries.	Normal	UR28

FR-27	The system should be able to support animal geo-tagging in conjunction with the Normalized difference vegetation index (NDVI).	Normal	UR29
FR-28	The system should be able to calculate the NDVI	Normal	UR30
FR-29	The system should be able to determine whether an area is safe and alert the end-user when necessary	Normal	UR31
FR-30	The system should offer video streaming possibilities to users	Normal	UR32
FR-31	The system should provide a place for storing photos for animal phenotypes	Normal	UR33
FR-32	The system should be able to offer real-time monitoring of processes	Normal	UR34
FR-33	The system should be able to quantify qualitative variables	Normal	UR36
FR-34	The system should offer means to exploit historical data	Normal	UR37
FR-35	The system‘s AI should enable smart energy consumption by offering suggestions, providing predictions and any other means necessary	Normal	UR39
FR-36	The system should be able to create forecast models along with visualizations and manually act if needed	Normal	UR38, UR41
FR-37	The system should be able to connect to the WTGs energy monitoring system to extract energy consumption data and visualize through its dashboard	Normal	UR43, UR44
FR-38	The system should monitor the daily activity and temperature of the livestock and combining with historic records shall send indicators on the animal’s status	Normal	UR46
FR-39	The system should monitor the milk tank and provide indicators regarding its temperature, fat and protein contained	Normal	UR47
FR-40	The system should be able to monitor temperature and moisture levels of silo	Normal	UR47
FR-41	The system should be able to identify and analyse the feedstock composition with the use of NIR technology	Normal	UR49
FR-42	The system should be able to deploy thermal imaging mechanisms for tracking animals’ mammary gland and feet	Normal	UR50

	in order to identify as soon as possible cases of mastitis and lameness.		
FR-43	The system should be able to utilize sensors and meteorological stations which will interact and cooperate each other in order to deploy an automated irrigation system.	Normal	UR51
FR-44	The system should be able to deploy NDVI glasses in order to indicate plants' stress which is manifested by the levels of light absorption and reflectance.	Normal	UR52
FR-45	The system should be able to offer an automated analysis of soil monitoring fertilization.	Normal	UR53
FR-46	The system should be able to deploy UAV & VR/AR glasses for monitoring the plant growth. Those mechanisms will collect and process images through which they will track and analyse the crop maturity.	Normal	UR55
FR-47	The system should be able to provide mechanisms and tools for remote maintenance. It should offer standardized and secure firmware upgrade mechanisms with respect to any metrology requirements.	Normal	UR59
FR-48	The system shall be able to provide mechanisms and tools for remote diagnostics in order to be monitored without the need of any physical interaction. It should offer a wide range of diagnostic information on the operation of the devices, including the core functionality, communication performance, and discovery of any fraudulent attempts.	Normal	UR59
FR-49	The exchange of Machine Learning models between hospital departments should be done among the TERMINET edge nodes and not through the hospital infrastructure.	Normal	UR61
FR-50	The system should provide an asset inventory for registering assets that are monitored for their health status in order to be utilized for predictive maintenance.	Normal	UR21
FR-51	The system should be able to calculate the NDVI	Normal	UR30

Table 2 Functional requirements

5.2 Non-Functional requirements

The non-functional requirements are listed in the table (Table 4) below. The priority of the requirement is also mentioned as derived from the stakeholder's requirements definition and prioritization. The table

uses five columns (ID, Category, Description, Priority and the Relevant User Requirement), where the ID associates the requirement with a unique identifier, Category, which categorizes the requirement with the categories recognised and presented in Table 3. The Description column represents a brief description of the requirement, the Priority represents the level of the importance of which non-functional requirements should be developed, implemented and deployed in the project and Relevant UR depicts the user's requirements from which derived. The priority is categorised into High, Medium and Low. Those with high priority should be addressed with more care and shall be followed and implemented as the necessary ones. The medium and low priority are of lower importance and should be implemented only if the High priority requirements are fulfilled. ID represents a unique identifier of each requirement. The relevant UR associates each requirement with the relevant user requirement derived from.

Category identifier	Requirement category
DPT	Data Protection Requirements
SEC	Data Security Requirements
TERSPEC	TERMINET-Specific Requirements
US	Usability Requirements
RL	Reliability Requirements
RES	Resilience Requirements

Table 3 Non-Functional requirements Categories

ID	Category	Description	Priority	Relevant UR
NFR-1	RL	Rendering latency should not overcome 20 milliseconds between contextual updates. Ideally it should be less than 13.8 milliseconds between contextual updates	High	UR4
NFR-2	RL	The compressed video stream of each client should be 24 fps – 11,45 Mbyte per second 60 fps – 22,90 Mbyte per second (approximately the double)	High	UR4
NFR-3	RL	Communication between IoT devices and intelligence layer should be reliable. Packet – loss should not drop below 4%	High	UR3
NFR-4	US	The application controlling the viewpoint of the virtual environment should be highly responsive	High	UR4

NFR-5	US	Since virtual reality sessions will be used for surgery training the quality of video and audio should maintain a specific minimum standard. In addition, low input lag should be assured.	High	UR4
NFR-6	RL	Ensure that latency is preserved below 40ms.	High	UR5
NFR-7	TERSPEC	Any integration to a hospital should not present changes to the existing IT infrastructure	High	UR7
NFR-8	TERSPEC	TERMINET should be independent to the hospital's IT infrastructure.	High	UR7
NFR-9	SEC	Take into consideration the sensitivity of medical information and related legislation, the system should provide anonymity to the patient and ensure that his privacy is secured.	High	UR8, UR11
NFR-10	TERSPEC	TERMINET should support edge nodes deployed to various different departments of a Hospital. At least 4 are defined for the relevant use case, specifically in radiology, oncology, pathology and surgery.	High	UR9
NFR-11	US	User centred design should be used for the devices involved to the smart farming scenario to enhance usability and accessibility.	Normal	UR10
NFR-12	TERSPEC	RTU's data gathering should follow industrial protocols such as Modbus, DNP 3.0, IEC 104, IEC 101 or IEC 61840.	Normal	UR13
NFR-13	RL	RTU should exchange data with IoT cloud using either MQTT or OPC_UA protocols	Normal	UR14
NFR-14	SEC	The IoT communication interface shall be well-secured to avoid cybersecurity attacks on the RTU substation, which is a critical infrastructure, as a successful attack may influence the normal operation of the substation by writing on the RTU database.	Normal	UR15
NFR-15	RL	The system should be able to support the collection of IoT data using either the OPC_UA or the MQTT communication protocol.	Normal	UR16
NFR-16	RL	The system should be able to support the collection of operational data from IoT devices via the NETCONF	Normal	UR17

		communication protocol, using the corresponding YANG model of the IoT device.		
NFR-17	SEC	The system should be able to offer symmetric encryption for data storage and ensure encrypted transmission.	Normal	UR18
NFR-18	RL	The system should be able to support Quality of Service (QoS) prioritization for real-time flows that controls network traffic and prioritize real-time applications.	Normal	UR24
NFR-19	SEC	The system should be able to authenticate all IoT devices before allowing them to join the network.	Normal	UR25
NFR-20	TERSPEC	The system should be able to provide the option to the user to establish Key Performance Indicators (KPIs) regarding the Quality of Service (QoS) of TERMINET applications.	Normal	UR26
NFR-21	SEC	The system should provide access to collected data only to authorized users	Normal	UR35
NFR-22	DTP	Data exchange should be secure and private.	Normal	UR40
NFR-23	RL	Similar entities should be able to follow a federated paradigm, exchanging useful information.	Normal	UR40
NFR-24	RL	The system should be able to handle heterogeneous IoT data from various devices, protocols/APIs and legacy equipment.	Normal	UR42
NFR-25	RES	The system should issue warnings to the administrators when the available disk space falls below a certain threshold	Normal	UR45
NFR-26	TERSPEC	The system should be able to improve the management of irrigation and to optimize the water usage.	Normal	UR51
NFR-27	DTP	The system should be able to provide high levels of security during the data transfer among the farming sites.	Normal	UR54
NFR-28	RL	The system should be able to mention and notify the users in case of an emergency issue that needs to be addressed immediately by generating alerts.	Normal	UR56

NFR-29	RL	The system should be able to offer standards-based interoperability and long-term stability so as to achieve ease of system integration through a multi-source way, control of time and costs spent and long-term stability of the underlying technologies.	Normal	UR58
NFR-30	RL	The system should be media agnostic in order to be able to be used over any transport technologies emerging and to follow the evolution of communica-tion technologies over the time.	Normal	UR60
NFR-31	US	The system should be able to provide its medical data and Machine Learning models to the medical staff in a daily basis and at every department of a hospital.	Normal	UR62
NFR-32	DPT	The system should not transfer clinical data off the hospital. The transportation of individual clinical data should be done strictly through the hospital infra-structure.	Normal	UR63
NFR-33	RL	The system should be able to store operational data with various structures and formats, at the same time.	Low	UR20
NFR-34	US	The design of the user interfaces for various devices should consider accessibility guidelines.	Low	UR10
NFR-35	RL	The system should offer interoperability of collected data.	Low	UR35
NFR-36	US	The system should be able to offer user-friendly inter-faces that provide ease of use and simple applications.	Low	UR57

Table 4 Non-Functional requirements

5.3 Summary of System Requirements

Following the overall results of the requirements elicitation and prioritization analysis, an overview of the user's requirements is presented in the following charts. Specifically, we extract certain numbers about the volume of the requirements based on their type (Functional / Non-Functional) in Figure 3 and based on the volume of the requirements for each priority indicator in Figure 4.

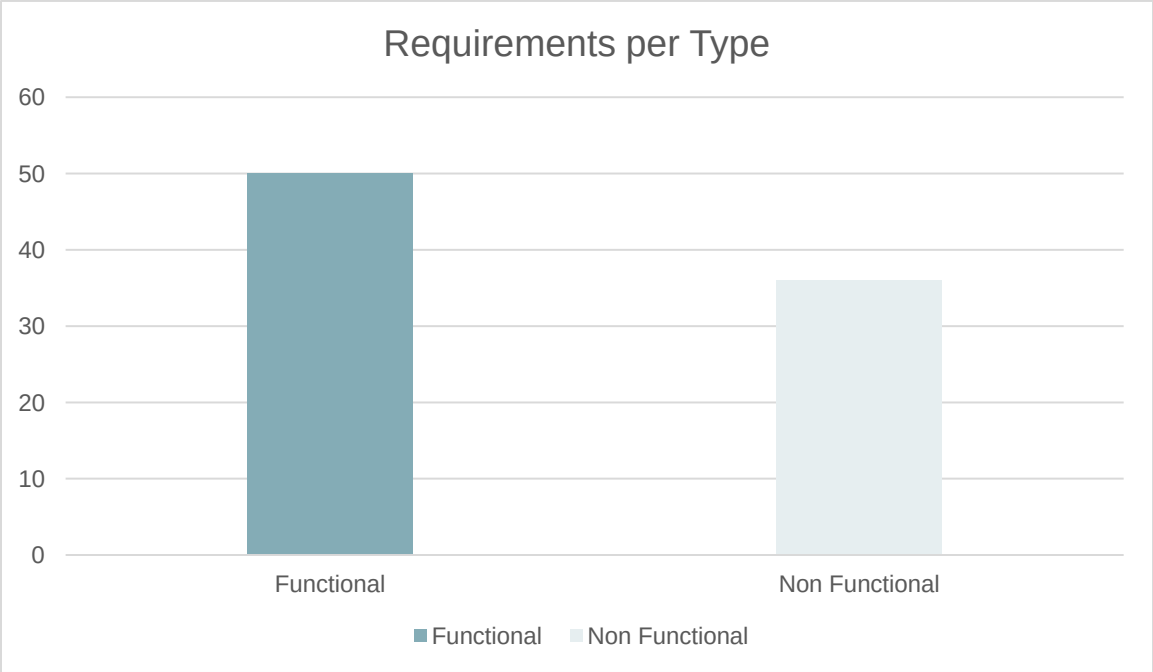

Figure 3 System Requirements per type

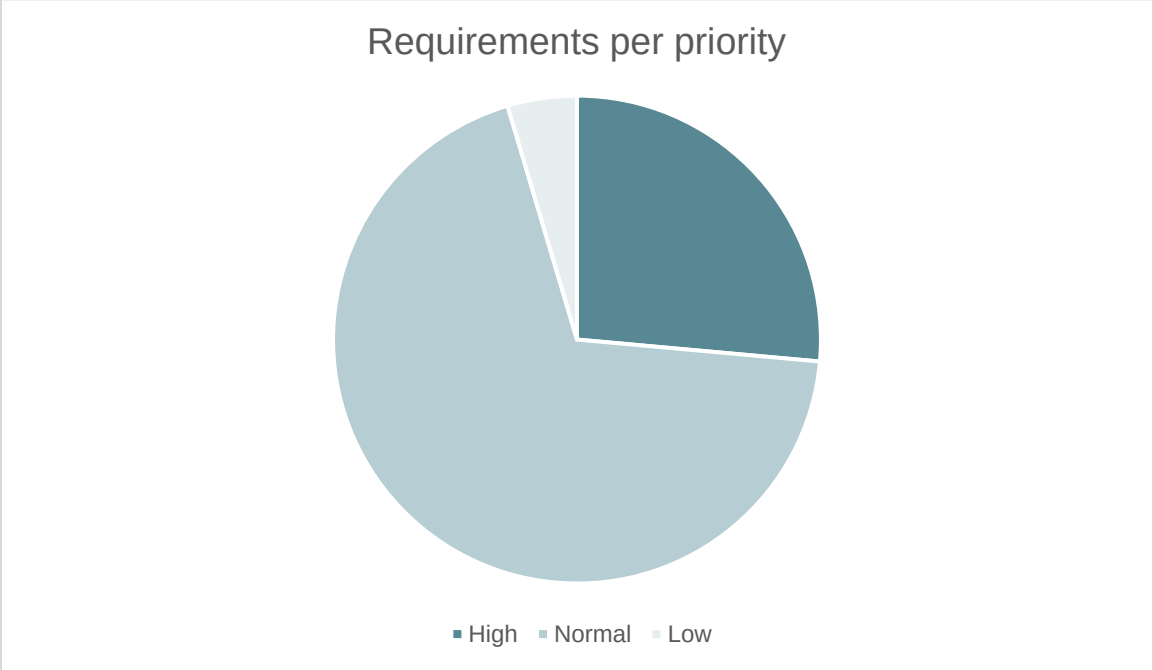

Figure 4 System Requirements per priority

In addition to the charts that concern all the requirements in general, we present the following pie chart (Figure 5), which presents the volume of the non-functional requirements for each category as presented in Table 3 Non-Functional requirements Categories.

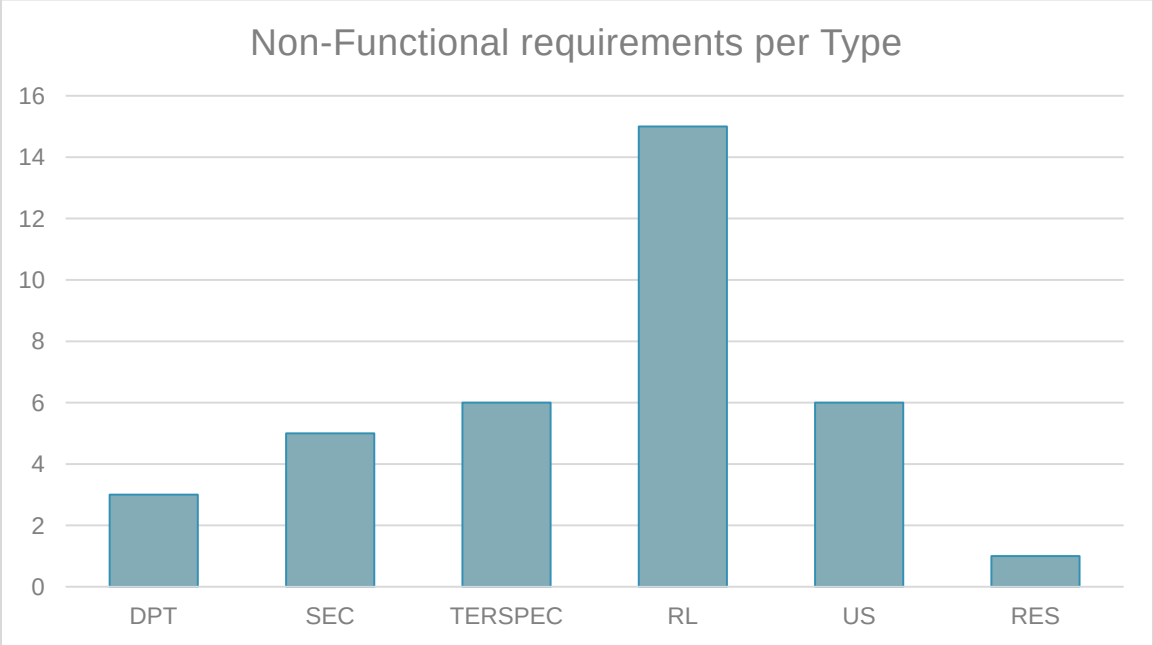

Figure 5 Non-functional requirements per type

6. Conclusions

In this deliverable, the stakeholder's analysis methodology, the requirements elicitation, prioritization and definition process, as well as the results of this investigation, has been described. The main objective of these processes is to describe the characteristics and the functionalities that the TERMINET system should provide to pose as a novel next-generation architecture in the IoT domain. The requirements that are presented in Section 5 and have resulted from the analysis, form the main output of Task 2.1. In this respect, several functional and non-functional requirements have been identified and prioritized, which will be used as a guide during the design and development process of the TERMINET system.

Section 2 of the document presents an overall description of the system, including the scope of the project and the challenges that might arise. In addition, this Section emphasizes n the stakeholders and the roles that have been identified and in the operational modes in which the TERMINET system will operate. Moreover, six application environments are presented in accordance with the six Use Cases that will be implemented in the context of the project.

In Section 3 of the document, the Stakeholders requirements investigation is presented. Information about the methodology followed and the methods used for requirements gathering form the main objective of this Section. In addition, detailed information about the questionnaire used during the stakeholders' requirements investigation is presented as well as the six different Use Cases that will be implemented during the project.

Section 4 concerns the definition of the stakeholders' requirements, as resulted by following the methodology of the previous section. The approach of elicitation and prioritization is described at first, followed by the list of requirements as those are identified by the involved partners.

The stakeholders' requirements identified in Section 4 are used as input to Section 5, and after further analysis, a tentative set of system requirements is presented. System requirements are presented in two tables, the first concerns the functional requirements followed by the non-functional ones. All requirements are associated with a relevant priority indicator, which aims to depict the importance of the requirement, and with at least one stakeholder's requirement. Non-functional requirements are further categorized based on the type of attribute they aim to ensure for the system. The system requirements of this deliverable are not final, since they will be updated while the system architecture is being finalized. The final set of system requirements will be presented in D2.2.

Appended to this report are the stakeholder's questionnaires as provided by them during the stakeholder's requirements investigation. To conclude, the output of this deliverable will be used as input for the deliverables 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 4.4, 4.5, 5.1, 5.2, 5.3, 5.4, 5.5, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6 and 7.1. The requirements presented will be implemented during the design and development process of the TERMINET system and, more specifically in the context of work packages 3, 4, 5, 6 and 7.

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Annex 1. Stakeholders Questionnaires

Use Case 1

Case study name and URL or other reference – Country, Sector, Role
Strategic Project Management Office (SPMO), American Farm School; Greece; Agriculture; RTO - Innovation Facilitator
Summary
SPMO coordinates an innovation ecosystem with demonstration farms, a LoRaWAN telecommunications network and a vertically integrated cluster (Internet of Food Alliance https://inofa.gr/)
1. Name of person filling out the form and role
Filippos Papadopoulos, director of SPMO
2. What are the key purposes your organization aims to fulfil? (Healthier citizens, economic growth, less pollution, please describe)
Reduced environmental footprint, traceability & efficiency in agricultural production
3. What are the key systems involved in your day2day activities? (Building, Housing, Energy, Health, Mobility, Transport etc.)
Farms, packing/ processing, distribution, retailers.
4. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)
No
5. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure etc.)
No
6. Who are the key stakeholders i.e. organisation, business, agency, citizen and what are their roles?
Real economy actors along the agrifood value chain; Technology providers; service providers (consultants); Universities; civil society organisations
7. What role does technology play?
Digital technologies are the integrating factor
8. Are you working with big amounts of unstructured data? If yes, in what extend?
Yes, from fixed sensors in the LoRa network; animal tracking sensors; weather stations
9. Do you have experience working with IoT infrastructure?

Yes, 2 years
10. If the answer to Q9 is yes, is there any feature that you fell is missing from the current IoT systems? (you can identify more than one)
Real time alarm management; Review & control of daily Communications; Review & control of energy values of gateways; Radio noise & interference check (to move into urban environments); Roaming; Automations/ industry 4; Integration of rural-urban operations.
11. What are the regulatory requirements and terms being used that are related to devices, communications and content?
Private network would be interested in exploring possibility of going public.
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?
Own cloud (Microsoft azure) with proprietary clouds of technology providers.
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 different departments or with other organizations you closely work? If so, what were they? How have they been solved?
Different strategic priorities? Data can disrupt balance of power between links of the value chain **Different business processes?** Obstacles to integrating retailer internal processes with digital traceability systems **Information sharing?** Across the links of the value chain; between competitors in the same link 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 (if they have)?
Data ownership issues; lack of knowledge on LoRaWAN & cloud security
16. Have there been any other issues about interoperability/ integration/ ethics/ informed consent?
17. Are there any aspects of your projects where good practice guidelines, certifications schemes or standards would have helped?

Testing/ Calibration of agricultural IoT equipment. Without such calibration there are potential issues of integrating digital tech with GACP & GMP certification. "Accuracy decay" tests in field conditions would be very useful.
18. What do you expect to gain from TERMINET? Which of the issues mentioned above you expect TERMINET to help overcome and how?
Any contribution in the above is welcomed
19. Have you been able to use only standard, non-proprietary technologies in your project? 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?
20. In your operations, is there a necessity for (near) real-time applications or services?
YES, issues with managing in an integrated manner fixed sensor (set at ½ or 1-hour intervals) with vehicle tracking
21. Is your competition using IoT solutions?
Partly
22. How are your human-machine interfaces? User-friendly, intuitive, complex?
Not very user friendly
23. How comfortable are you in using cloud-based solutions for hosting your data (external to your infrastructure)
Comfortable; some concerns with security and pricing

Use Case 2

Case study name and URL or other reference – Country, Sector, Role
Facilitate exchange of information between hospital departments; Fondazione Policlinico Universitario Agostino Gemelli (GEM); Italy; Healthcare; Andrea Damiani (Head AI strategy, R&D)
Summary
The aim of this case study is to develop more efficient and personalized treatments by facilitating exchange of information between hospital departments and utilising the medical knowledge from various sources.

1. Name of person filling out the form and role
Andrea Damiani (Head AI strategy, R&D)
2. What are the key purposes your organization aims to fulfil? (Healthier citizens, economic growth, less pollution, please describe)
Healthier citizens; improve efficiency of healthcare delivery (e.g., by reducing hospitalization time) and patient quality of life.
3. What are the key systems involved in your day2day activities? (Building, Housing, Energy, Health, Mobility, Transport etc.)
Health
4. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)
Hospital (wards and clinics)
5. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure etc.)
No
6. Who are the key stakeholders i.e. organisation, business, agency, citizen and what are their roles?
Citizens, other healthcare organizations, Health Systems
7. What role does technology play?
Technology is already used in day-to-day activities and a number of IT solutions exist in the hospital. There is a need to improve interoperability and exchange of information between different settings inside the hospital.
8. Are you working with big amounts of unstructured data? If yes, to what extent?
Not in the setting that is addressed by this project. In other projects we frequently encounter unstructured data such as Histopathology reports, Radiology reports, Surgical reports, and many others for which text mining is often necessary.
9. Do you have experience working with IoT infrastructure?
Yes, we have four ongoing protocols using IoT's: related to COVID-19 patient monitoring during radiotherapy treatment, PROMS assessment in GYN patients during radiotherapy, COVID-19 infection monitoring in patients with HIV. An app is used to monitor Adverse Drug Reactions after COVID-19 vaccine subministration.
10. If the answer to Q9 is yes, is there any feature that you feel is missing from the current IoT systems? (you can identify more than one)
No

11. What are the regulatory requirements and terms being used that are related to devices, communications and content?
SENTIRE ALICE FRANCESCA
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?
When different IT systems need to establish a continuous communication in order to exchange timely information, either a) they are enabled by design to do that, or b) an integration process needs to be put in place at a later time. This is especially true when heterogeneous data sources (structured, unstructured, processed images, omics …) are needed for some research task. This issue is usually solved by building one or more integration layers to project data from sources to data marts, where they are made available to data scientists.
13. Have there been any issues around technical interoperability which are <u>not</u> related to ICT? If so, what were they? How have they been solved?
No.
14. Have there been any issues around managing the relationships between different departments or with other organizations you closely work with? If so, what were they? How have they been solved?
Different strategic priorities? Guidelines harmonisation is sometimes needed when the same disease is assessed by different specializations. Specific interdisciplinary groups are appointed to deal with this issue. *Different business processes?* No Information sharing? Yes, with two different levels: Inside a hospital, there can be different data collection procedures with different formatting and terminological systems. All these issues need to be fixed before any research effort is initiated. Between different institutions, all the above apply, and the data exchange issues, related to privacy and data property, should also be kept in consideration. *Other?* NA
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 (if they have)?
As a general policy, patient data are not allowed to leave the Hospital, even in (pseudo-) anonymized form. The general solution is Federated Learning, which we have developed locally and put in place for many multi centric studies.

When special permissions are given and positively evaluated by the Ethical Committee, pseudonymized data are allowed to leave the hospital for research aims. We have specific experience on terminological systems and semantic preservation across data sources, which is indeed a problem, but with feasible solutions.
16. Have there been any other issues about interoperability/ integration/ ethics/ informed consent?
No
17. Are there any aspects of your projects where good practice guidelines, certifications schemes or standards would have helped?
All our projects are approved by the Ethical Committee after close scrutiny and are conducted under rules approved by our Data Protection Officer, in full respect of good practice guidelines, official clinical guidelines, national and E.U. rules.
18. What do you expect to gain from TERMINET? Which of the issues mentioned above you expect TERMINET to help overcome and how?
We expect to experience an improved communication level between different specialists. At the same time, a raised patient awareness level and an improved qualitative communication between patient and doctor are also expected.
19. Have you been able to use only standard, non-proprietary technologies in your project?
If not, was this because: *d) There was no standard, non-proprietary technology available?* We developed proprietary solutions for extracting information from clinical images, and for Federated Learning algorithms, because the needed level of customization was not available. Also, in other projects mentioned above, we made use of proprietary technology (Healthentia) because it offered us the right level of personalization. That we needed for our use cases and was not available in standard products. *e) The standard, non-proprietary technology was not as good as, or was more expensive than, the proprietary one* f) *Pressure from your commercial partners?*
20. In your operations, is there a necessity for (near) real-time applications or services?
Not strictly speaking.
21. Is your competition using IoT solutions?
N/A
22. How are your human-machine interfaces? User-friendly, intuitive, complex?
We adhere to the XAI (eXplainable Artificial Intelligence) paradigm, under which human – machine interfaces should make the user aware of the meaning of the A.I. solution(s) underlying

the model in use. This includes user friendliness and clear explanations, in terms suitable for the average user, of the interactions with the system.
23. How comfortable are you in using cloud-based solutions for hosting your data (external to your infrastructure)
I would expect some data privacy considerations here as we are dealing with medical data. Cloud based solutions need a special permission from the Hospital Ethical Committee. Full certifications of adherence to GDPR are needed and the cloud should be physically located in E.U. under E.U. jurisdiction.

Use Case 3

Case study name and URL or other reference – Country, Sector, Role
Use Case 3: Smart, Sustainable and Efficient Buildings – Spain
Summary
To transform a legacy building into a Smart Building, providing mechanisms (sensors, learning models, and IoT platforms) to improve the energy consumption.
1. Name of person filling out the form and role
Vicente Mayor, R&D Project Manager in WTG
2. What are the key purposes your organization aims to fulfil? (Healthier citizens, economic growth, less pollution, please describe)
Comfort and Energy Efficiency
3. What are the key systems involved in your day2day activities? (Building, Housing, Energy, Health, Mobility, Transport etc.)
Energy, IoT Platforms
4. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)
An existing building in Algeciras
5. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure etc.)
The electricity infrastructure, energy generation system (thermal solar and photovoltaic solar system), air conditioning systems of the building
6. Who are the key stakeholders i.e. organisation, business, agency, citizen and what are their roles?
Centro Tecnológico de Algeciras: Building owner

Wellness TechGroup: Pilot provider
7. What role does technology play?
As a data acquisition and processing mechanism, so thanks to the sensoring in the building we can improve the energy efficiency.
8. Are you working with big amounts of unstructured data? If yes, in what extend?
At the moment no sensors have been deployed yet.
9. Do you have experience working with IoT infrastructure?
Yes. WTG is an IoT provider for Smart Cities.
10. If the answer to Q9 is yes, is there any feature that you fell is missing from the current IoT systems? (you can identify more than one)
-
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?
No systems have been deployed yet, to be done during the execution of the project.
13. Have there been any issues around technical interoperability which are <u>not</u> related to ICT? If so, what were they? How have they been solved?
No systems have been deployed yet, to be done during the execution of the project.
14. Have there been any issues around managing the relationships between different departments or with other organizations you closely work? If so, what were they? How have they been solved?
Different strategic priorities? No Different business processes? No Information sharing? No Other? No
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 (if they have)?
No systems have been deployed yet, to be done during the execution of the project.
16. Have there been any other issues about interoperability/ integration/ ethics/ informed consent?
No systems have been deployed yet, to be done during the execution of the project.

17. Are there any aspects of your projects where good practice guidelines, certifications schemes or standards would have helped?
-
18. What do you expect to gain from TERMINET? Which of the issues mentioned above you expect TERMINET to help overcome and how?
An integral platform to provide IoT capabilities to a non-smart environment.
19. Have you been able to use only standard, non-proprietary technologies in your project?
No systems have been deployed yet, to be done during the execution of the project. If not, was this because: g) There was no standard, non-proprietary technology available? h) The standard, non-proprietary technology was not as good as, or was more expensive than, the proprietary one i) Pressure from your commercial partners?
20. In your operations, is there a necessity for (near) real-time applications or services?
Yes, the control and monitor of some devices should be close to real-time
21. Is your competition using IoT solutions?
Yes
22. How are your human-machine interfaces? User-friendly, intuitive, complex?
No systems have been deployed yet, to be done during the execution of the project.
23. How comfortable are you in using cloud-based solutions for hosting your data (external to your infrastructure)
WTG is also the provider of the IoT platform.

Use Case 4

Case study name and URL or other reference – Country, Sector, Role
Case study name: Use Case 4: Prediction and Forecasting System for Optimising the Supply Chain in Dairy Products URL: https://mevgal.gr/ Country: Greece Sector: Dairy products
Summary
MEVGAL S.A. is a private company located in Northern Greece. The firm produces and markets a full range of products such as milk, yogurts, and various types of soft, semi-hard and hard cheese. MEVGAL S.A. is actively involved in a number of research and technological

development projects. The Q&A Department in co-operation with, R&D Department, Production, Production Support and Technical departments is in constant pursuit of innovation. It concentrates the experience of more than 20 years in proposal submission, co-ordination and implementation of new ideas and products and represents the driving force of this endeavour. They have expertise on chemical, quality, microbiological and sensory analysis and evaluation according to the national and European standards (HACCP, ISO) and the related legislation. They also have an interdisciplinary profile in food chemistry/ food characterization, Food legislation, Food adulterations, Process Analytical Technologies along the food chain
1. Name of person filling out the form and role
Konstantinos Georgakidis, Production Support dpt. Dimitris Iatropoulos, Junior Project Manager
2. What are the key purposes your organization aims to fulfil? (Healthier citizens, economic growth, less pollution, please describe)
Optimization of supply chain Increase of productivity Reduction of wastage Economic growth Improvement of forecast accuracy Simplification of the processes
3. What are the key systems involved in your day2day activities? (Building, Housing, Energy, Health, Mobility, Transport etc.)
We run daily a production schedule, according to our needs, forecasting and orders.
4. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)
No
5. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure etc.)
No
6. Who are the key stakeholders i.e. organisation, business, agency, citizen and what are their roles?
Apart from the owners key stakeholders are the personnel and our customers.
7. What role does technology play?
Technology plays a crucial role during the whole the supply chain of the industry. From the production of the milk up until its distribution, or its products, most of the actions are monitored.
8. Are you working with big amounts of unstructured data? If yes, in what extend?

Yes. We run daily many production systems that produce data such as production orders, sales data, route data, production sensors data (temperature, control, process data etc.)
9. Do you have experience working with IoT infrastructure?
Yes. Some of our systems have IoT capacity as part or control production system (i.e. ACMON Data etc.)
10. If the answer to Q9 is yes, is there any feature that you fell is missing from the current IoT systems? (you can identify more than one)
"smart forecasting"
11. What are the regulatory requirements and terms being used that are related to devices, communications and content?
Device safety of use, Communications Security, Security and Data Protection.
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?
Interoperability issues like collaboration between systems have been solved through the usage of appropriate s/w services or export suitable files from one system and import to another.
13. Have there been any issues around technical interoperability which are <u>not</u> related to ICT? If so, what were they? How have they been solved?
No.
14. Have there been any issues around managing the relationships between different departments or with other organizations you closely work? 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 (if they have)?
?
16. Have there been any other issues about interoperability/ integration/ ethics/ informed consent?
No

17. Are there any aspects of your projects where good practice guidelines, certifications schemes or standards would have helped?
Yes. ISO 9001 certification helped to set procedures for every crucial aspect of our work.
18. What do you expect to gain from TERMINET? Which of the issues mentioned above you expect TERMINET to help overcome and how?
We expect to have a tool that will produce and get better in time of the forecasting of certain product codes. We think that AI could really help making forecasting more accurate and predictable over time.
19. Have you been able to use only standard, non-proprietary technologies in your project?
We mainly use proprietary technology. Our systems are crucial for our operations and in FMCG we need very quickly respond time in a problem that only proprietary technology could usually offer. If not, was this because: j) There was no standard, non-proprietary technology available? k) The standard, non-proprietary technology was not as good as, or was more expensive than, the proprietary one l) Pressure from your commercial partners? **?**
20. In your operations, is there a necessity for (near) real-time applications or services?
Yes
21. Is your competition using IoT solutions?
Yes
22. How are your human-machine interfaces? User-friendly, intuitive, complex?
User-friendly
23. How comfortable are you in using cloud-based solutions for hosting your data (external to your infrastructure)
Very comfortable

Use Case 5

Case study name and URL or other reference – Country, Sector, Role
Use Case number 5: TeamSimulator, a surgery and medical treatment training platform.
Summary

TeamSimulator is a virtual reality training software for medical staffs and universities. Nurses, doctors and students can train specific surgery and treatments at site or over the internet. It supports both skills training and team training.
1. Name of person filling out the form and role
Dag Eklund, project leader for Alteruna.
2. What are the key purposes your organization aims to fulfil? (Healthier citizens, economic growth, less pollution, please describe)
We will provide better training for health care professionals and students, leading to less harm to patients. Eventually that will result in healthier citizens.
3. What are the key systems involved in your day2day activities? (Building, Housing, Energy, Health, Mobility, Transport etc.)
Health, Education
4. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)
Universities (KI and possibly others) and hospitals (yet to be decided)
5. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure etc.)
Electricity and communication networks (Internet, Terminet)
6. Who are the key stakeholders i.e. organisation, business, agency, citizen and what are their roles?
Hospitals and universities.
7. What role does technology play?
The use case requires mobile virtual reality equipment (Oculus Quest and others)
8. Are you working with big amounts of unstructured data? If yes, in what extend?
No
9. Do you have experience working with IoT infrastructure?
No
10. If the answer to Q9 is yes, is there any feature that you fell is missing from the current IoT systems? (you can identify more than one)
11. What are the regulatory requirements and terms being used that are related to devices, communications and content?
The application doesn't require CE approval. User data, if collected and stored, must comply with GDPR.

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?
No
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?
Content/screen casting in closed hospital networks. The problems have been solved by setting up internal networks.
14. Have there been any issues around managing the relationships between different departments or with other organizations you closely work? If so, what were they? How have they been solved?
Not applicable to Alteruna/KI 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 (if they have)?
We have no sensitive content and we are not storing user data yet
16. Have there been any other issues about interoperability/ integration/ ethics/ informed consent? Not yet but concerns have been raised from customers concerning storing user data (GDPR)
17. Are there any aspects of your projects where good practice guidelines, certifications schemes or standards would have helped?
There are certain issues with virtual reality that should be addressed. Nausea, Tired eyes or inability to have a stereoscopic view, etc. Guidelines and standards will be appropriate. Rendering in consistent full framerate will be important. Certifications might be useful for certain training applications.
18. What do you expect to gain from TERMINET? Which of the issues mentioned above you expect TERMINET to help overcome and how?
Low latency is a key quality for experiencing virtual reality with quality and avoiding several of the issues mentioned. Ability to observe and manage users through a device management application will be important.
19. Have you been able to use only standard, non-proprietary technologies in your project?
Yes

If not, was this because: m) There was no standard, non-proprietary technology available? n) The standard, non-proprietary technology was not as good as, or was more expensive than, the proprietary one o) Pressure from your commercial partners?
20. In your operations, is there a necessity for (near) real-time applications or services?
Yes
21. Is your competition using IoT solutions?
Not to our knowledge
22. How are your human-machine interfaces? User-friendly, intuitive, complex?
Virtual reality is a complex technology as such. However, user friendly and intuitive despite the complexity of the technology. We use consumer virtual reality equipment from Oculus/Facebook).
23. How comfortable are you in using cloud-based solutions for hosting your data (external to your infrastructure)
Comfortable

Use Case 6

Case study name and URL or other reference – Country, Sector, Role
Summary
1. Name of person filling out the form and role
Marios Valsamakis, Electrical Engineer, Inspector and Head of Electrical Testing and Measurements Subsection of TRSC/PPC.
2. What are the key purposes your organization aims to fulfil? (Healthier citizens, economic growth, less pollution, please describe)
-PPC aims to increase the efficiency of maintenance tasks (in terms of success rate, accuracy of the performed tasks and task duration – including minimum errors). Moreover, PPC aims to centralise the monitoring of critical infrastructure and be informed about possible upcoming faults, leading to cost savings and increased availability.
3. What are the key systems involved in your day2day activities? (Building, Housing, Energy, Health, Mobility, Transport etc.)

Energy-related equipment, including generators, PLCs, RTUs, as well as networking equipment like switches, routers, and servers.
4. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)
Power station.
5. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure etc.)
RTUs, PLCs, servers, virtualised infrastructure, network switches.
6. Who are the key stakeholders i.e. organisation, business, agency, citizen and what are their roles?
Manufacturers that provide the infrastructure under maintenance, engineers that perform maintenance tasks.
7. What role does technology play?
• Facilitate data management, and access to historical data. • Enables remote access and transmission. • Studies tendencies and predicts possible future events. • Assists engineers to detect faults and guide them via mixed reality through complex tasks
8. Are you working with big amounts of unstructured data? If yes, in what extend?
Our workflows involve known and structured data, however, the various workflows (e.g., monitoring different type of assets) introduce multiple, totally different data structures.
9. Do you have experience working with IoT infrastructure?
We operate some IoT equipment that use common communication protocols (e.g., Modbus, MQTT)
10. If the answer to Q9 is yes, is there any feature that you fell is missing from the current IoT systems? (you can identify more than one)
TBD
11. What are the regulatory requirements and terms being used that are related to devices, communications and content?
TBD
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?
Custom software must be developed to collect and store IoT data flows, resulting to additional effort and lack of scalability.
13. Have there been any issues around technical interoperability which are <u>not</u> related to ICT? If so, what were they? How have they been solved?

N/A
14. Have there been any issues around managing the relationships between different departments or with other organizations you closely work? 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 (if they have)?
Data sharing is restricted since health status from generators, actuators and critical devices should remain confidential. Therefore, this information is disclosed only to authorized personnel. There is no established procedure for handling this data,
16. Have there been any other issues about interoperability/ integration/ ethics/ informed consent?
N/A
17. Are there any aspects of your projects where good practice guidelines, certifications schemes or standards would have helped?
TBD
18. What do you expect to gain from TERMINET? Which of the issues mentioned above you expect TERMINET to help overcome and how?
TBD
19. Have you been able to use only standard, non-proprietary technologies in your project?
We have not been able to use only standard and non-proprietary technologies in internal projects, mainly because the proprietary solutions are already established in the business workflow, are more trusted by the management, and there is no strong incentive to move to non-proprietary and standard solutions. Moreover, the proprietary solutions are more established and trusted in the market.
20. In your operations, is there a necessity for (near) real-time applications or services?
TBD
21. Is your competition using IoT solutions?
Yes.
22. How are your human-machine interfaces? User-friendly, intuitive, complex?

Our existing human-machine interfaces are complex and inflexible, meaning that they cannot be easily adapted to the various data structures.
23. How comfortable are you in using cloud-based solutions for hosting your data (external to your infrastructure)
We are comfortable for storing data in the cloud if non-disclosure agreements have already been taken place. For example, data indicating faults at specific time should remain private.

Case study name and URL or other reference – Country, Sector, Role
Use Case 6: Mixed Reality and ML Supported Maintenance and Fault Prediction of IoT-based Critical Infrastructure??
Summary
1. Name of person filling out the form and role
Amelia Alvarez, Schneider Electric Project Manager.
2. What are the key purposes your organization aims to fulfil? (Healthier citizens, economic growth, less pollution, please describe)
Schneider Electric provides energy and automation digital solutions for efficiency and sustainability. Schneider Electric combines world-leading energy technologies, real-time automation, software and services into integrated solutions for homes, buildings, data centres, infrastructure and industries. We make process and energy safe and reliable, efficient and sustainable, open and connected.
3. What are the key systems involved in your day2day activities? (Building, Housing, Energy, Health, Mobility, Transport etc.)
Electric substation controllers / Remote Terminal Unit (RTU)
4. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)
Power Plant
5. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure etc.)
electricity infrastructure
6. Who are the key stakeholders i.e. organisation, business, agency, citizen and what are their roles?
Utilities that acquire Schneider Electric's RTUs, manufacturers of equipment or systems to be integrated with our RTUs, engineers that perform the installation and maintenance tasks.

7. What role does technology play?
• Facilitate data management, and access to historical data. • Enables remote access and transmission. • Studies tendencies and predicts possible future events. • Assists engineers to detect faults and guide them via mixed reality through complex tasks
8. Are you working with big amounts of unstructured data? If yes, in what extend?
RTUs handle databases specifically designed for the customer; those data are sent as structured data using a previously selected communication protocol.
9. Do you have experience working with IoT infrastructure?
We have made some progress on the development of an embedded prototype of IoT interface under the scope of other R&D project but not with IoT infrastructure itself
10. If the answer to Q9 is yes, is there any feature that you fell is missing from the current IoT systems? (you can identify more than one)
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?
Limited set of IoT protocols: MQTT, AMQP, OCP UA
13. Have there been any issues around technical interoperability which are <u>not</u> related to ICT? If so, what were they? How have they been solved?
For IoT communications protocols such as MQTT, the JSON content needs to be adjusted to the requirements of the broker that is retrieving data or at the opposite.
14. Have there been any issues around managing the relationships between different departments or with other organizations you closely work? If so, what were they? How have they been solved?
no
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 (if they have)?
RTU handle the information that is defined for the customer database. The Data sharing policy is not handled by Schneider Electric but by the customer that installs the RTU.
16. Have there been any other issues about interoperability/ integration/ ethics/ informed consent?

N/A
17. Are there any aspects of your projects where good practice guidelines, certifications schemes or standards would have helped?
18. What do you expect to gain from TERMINET? Which of the issues mentioned above you expect TERMINET to help overcome and how?
Technology validation
19. Have you been able to use only standard, non-proprietary technologies in your project?
N/A
20. In your operations, is there a necessity for (near) real-time applications or services?
RTUs operates on an embedded real-time operating system. Controllers running on the RTUs are real-time services.
21. Is your competition using IoT solutions?
Not for RTUs
22. How are your human-machine interfaces? User-friendly, intuitive, complex?
User-friendly. The complexity depends on the complexity of the RTU configuration for the customer installation to be controlled.
23. How comfortable are you in using cloud-based solutions for hosting your data (external to your infrastructure)
We are comfortable as long as our customers rely on them.

Case study name and URL or other reference – Country, Sector, Role
Summary
1. Name of person filling out the form and role
Marcello Morchio, Electronic Engineer, System Manager in Optical Solutions & Fronthaul in the in Ericsson R&D Italy (TEI)
2. What are the key purposes your organization aims to fulfil? (Healthier citizens, economic growth, less pollution, please describe)
Ericsson vision & purpose is "Empowering a more intelligent and sustainable connected world by relentlessly innovating networked technologies that are easy to use, adopt and scale"

3. What are the key systems involved in your day2day activities? (Building, Housing, Energy, Health, Mobility, Transport etc.)
Optical Transport equipment as part of the Ericsson Radio Access Network for 4G and 5G connectivity
4. Are any community facilities involved (hospital, clinic, home, school, park, warehouse, shop, carpark)
Radio access network is spread between radio antennas in outside towers in indoor locations and telecom operator central offices. Optical transport network includes distribution nodes and cabinets located on poles, strands, curbs or underground in manholes.
5. Are any key infrastructures involved? (Roads, gas infrastructure, electricity infrastructure etc.)
Antennas, telecom infrastructure, physical and virtualized servers and network components
6. Who are the key stakeholders i.e. organisation, business, agency, citizen and what are their roles?
In general: business and individual mobile users, network roll out and maintenance teams, network integrators, city planners, network operators. For the scope of TERMINET UC.6 the direct stakeholders are network maintenance teams and network operators and integrators.
7. What role does technology play?
Referred to TERMINET UC.6 Reduce optical network maintenance cost by predicting possible failures on SFP modules and allowing planning of maintenance actions.
8. Are you working with big amounts of unstructured data? If yes, in what extend?
Our workflows involve known and structured data.
9. Do you have experience working with IoT infrastructure?
As telecom manufacturers, we usually provide the network infrastructure, either fixed or mobile for the IoT networks. In this case we consider the components of the network itself as sensors, and thus as IoT devices, generating performance data to be correlated with configuration data.
10. If the answer to Q9 is yes, is there any feature that you fell is missing from the current IoT systems? (you can identify more than one)
TBD
11. What are the regulatory requirements and terms being used that are related to devices, communications and content?

w.r.t. SFP modules, the reference standards are maintained by SNIA "Storage Networking Industry Association" see https://www.snia.org/technology-communities/sff/specifications
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?
SFP modules are used in many kinds of network products which have their own Operation and Management workflow. Integration of collection and processing of common data across different managed elements is a challenge. The current solution is a cross platform data collection to cover many hardware maintenances services, the challenge is to exploit that platform for advanced use cases such as predictive maintenance
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?
N/A
14. Have there been any issues around managing the relationships between different departments or with other organizations you closely work? 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 (if they have)?
Data sharing is restricted since health status from optical modules and critical devices should remain confidential. Therefore, this information is disclosed only to authorized personnel and managed according to local data protection rules.
16. Have there been any other issues about interoperability/ integration/ ethics/ informed consent?
N/A
17. Are there any aspects of your projects where good practice guidelines, certifications schemes or standards would have helped?
TBD
18. What do you expect to gain from TERMINET? Which of the issues mentioned above you expect TERMINET to help overcome and how?
To address the challenge of exploiting exploit the data platform for advanced use cases such as predictive maintenance, coping with the need of avoiding data spread beyond the regulatory constraints.

19. Have you been able to use only standard, non-proprietary technologies in your project?
TBD
20. In your operations, is there a necessity for (near) real-time applications or services?
TBD
21. Is your competition using IoT solutions?
Yes.
22. How are your human-machine interfaces? User-friendly, intuitive, complex?
There are many types of interfaces and presentation pipelines in the network management realm, with different level of complexity and targeted to different types of users. Their usage is intuitive provided the right competence level of the user.
23. How comfortable are you in using cloud-based solutions for hosting your data (external to your infrastructure)
We are comfortable for storing data in the cloud, there are constraints about cloud being propriety of our customers for some data types and ours for others.