TREEADS

A Holistic Fire Management Ecosystem for Prevention, Detection and Restoration of Environmental Disasters

TREEADS D7.1 Holistic Fire Management System and Incremental deployment of all Phases V1

Work package	WP7: TREEADS Holistic Fire Management System and Incremental approach of all Phases
Task	Task 7.1: TREEADS Re-use of recourses of all Phases Task 7.2: TREEADS Holistic fire management Incremental approach Task 7.3: TREEADS Micro "Plugin" Platform Building and Interoperability Services Task 7.4: TREEADS Integrated Fire Management and Services
Authors	**Tord Kaasa -Jotne**, Margherita Forcolin -MAGG, Marios Papamichalopolos-MAGG
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Revision and history chart

Version	Date	Main author	Summary of changes
0.1	02/01/2023	Tord Kaasa	Draft outline
0.2	11/01/2023	Tord Kaasa	Further defined structure
0.3	25/01/2023	Tord Kaasa, Margherita Forcolin	Revision
0.4	27/01/2023	Tord Kaasa, Margherita Forcolin	Consolidated information and updated the text based on comments
0.5	31/01/2023	Tord Kaasa, Margherita Forcolin	Draft for internal review
0.6	13/02/2023	Tord Kaasa, Margherita Forcolin, Marios Papamichalopolos	Updated draft for internal review-based feedback received
1.0	28/02/2023	Tord Kaasa, Margherita Forcolin	Final submitted version
2.0	24/11/2023	Margherita Forcolin	Modified based on the comments received with the 1st review report

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GLOSSARY OF TERMS

Term	Description
Digital Twin	Virtual representation of a connected physical asset
Database	Structured set of data
Product lifecycle management	Management of engineering data thought a product/project lifetime
Inventory	Itemised list of all hardware, software, services that is available to the TREEADS pilots

LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Meaning
AI	Artificial Intelligence
AIA	Aerospace Industries Association
AIAA	American Institute of Aeronautics and Astronautics
API	Application Programming Interface
A&R	Adaptation and Restoration
CAD	Computer Aided Design
DR	Detection and Response
DT	Digital Twin
HW	Hardware
ID	Identification
IPC	Industrial Personal Computer
JSON	JavaScript Object Notation
MS	Microsoft
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management

PP	Prevention and Preparedness
STEP	Standard for the Exchange of Product model data
SW	Software

EXECUTIVE SUMMARY

This document is the deliverable "D7.1 - Holistic Fire Management System and Incremental deployment of all Phases V1" of the Horizon Europe Innovation Action project "TREEADS, A Holistic Fire Management Ecosystem for Prevention, Detection and Restoration of Environmental Disasters" (hereinafter also referred to as "TREEADS").

This deliverable describes the effort done towards creating an implementation procedure for the TREEADS platform. Data collected to analyse the potential for reuse between the pilots and interoperability between software modules is also described.

The early platform for the TREEADS project is described, including an overview of Digital Twins, the digital assets, and an overview of the main features foreseen.

Data was collected from pilot partners using an Inventory List that describes the tools, and data sets that will be used to define the TREEADS solutions for the pilots.

This document will act as a living document that describes all steps taken towards the integration of all components to a consolidated TREEADS platform, as such it will act as a framework for further updates and enhancements. The document describes the following: WP7 methodology, Inventory creation and maintenance, the TREEADS platform, the Interoperability plan, proposed reuse of resources, and the way froward, proposed changes in the next issue of the living document.

INTRODUCTION

BACKGROUND

TREEADS aims to deliver a holistic Fire Management platform that integrates, optimises, and reuses available Socio-technological Resources to provide a better response in the different phases of the fire management: prevention and preparedness (PP), Detection and response (DR) and Adaptation and Restoration (A&R) and to improve the overall quality of total Wildfire Lifecycle interaction.

The work package 7, "*TREEADS Holistic Fire Management System and Incremental approach of all Phases"* aims to define and create an optimised solution for the TREEADS technology services and provide details regarding the interoperability of the different technological modules to guide the integration process. The following points describe the purpose of WP7 according to the grant agreement:

- To consider all toolsets and solutions built in the three phases of TREEADS and come back with an optimisation solution for the use of every technological service and solution.
- To build an Incremental deployment strategy that follows a step-by-step procedure for enhancing per-phase toolsets for the enhancement of current fire Management systems.
- To produce all necessary interfaces during the integration process.
- To define and specify a detailed interoperability plan among the TREEADS Ecosystems mechanisms.
- To integrate the developed software components to form the final TREEADS Ecosystem.
- To build a Continuous Integration and Deployment approach.
- To deploy and operate a code maintenance repository with enhanced version control and continuous integration capabilities.
- To establish the governance model and requirements for the creation and management of the TREEADS Ecosystem, aiming to achieve sustainability after the end of the project.

PURPOSE AND SCOPE

The main objectives of this deliverable are summarised in the following points.

- Deliver an overview of the methodology,
- Provide an overview of the main technological and service components for each pilot,
- Provide the foundation for the analysis of the collected technological assets,
- Provide information on how the various socio-technological components can be integrated into a common target.

This deliverable will be a living document updated in three main versions. The living document will be periodically revised based on feedback from the pilot leaders. The first version will be delivered in month 15 and the second in month 23, together with a demonstration of the TREEADS platform and inventory system. Subsequently, the final version will be delivered in month 33, along with the platform. All other updates of this living document will be available on the project SharePoint. The initial version of this document presents an overview of the work done in the corresponding tasks, harmonising with the work done in WP 2. The purpose of this document is to provide a comprehensive overview of the steps taken to uncover the available technology solutions as well as the services that will be involved for each pilot.

As this is the first version of the deliverable, at a point where WP7 has collected the information but not analysed it yet, this version of the document will create a framework for further iterations of this living document. The data collected from the pilots will not be covered in this version of the deliverable.

The main sections of this document that will be updated periodically are the following:

- Inventory Results
- Platform
- Incremental deployment strategy
- Interoperability plan
- Overlapping technologies
- The way forward
- List of changes in this version

All these sections will be marked with the update date and all relevant changes will be marked in the list of changes section.

SCALE OF THE SOLUTION AND SCALE-UP CAPABILITIES

TREEADS Holistic Platform solution is intended first to provide an operational tool for the control and monitoring of fire-related hazards, with a specific focus on the pilots' ecosystems, which plays a pivotal role in fulfilling the objectives of the project while simultaneously showcasing an agile methodology and tools for crafting customised pilot-specific operational environments.

The fundamental goal of the platform is to meet the needs of the pilots. Although, it will be possible to include technologies from geographically dispersed providers (I.e., TREEADS partners), these will be localised to comply with the scope of the pilot, therefore the scale is local. However, the platform implements an agile and adaptable approach, which is crucial for enabling the efficient deployment of tailored solutions to meet specific demands, but it is also crucial to

However, by prioritising modularity and agility at its core, the platform is prepared to evolve and grow not only with the changing requirements and ambitions of its stakeholders, but also to comply with wider geographical and administrative scale.

While the primary focus is currently on pilots, the platform is well-equipped to transition to larger scopes of operation. It can easily expand to serve larger geographic regions, such as entire countries or even Europe as a whole.

Nevertheless, the platform's capacity for scaling up depends significantly on the scale and scope of the technological resources available to be integrated and included in the solution. This means that if the scale of a given technology is local, the integrated solution will have a local scale, at least in relation to that specific technology.

At the end of the project, the final version of the platform will be complemented with technical documentation and guidelines. This will facilitate broader adoption and scalability.

METHODOLOGY

To fulfil the goals as stated in the description of WP7, namely the integration process of a TREEADS platform, the need arose for a standardised way of describing tools and technologies that will be a part of the pilots. Work done in other work packages (WP2-4) has led to several descriptions of the TREEADS partners' technology and tools. However, these lists are often not formalised. The need for a more rigid structure to describe the information so that it might be analysed further was a necessity to uncover overlaps and potential reuse. Subsequently, a formalised information structure of the partners' input will be imperative to realise the interoperability plan for the software that will be integrated into the TREEADS platform. To this end, a dedicated inventory was created and populated by the pilots' leaders with input from all pilot partners. The inventory list, collecting all the projects' hardware, software, and services, was created for each pilot and distributed among the pilot leaders. Each pilot provided feedback on the list that was made available on the project SharePoint. This information was later compiled, and the information was made available in a database to facilitate the interoperability of the data. The current solution is running on the Product Data Management (PLM) module TruePLM, a software module provided by the TREEADS project partner Jotne.

The information gathered from the pilots through the inventory will lay the foundation for further analysis of the available tools and will uncover the potential for the reuse of resources in the integration process.

At the current point of writing, the initial feedback from all pilots regarding the inventory has been completed, and the information has been aggregated. The next phase will focus on the analysis of the gathered information. This will result in suggestions for reuse and cooperation across pilots, a detailed interoperability plan for the integration of software to the TREEADS platform and a further description of the incremental deployment strategy.

Consequently, this document adapts the living document style of updates, where this is the initial version providing a foundation for enhancement and further updates.

INVENTORY

As described in the methodology section, in order to be able to realise the goal of a holistic platform and resource reuse system, an in-depth categorisation of available technology that will be used for each pilot must be created, with the aim of creating an inventory of all TREEADS technologies, including all hardware (HW), software (SW), and services. The inventory list is a defined list that describes the available resources in a formalised way that is more manageable than the text descriptions that have existed in the project until now. The inventory list template was created based on information collected and described in the D2.9 pilots' operational scenarios and distributed to the partners and pilot leaders. The following sections describe the format and categorisation of the inventory as well as the eventual aggregated material in a database.

The final section, *Inventory Results*, concludes and provides a link for the project partners to the inventory list on SharePoint, providing a way of updating their current information, together with instructions on how to inform the WP7 WP/task leads on their update. In further updates, a link to the database containing the entirety of the collected information will be provided for simpler browsing.

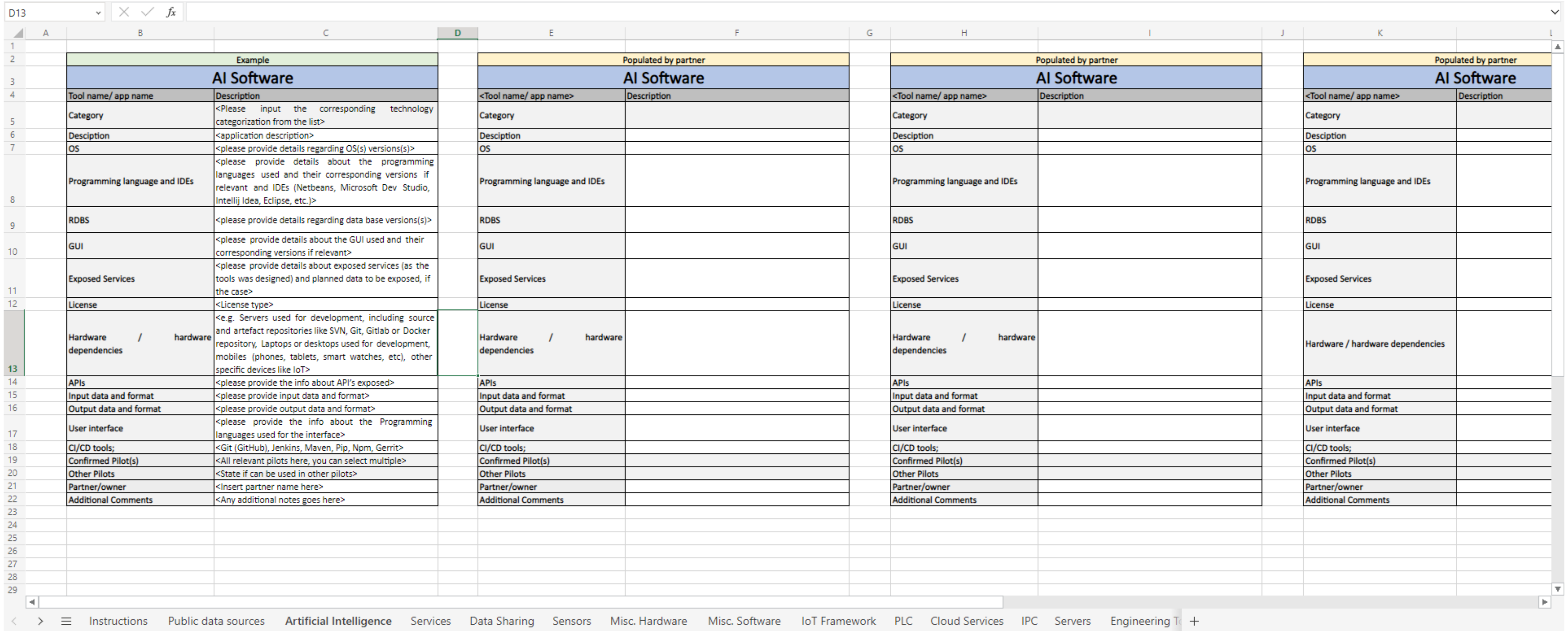
The inventory list was a central point in several plenary meetings to ensure that the right technology and services were included. Some pilots needed additional time to populate the list, as the requested information required time and significant effort to populate. The information available in the Inventory List will be progressively more low-level and complete as the pilots and available information mature with time.

INVENTORY LIST FORMAT

The inventory list is realised through a macro-enabled MS Excel document. The first sheet of the document contains step-by-step instructions and a detailed overview of how the inventory list will be used and populated to simplify the work for the pilot leaders and partners. Furthermore, the document features a number of sheets, each representing a technology classification. An overview of these categories is given in the section below. Figure 1 provides a view of the inventory list.

Some partner contributions were difficult to categorise. In such cases, discussions would be held to attempt to place the contribution in the category that makes the most sense and to uphold consistency among the different pilots. The WP7 partners also changed the categorisation of certain contributions to uphold this consistency. This will be important during the next phase for the purpose of analysis.

Each category had multiple information boxes to be filed. The unfilled template can be seen in Figure 1. As the pilots are not yet at a stage where all information is clarified, some boxes remain empty for some of the contributions in the pilots, or the information is generic. The specificity of the information will be increased as the project and pilots mature.



Example		Populated by partner		Populated by partner		Populated by partner	
AI Software		AI Software		AI Software		AI Software	
Tool name/ app name	Description	<Tool name/ app name>	Description	<Tool name/ app name>	Description	<Tool name/ app name>	Description
Category	<Please input the corresponding technology categorization from the list>	Category		Category		Category	
Desciption	<application description>	Desciption		Desciption		Desciption	
OS	<please provide details regarding OS(s) versions(s)>	OS		OS		OS	
Programming language and IDEs	<please provide details about the programming languages used and their corresponding versions if relevant and IDEs (Netbeans, Microsoft Dev Studio, Intellij Idea, Eclipse, etc.)>	Programming language and IDEs		Programming language and IDEs		Programming language and IDEs	
RDBS	<please provide details regarding data base versions(s)>	RDBS		RDBS		RDBS	
GUI	<please provide details about the GUI used and their corresponding versions if relevant>	GUI		GUI		GUI	
Exposed Services	<please provide details about exposed services (as the tools was designed) and planned data to be exposed, if the case>	Exposed Services		Exposed Services		Exposed Services	
License	<License type>	License		License		License	
Hardware / hardware dependencies	<e.g. Servers used for development, including source and artefact repositories like SVN, Git, Gitlab or Docker repository, Laptops or desktops used for development, mobiles (phones, tablets, smart watches, etc), other specific devices like IoT>	Hardware / hardware dependencies		Hardware / hardware dependencies		Hardware / hardware dependencies	
APIs	<please provide the info about API's exposed>	APIs		APIs		APIs	
Input data and format	<please provide input data and format>	Input data and format		Input data and format		Input data and format	
Output data and format	<please provide output data and format>	Output data and format		Output data and format		Output data and format	
User interface	<please provide the info about the Programming languages used for the interface>	User interface		User interface		User interface	
CI/CD tools;	<Git (GitHub), Jenkins, Maven, Pip, Npm, Gerrit>	CI/CD tools;		CI/CD tools;		CI/CD tools;	
Confirmed Pilot(s)	<All relevant pilots here, you can select multiple>	Confirmed Pilot(s)		Confirmed Pilot(s)		Confirmed Pilot(s)	
Other Pilots	<State if can be used in other pilots>	Other Pilots		Other Pilots		Other Pilots	
Partner/owner	<Insert partner name here>	Partner/owner		Partner/owner		Partner/owner	
Additional Comments	<Any additional notes goes here>	Additional Comments		Additional Comments		Additional Comments	

Figure 1: View of Inventory List template. This sheet contains the information on Artificial Intelligence to be populated by the pilot partners.

Each category sheet contains templates for one or more specific instances of each technology. Figure 2 provides a filled-in example of the template "Data sharing and infrastructure software" within the "Data sharing" category.

Example	
Data sharing and infrastructure software	
Component Name	ISO 10303 repository (EDMtruePLM, EDMopenSimDM)
Category	
Description	A complete repository that can manage CAD, CAE, PLM and sensor data as well as maintenance and support data
Operating System	Windows
Input Description	All relevant engineering and sensor data
Input Formatting	STEP AP209 (AP242, AP239, on request: openBIM/IFC)
	XML, JSON using ISO 10303
Input Interfaces	File based (ISO 10303-21, ISO 10303-28), C++, .NET, SOAP web-services, REST API, Arrowhead Framework
Output Description	All relevant engineering and sensor data
Output Formatting	STEP AP209 (AP242, AP239, on request: openBIM/IFC)
	XML, JSON using ISO 10303
Output Interfaces	File based (ISO 10303-21, ISO 10303-28), C++, .NET, SOAP web-services, REST API, Arrowhead Framework
Hardware Dependencies	<e.g. Servers used for development, including source and artefact repositories like SVN, Git, Gitlab or Docker repository, Laptops or desktops used for development, mobiles (phones, tablets, smart watches, etc), other specific devices like IoT>
Confirmed Pilot(s)	<All relevant pilots here, you can select multiple>
Other Pilots	<State if can be used in other pilots>
Partner/owner	<Insert partner name here>
Additional Comments	<Any additional notes goes here>

Figure 2: Template for "Data sharing and infrastructure software" within the "Data sharing" category.

An important point regarding these templates within categories is that project partners were expected -and also are for future updates of the Inventory List -to add additional information where necessary, as it is not likely that the pre-defined templates will fully cover all applicable technologies within all use cases.

INVENTORY CATEGORISATION

As described in the previous section, to simplify the analysis process of the collected data, the inventory was divided into categories. The categories were decided after consulting with partners in the regular WP7 meetings in order to properly prepare the inventory list template such that it covered the most critical aspects of the pilots.

The following section offers an elaboration on the main classifications:

Public data sources consist of all data sources that are planned to be used at any point during the described pilot.

AI (Artificial Intelligence) pertains to all modules that consume data from the data-sharing tool to use it for machine learning, analyses, simulations, etc.

Services include all TREEADS software provided as a service by the different partners.

Data Sharing pertains to repository software for concurrent access to product data. The data stored includes sensor data, CAD models, technical documentation, etc.

Sensors describe the components that measure physical characteristics.

Hardware contains hardware components that will be used for the pilots. Includes tablets, AR glasses, PCs, etc.

Software contains software components that will be used for the pilots. Includes visualisation and rendering tools.

IoT Framework (Internet of Things) includes relevant IoT platforms/frameworks that will be used to connect all DT components.

PLC (Programmable Logic Controller) pertains to the ruggedised industrial computers controlling the manufacturing process.

Cloud Services are all cloud services that will be used to fulfil the goal of the pilots.

IPC (Industrial Personal Computer) pertains to computers designed for industrial use with high reliability and uptime.

Engineering Tools pertains to all tools that create technical engineering data such as 3D models, 2D technical drawings, and other engineering artefacts.

Servers that will be used to fulfil the goal of the pilots.

EXTRA offers room for their contribution for any partner who has contributions that do not fit into another classification. At a later point, these contributions can be moved into another classification, or new ones can be created if necessary.

Additionally, to help identify overlaps and to aid with the categorisation, partners could assign a specific category to their technical contributions. The following categories can apply. The categories were derived from work based on WP2:

Risk analysis tool pertains to the software or methodology used to identify and assess potential risks throughout the project chain.

Fire-resilient materials categorise all contributions regarding the resilience of material to fire.

Governance and parametric Insurance models and Guidelines

Fire detection relates to sensors and systems that are integral to detecting the wildfire at an early point.

Fire and smoke propagation forecasting is the technology that can describe or predict the smoke propagation and the spread of wildfire.

Fire emergency management, technology related to the emergency management of the wildfire, such as logistics.

Equipment for emergency responders is the equipment that will be used by the first responders during the pilots.

Restoration and Adaptation constitute technology directly related to the restoration and adaptation phase.

Space and aerial means are the technology for aerial surveillance and services, such as drones.

XR is the technology related to virtual reality and augmented reality.

ICT tools for detection and response are information and communications systems that will be used for the pilots.

Data sharing refers to the approach or system(s) used to make data available throughout all the project stages, users, and relevant tools. This can include the utilisation of a central data- or knowledge-repository or other forms of data access, such as APIs or particularly interoperable file formats.

Infrastructure contains all services related to the infrastructure of the place where the pilot will be held.

INVENTORY DATABASE/ AGGREGATE LIST

A master spreadsheet for each pilot will be made available on the project SharePoint. Partners will be prompted to periodically review their contribution to the list and provide updated information if progress or changes have been made. Jotne will be the editor of the master spreadsheet and thus responsible for keeping the inventory updated with new information submitted by partners.

At the time of writing this document, the inventory list exists as an MS Excel spreadsheet. This is done solely for the convenience of populating it with information. However, it should be noted that a spreadsheet is not the optimal solution for browsing the available data nor searching for specific technologies or UC contributions.

The collected data shall be made available in a database for ease of access. Multiple solutions are considered. TREEADS partner Jotne's PLM software based on the open standard ISO 10303 will be a possible implementation; SharePoint could also be viable. However, other options will be evaluated based on the need to make the information easily consumable both by humans and by digital tools.

TRUEPLM DATABASE

This section provides insight into the PLM database that will contain all contributions from the pilots regarding the inventory. All data is imported directly from the spreadsheet populated by the partners.

The repository is built on the open standard ISO 10303 (STEP) and provides easy access to the data.

EDMtruePLM comes with a web-client interface that can be accessed to review the archived data. The web TruePLM application contains a front-end developed in JavaScript with the VUE.js framework (https://vuejs.org/) and a backend, developed in Java with the Spring Boot framework (https://spring.io/projects/spring-boot). Front-end and back-end communicate with each other through the REST API of EDMtruePLM. The descriptions of the REST API functions are on the following swagger page:

(https://demo.jotne.com/EDMtruePLM/swagger.html).

The web application itself does not provide additional data storage; all data is stored on the server in the EDM database. The web application, that is, the EDMtruePLM GUI, may be executed by any of the modern web browsers.

The available client functionality depends on the type of user who is logged in. For details, see https://jotne.atlassian.net/wiki/spaces/EDM/pages/3471409196/User+Manual+-+3.3.

In the database, information can be structured and sorted by pilot. Through the REST API, it is simple to export the data. Further updates of this deliverable will include a link to the PLM Database for browsing.

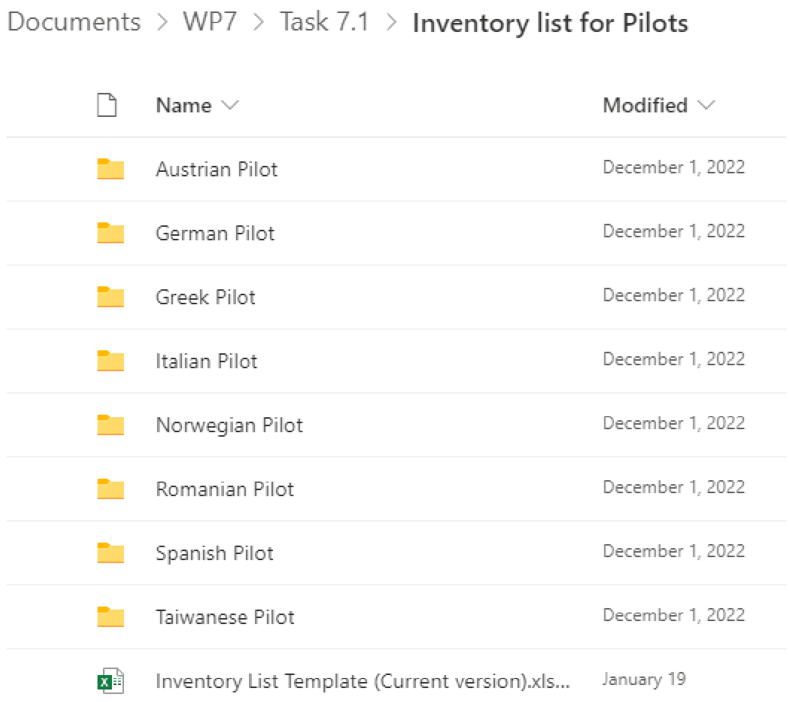
INVENTORY RESULTS

This section summarises the Inventory List results.

By the time of writing, all pilots had provided information and started to populate the list with their current information. It is worth noting that most pilot leaders stressed that it was difficult to provide the exact information as some aspects of the pilots are yet to be defined/finalised at this stage of the project. The inventory is consequently populated with a lower level of detail at this point. The level of detail will increase with each update of this document.

The pilots contain a large number of differing technologies. Consequently, the full list will not be a part of this deliverable, as it would be too extensive and hard to upkeep in document form. Nevertheless, project partners will be able to view the list in two different ways.

- Through the TREEADS SharePoint repository



Documents > WP7 > Task 7.1 > **Inventory list for Pilots**

Name	Modified
Austrian Pilot	December 1, 2022
German Pilot	December 1, 2022
Greek Pilot	December 1, 2022
Italian Pilot	December 1, 2022
Norwegian Pilot	December 1, 2022
Romanian Pilot	December 1, 2022
Spanish Pilot	December 1, 2022
Taiwanese Pilot	December 1, 2022
Inventory List Template (Current version).xls...	January 19

Figure 3: SharePoint repository for Inventory Input

- Through TruePLM

Login and link to the TruePLM database will be provided in further updates.

PLATFORM

OVERVIEW

In the past decades, digitalisation has been extremely important in improving the efficiency of organisations.

Besides the increased efficiency deriving from the improved control and monitoring capacity, digitalisation provides additional benefits, such as:

Better decisions making - digitised information can be easily analysed and visualised in new ways, providing new insights and, in general, supporting a more informed decision-making process.

Greater accessibility - Digital information is easily accessed and shared, paving the way to more collaborative models and knowledge sharing.

Cost reduction – the increased efficiency, improved accessibility, improved accuracy and reliability, and improved decision-making help organisations to reduce costs, thus becoming more agile, responsive, and competitive.

Most importantly, data obtained can be used to perform data analytics, machine learning and AI to gain new insights, make predictions and make decisions.

The emergence of the Digital Twin (DT) concept brought the capacity to simulate the physical world through a digital model and bridge the gap between digital and physical systems.

DIGITAL TWIN CONCEPT

There are several definitions and interpretations of what a Digital Twin is, according to the definition provided by the Digital Twin consortium**,** "*A digital twin is a virtual representation of real-world entities and processes, synchronised at a specified frequency and fidelity*" [1]. Further explanations of DTs and their value can also be found in the American Institute of Aeronautics and Astronautics (AIAA) and Aerospace Industries Association (AIA) Position Paper, *digital twin: definition & value* [2].

The digital nature of this representation allows for manipulation of the structure and behaviour of the virtual object. However, a digital twin is a representation of a *real-world entity,* and the digital and physical representations are synchronised; this means that the state of the physical system is reflected in the digital system and *vice versa*.

This bi-univocal relationship allows Digital twins to play five key roles.

Explain what happened in the past: for instance, by analysing historical data from sensors, it is possible to identify patterns and detect anomalies in sensor readings.

Predict future behaviours: for example, given the historical behaviour of a specific sensor, it is possible to predict future values.

Explore alternatives by using historical data to simulate what-if scenarios in the digital world and evaluate these alternative scenarios against desired criteria.

Change the physical world: based on the explorations in the digital world, it is possible to derive insights to change the physical world.

Generate synthetic data for testing: the availability of historical data allows the generation of potential values (synthetic data) to test the physical world. This use of digital twins gives a powerful tool to operate with when data is incomplete and uncertain [3].

The applicability of DT is not limited to sensor' data. Real-world entities can range from sensors to machinery, to people, to organisational entities. A digital twin can also be a representation of a process.

In TREEADS, the digital assets to be considered are the area of interest (forest), relevant or critical infrastructures, equipment, etc. TREEADS holistic platform provides the capacity to use TREEADS technologies and operate on the digital assets of interest.

DIGITAL ASSETS

Based on the definition given above, being the virtual representation of real-world entities, Digital twins can be very complex.

From a theoretical point of view, a digital asset can be seen as a digital object that has *properties* and *telemetries* (Figure 4), where:

Property is an attribute characterising the asset.

Telemetry represents data that is automatically collected, transmitted, and measured from other (remote) sources. Therefore, telemetry enriches the digital assets, providing the data to be analysed to monitor and control the remote system.

As a minimum, a Digital Asset has at least one Property and one Telemetry. This constitutes an *Elementary Digital Asset* (highlighted by the red circle in **Error! Reference source not found.**). But in the complexity of the real world, an object, and consequently its digital representation, has several Properties and several Telemetries. Additionally, Digital Assets can be in a *Relationship* with one another. Relationships among assets create *Networks*, chains of digital assets that can represent different things, such as value chains, processes, hierarchies, or any permanent aggregation of digital assets.

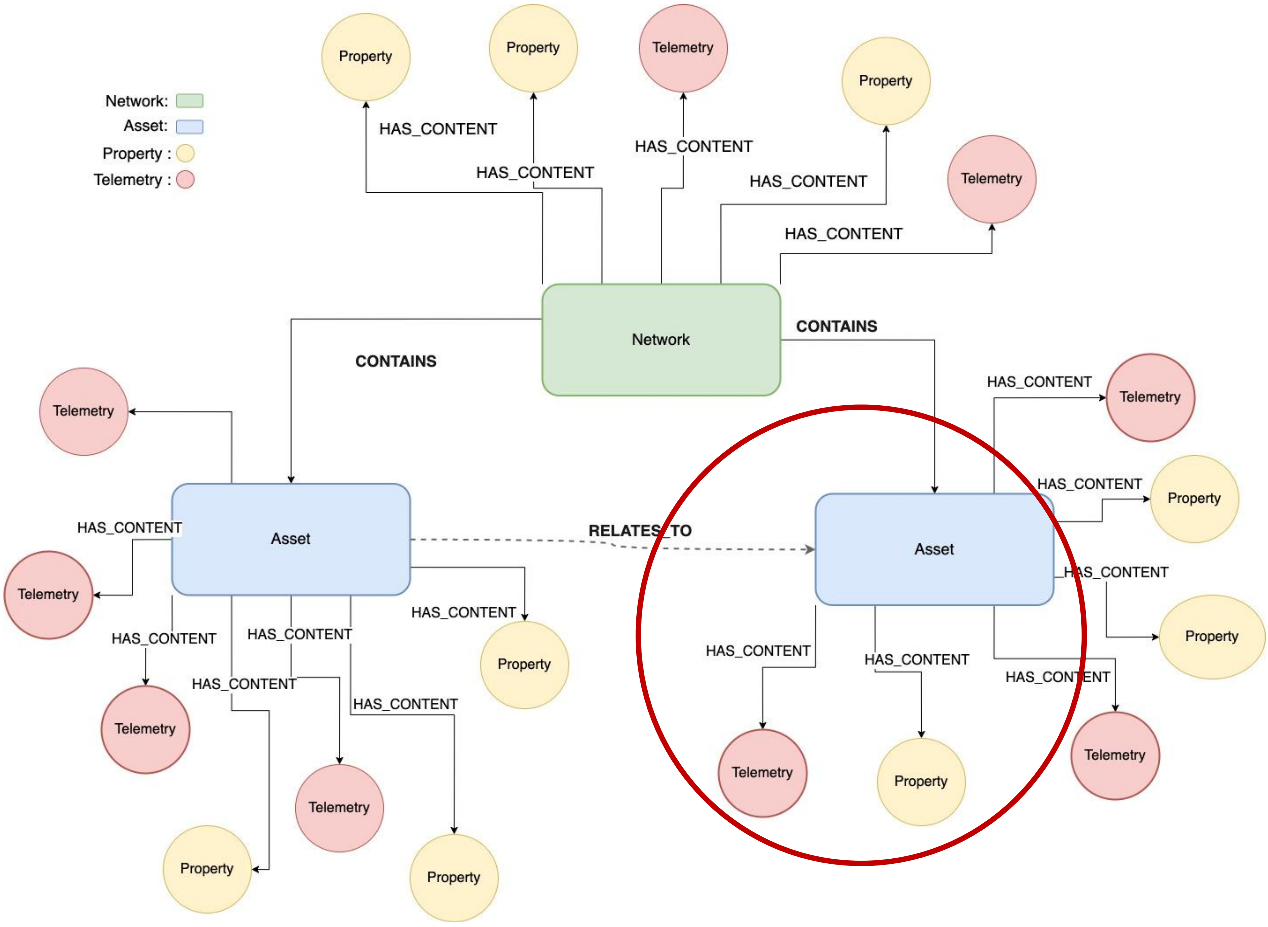


Figure 4: Digital Assets model of a simple structure

Based on these simple premises, it is possible not only to model complex systems but also to operate and monitor such systems.

HOLISTIC PLATFORM OVERVIEW

TREEADS holistic platform builds on MIRA, a Digital Twin enabler platform developed by Maggioli in previous EU-funded projects (i.e., FactLog).

MIRA provides core features allowing the user to *define its environment* in terms of:

- Digital assets (with related properties and telemetries)
- Relationships
- Networks

This digital representation can be used to:

- Store, track, manage and monitor the physical asset's data in a secure and organised manner.
- Automate and optimise the asset's operations.

- Simulate different scenarios (analytics and machine learning) and make better-informed decisions.
- Create a digital identity for physical assets, enabling secure and seamless data access from multiple devices.

TREEADS HOLISTIC PLATFORM ARCHITECTURE

To derive the TREEADS holistic platform architecture, we used a two-fold approach: top-down from the architecture description (WP3) and bottom-up from refined pilot stories (WP2). **Figure 5** provides an overview of TREEADS holistic platform architecture. The main components are:

Web interface, implemented with Angular, is the web app/UI the users interact with after having correctly authenticated in the system.

Gateway is the core component of the platform. All requests pass through the Gateway microservice first. It may propagate the request to other services and return a response to the UI. The main functions performed by the Gateway are:

Authentication and authorisation. PostgreSQL database is used to store related information (users, roles, authorisations, organisations, etc.).

Manage the business logic. The Gateway is a reverse proxy that isolates the outside world from the services. Thus, it acts as an orchestrator for analytics-related calls, authenticates and authorises users and contains the core logic of the (pilot) applications concerning Networks, Assets, their properties, telemetries and relationships, and the processes the assets are involved in. Users need to define the system they want to manage in terms of digital assets, networks and relationships and define the eventual process to be orchestrated. The Gateway uses Neo4j, a graph database that is particularly fitted to store this type of information.

Routes requests to the other (micro)services.

Analytics Service is responsible for batch-consuming messages from the RabbitMQ broker telemetry-logs queue and writing the data to a new database. This feature is propaedeutic for generating analytics. Users can post their data regarding a given telemetry to that queue. Additionally, this service is also responsible for producing the charts and KPIs of telemetries (Charts are currently being implemented).

NEO4J is a no-SQL graph database that stores and manages data in its more natural, connected state, maintaining data relationships. Consequently, Neo4j is characterised by improved query performance, a deeper context for analytics, and easily modifiable models. Neo4j is used to manipulate Digital Assets entities in the platform. [4]

Email Service consumes emails sent by the Gateway to the email queue. We use a queue so as not to lose any messages during communication between the microservices. In this current version, it is used mainly for authentication purposes, but in the next versions. It will be in charge of sending alerts and notifications (via email) to involved stakeholders.

RabbitMQ queues. RabbitMQ is one of the most popular open-source message brokers is the most widely deployed open-source message broker. It is lightweight and easy to deploy both on-premises and in the cloud. It supports multiple messaging protocols. RabbitMQ is used to implement two separate queues [5].

- **Email queue** consumed by the Email service.
- **Telemetry queue** consumed by the Analytics service.

Databases. Besides Neo4J, the no-SQL database that stores information about the models, the platform manages two different instances of PostgreSQL databases: one stores information related to authentication and the other stores the telemetry logs. These two separate instances allow for keeping serialised data separate from regular data and the scale-up of analytics for big data.

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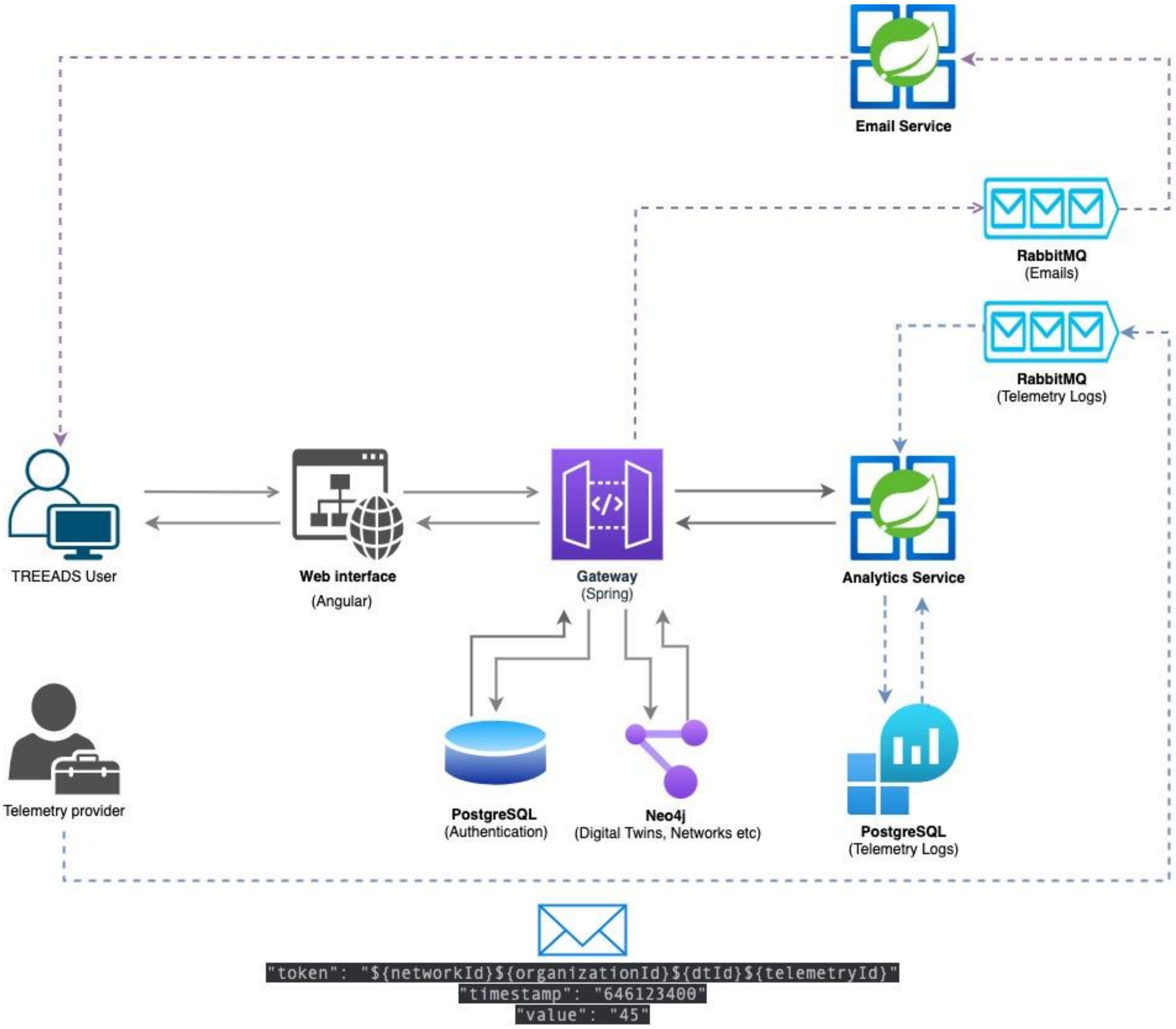

Figure 5: TREEADS Holistic platform internal architecture

Public interface and Main features. The user interface will allow registered users to access the platform and create their own "system" in terms of assets to be monitored and "features" (i.e., services) to be used.

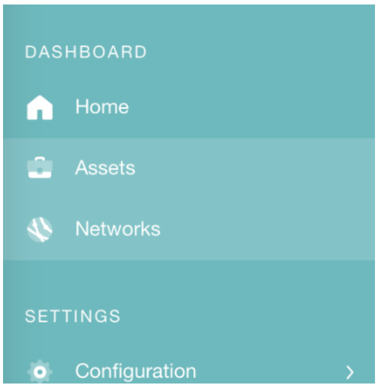

Figure 6: Public Interface

The user interface has been designed to be very user-friendly: at the moment, the main menu contains only a few options, as shown in Figure 6.

Once the system has been defined, <<Home>> will provide the logged-in user with a complete view of the assets, their status, and any critical issues. Additionally, the user will be able to request the execution of services, and the resulting outputs will be stored in the platform, enriching the status of the digital assets involved, thus providing a more accurate view of the users' system.

The other two options, <<Assets>> and <<Networks>>, allow to **Model the system-** by creating Assets, Relationships and Networks>. Additionally, it will be possible to **Select the *services*** to be used. This feature is currently under development. The idea is to provide a list of available TREEADS technologies from which the user will be able to select the ones he/she wants to use.

MODEL THE SYSTEM

To model the system, the user needs to:

- identify the assets to be digitalised,
- define the properties characterising the asset and the telemetries that will provide data supporting the monitoring phase,
- aggregate the assets in networks, eventually establishing relationships among assets.

Assets, properties, and telemetries

Selecting the option <<Assets>> from the main menu, the user will access a page with the list of all assets defined so far (Figure 7). Clicking on the <<+ Add New>> button will open the form to create a new asset (Figure 8).

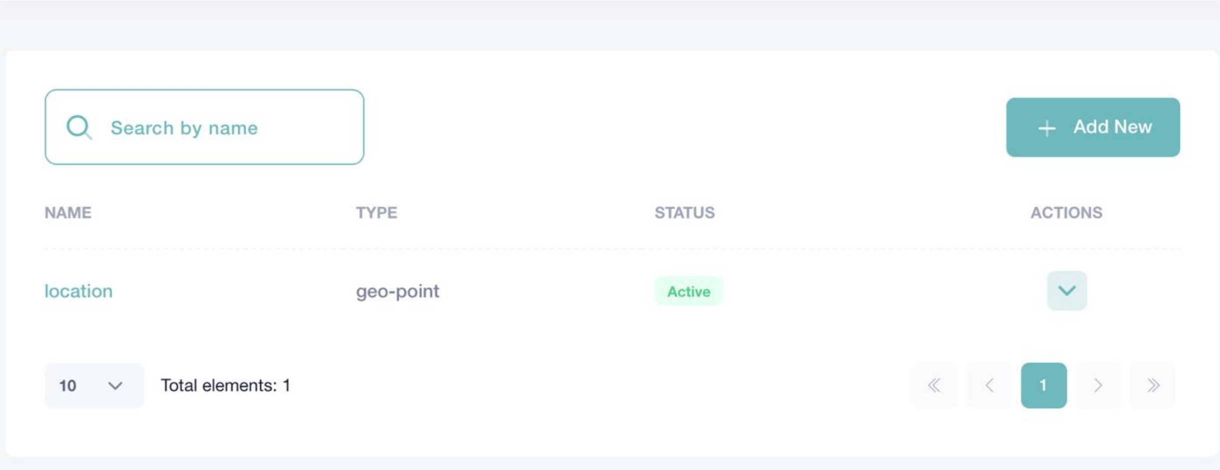

Figure 7: Holistic Platform: list of assets

The button below the label Actions will open a pane with the actions that can be done on the asset (Edit/Delete).

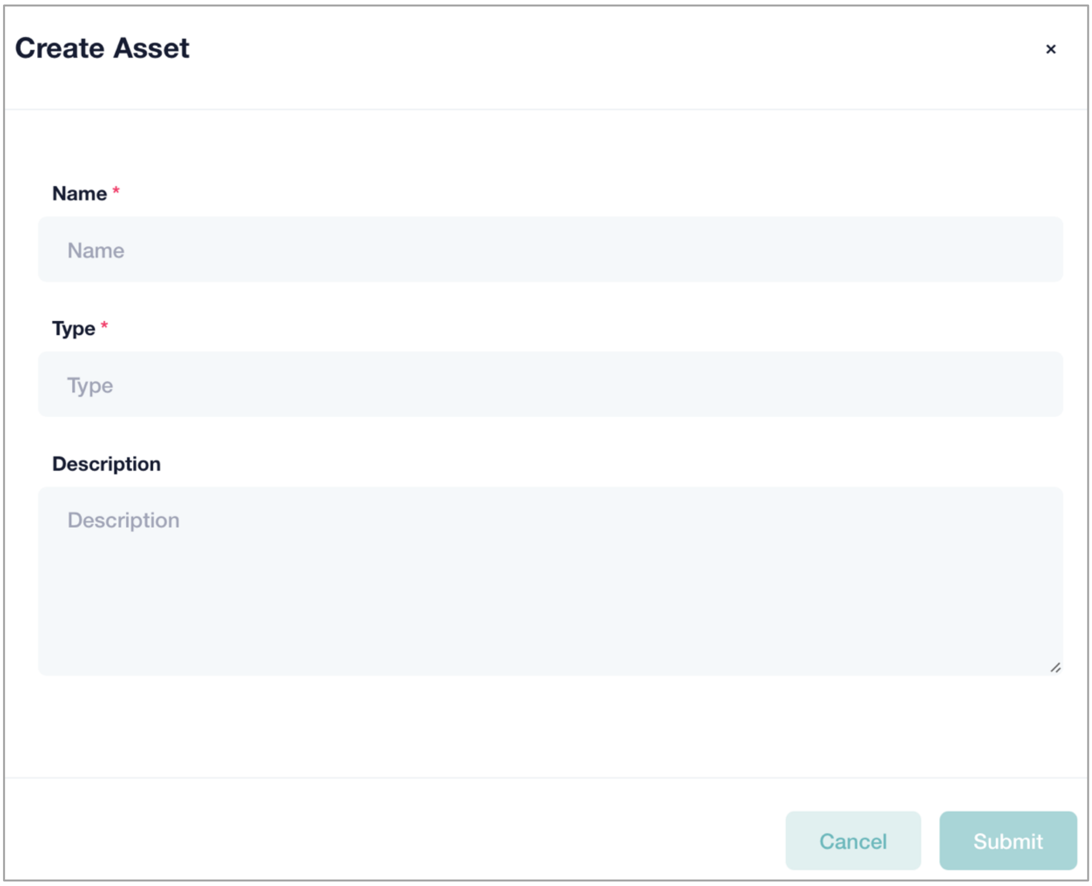

Figure 8: Holistic platform - Create an asset.

The asset is described by its identifier, its type, and a short description. Since a digital asset can theoretically represent any physical object, there are no restrictions concerning the" type".

As stated before, an asset can have properties and telemetries. From the list of Assets, clicking on one asset, the user accesses a page that provides a summary of the characteristics and measures of that asset, such as the number of networks it participates in, the number of properties and telemetries and the most recent values for the defined telemetries (Figure 9).

Selecting the *Properties tab* and clicking on the <<+ Add New>> button, the user will access an input form, similar to the asset input form, where to define the property. The required input fields are 1) Property identifier, 2) property name and 3) type. While selecting *the Telemetry tab* and Clicking on the <<+ Add New>> button, the user will be redirected to the telemetry input form where the required fields are 1) telemetry identifier, 2) telemetry name, 3) source (where the data come from, for instance, it could be a sensor or a service), 4) the unit (of measure of the telemetry), and 5) the type.

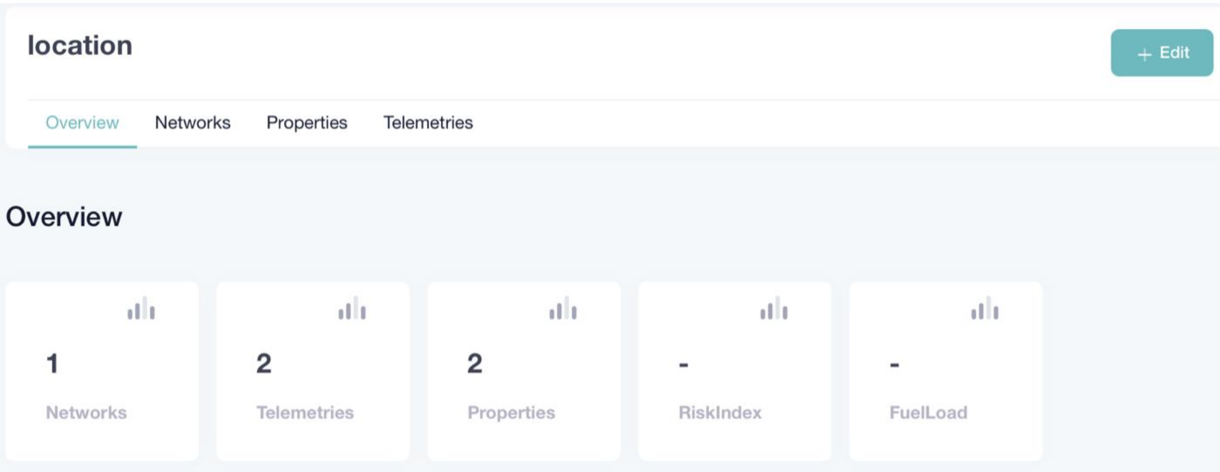

Figure 9: Holistic platform – detailed view of an asset.

Networks and relationships

Having defined the assets, the user can define the networks that are relevant to the operational scenarios. The general idea is that a Network aggregates assets that are somehow related (E.g., they participate in the same process)

Selecting the option <<Networks>> from the main menu, the user will access a page with the list of all networks defined so far. Clicking on the <<+ Add New>> button will open the network input form, where only two fields are required: 1) Network name and 2) a short description.

Also, in this case, the button below the label Actions will open a pane with the actions that can be done on the network (Edit/Deactivate/Delete).

While selecting an existing Network, the user accesses a page that provides a summary of the characteristics of that network, specifically the number of assets included in the network, and the number of properties and telemetries.

Indeed, a network can have properties and telemetries, which can be defined in the same way described for assets by selecting the corresponding tab (Figure 10) and clicking on the <<+ Add New>> button.

To associate assets to the network, the user needs to select the *Model tab* and click the <<+ Add Asset>> button. A new window will open, listing all the assets that are not associated with the network. Here, the user will have to select the assets to include in the network.

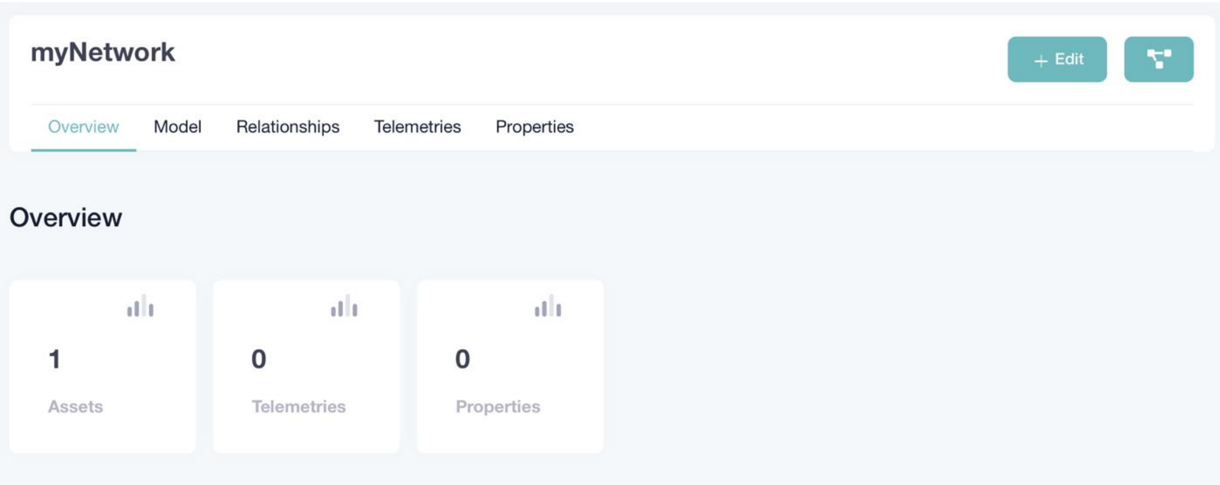

Figure 10: Holistic platform - detailed view of a Network

From the Network view, it is also possible to declare a relationship between two assets: selecting the *Relationships tab* and clicking the <<+ Add New>> button, the user will be presented with a simple form where to declare the relationship.

From the Network page, it is possible to view a graphical representation of the system defined, like the one in Figure 4, by clicking on the graph button ().

INTEROPERABILITY PLAN

This section describes the interoperability plan for the integration of software components to the TREEADS platform. Data interoperability refers to the ability of different systems, devices, or applications to exchange and use data in a meaningful and consistent way. This can include the ability to share data between different software programs, between different organisations, or between different types of equipment. Data interoperability is important for ensuring that information can be easily shared and used in a variety of contexts, and it is a key aspect of many modern technologies.

Consequently, for the TREEADS project, it is imperative that all software modules developed within the TREEADS project (WP 4-6) can connect to the platform and that all data be securely transferred without any data loss occurring or any other complication. The same goes for all software components that will be provided to be used by the different partners for the pilots.

This section will, therefore, act as a guide for interoperability and implementation between the different software modules of the TREEADS holistic platform.

This section will be further expanded and updated during the next phase of the work package based on analysed information from the inventory and the progression of the other technical work packages.

REUSE OF PILOT RESOURCES

Reusing technical resources within the TREEADS project can have several benefits that can help to improve the efficiency, effectiveness, and overall success of the project as a whole. Some of the main benefits include:

Cost savings: Reduce the cost of a project by avoiding the need to create new resources or deploy new solutions if such solutions already exist within the project.

Time savings: Reusing existing resources can help to speed up the planning process of the pilots by avoiding the need to spend time and effort on planning the implementation of new resources.

Improved quality: Reusing existing resources can help to improve the overall quality of a project by leveraging resources that have already been tested and proven to be effective.

Consistency: Reusing existing resources can help to ensure consistency and facilities interoperability to the main platform by limiting the number of software components that need to link to the main platform.

For the TREEADS project, it aims to reuse assets to increase the efficiency of the pilots. The following section describes methods to identify the opportunities for reuse and cross-pilot cooperation.

OVERLAPPING TECHNOLOGIES

Leveraging on the information gathered from the pilots through the inventory list, it is planned to identify areas and technologies of interest for reuse. For the TREADS project, two main ways of resource use have been identified:

Reuse of overlapping technology: Some pilots require the use of technologies or services that overlap with other pilots. For instance, pilots that require a repository for sensor data should be able to use the same software component for this purpose. Such reuse of components where there are overlapping needs will also lead to a more harmonised overall framework for the TREEADS project.

Reuse of technologies with adapted capabilities: some technologies can be adapted and reused in other pilots to serve a different function than what was originally intended. For instance, a drone can be used to carry seeds or water, depending on the needs of the pilot. To be able to chart this, a more in-depth inventory must be established, with an extended focus on the pilots' needs in addition to the available technologies. This will be expended in the next release of this deliverable.

The main strategy for identifying the overlap is through the application of the inventory list categorisation. Each contribution to the list is sorted by a main category, as shown in the "*Inventory List*" section of this document. The specific categories were decided on to cover the main groups of technologies for the pilots and should be sufficiently detailed to enable comparison of the overlap within each group. Moving forward towards the M18 iteration of this document, discussions will be held among the pilot leaders to discuss and potentially choose common candidates where overlap has been identified.

DISCUSSION AND CONCLUSION

The current state of the integration process is that data has been collected from the pilot partners in the inventory. An early demonstration of the platform using information gathered from the Spanish pilot is ready. The information gathered will lay the foundation for future analyses to uncover the potential for reuse and the integration steps needed to connect the different modules to the TREEADS platform.

No analyses regarding reuse or interoperability have been conducted at this point. This will be the focus for WP7 moving forward towards the next period.

THE WAY FORWARD

The next iteration of this document will be submitted in M18. In the period leading up to this, the inventory list along with this document will be continuously updated as more details and information are collected and systematised. An in-depth explanation of this planned process is given in the "*Inventory*" section. The identified technologies will be added to the PLM system as described there and support the fulfilment of the objectives listed in the "*Purpose and Scope*" section.

An important part of the effort moving forward with this work will be the participation of all partners in providing a sufficient level of detail regarding their technological contributions. A higher level of detail is needed to fulfil the objectives of the activity in a sufficient manner.

In addition, work on identifying the amount of overlap and the potential for reuse of the available technologies among the pilots will be central as this document is refined in the period leading up to M18.

The deliverable scheduled for M18 will also feature a demonstration of the platform with a detailed breakdown of the corresponding technological components from the inventory list.

LIST OF CHANGES IN THIS VERSION

This is the initial version of this living document. For subsequent iterations of this document, the changes and additions will be noted in this section.

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TREEADS

A Holistic Fire Management Ecosystem for Prevention, Detection and Restoration of Environmental Disasters

The Members of the TREEADS Consortium:

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Contact:

Project Coordinator: **Kemal S. Arsava** RISE Fire Research AS	kemal.sarp.arsava@risefr.no

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