EU RIA Horizon Europe Proposal Template

Project IDIoHMA

Abstract

The interactions of humans and AI systems are becoming a cornerstone of research and digital innovation not only in ICT but also in any field that needs a digital interface to be used to its full potential. With the growing population of smart devices and the IoT, along with the interconnection of multiple devices in a network via the Continuum Cloud-to-edge, and the 6G wireless communication technologies, the world is evolving into a smart world fully connected and aimed toward the collaboration of humans and machines powered by AI, and where complexity rises along with the number of functionalities and interactions that humans have with their creations, as well as the techno-dependency for this products. All these phenomena lead to a greater quantity of situation and boundaries that need to be taken into account when designing the architecture and the interconnection substructure of the AI system in the context in which It operates and should be implemented. To address these problems, we developed a consensus theory and an adaptable and flexible infrastructure as a distributed and decentralised framework that could be used in every situation to create a network of AI that is built and act based on human interactions with them, in a consensus environment to provide DSS capabilities, that is IDIoHMA(Infrastructure for Dynamic Interfaces of Humans-Machine AI). We measure the impact of our project directly in the context of smart cities, specifically in the city of Madrid where it will be deployed on some applications developed by the university and distributed to the public to measure the involvement and engagement of people with AI applications.

Project abstract. **Important:** limit to 2000 characters.

0.1 Glossary of terms

Acronym	
RIA	Research and innovation action
DSS	Decision support system
AI	Artificial intelligence
FIPA	Foundation for Intelligent Physical Agents
PPP	Public private partnership

Table 0.1b: Glossary

1 Excellence

1.1 Objectives and Ambition

The IDIoHMA project is a collection of methodologies, software, framework and good practices that will support the deployment of an AI-capable distributed system based on multi-agent that will exploit the distribution and decentralization of the devices to provide the capabilities in a simple and performing way. The main focus of the project is to provide a framework for a distributed system of heterogeneous devices and to give DSS capabilities to the system. The interactions between AI systems and humans are becoming more and more difficult since the complexity of the system and the capabilities provided influence directly the complexity and importance of the interactions, a common example (not much related to the topic but very common) is modern printers that do a lot of things, and common people that interact with these printers are usually not that fond of the process of reading a whole manual for simply printing and scanning things. A more closer example to our use case is smart-cities and the interactions of the citizens with the AI systems, e.g. for following some routes or for advice for how to choose some kind of action around the city, such as meeting new people, coordinating some workers, etc.

Our project aims to address most of the objectives of the call and also focuses on the topic at hand by interlacing the research with the whole work programme affiliated with the call. The main focus of the project is to provide a solid and flexible infrastructure to address the growing complexity of the interactions between humans and AI(robots, devices, decisional support systems, etc.) to improve the support and the capabilities that could be given by the technology at hand. With the growing support for fast internet(with 6G technologies) and the possibility of having a smart device always at hand(smartphones, smartwatches, smart glasses) that could be used as a part of an edge-AI system capable of getting very good results for a reduced cost of production, the opportunities to build a system useful for humans are innumerable as introduced before.

The deployment of the final product will be on smart devices that need some type of information network to share collected data in a decentralized architecture. Our objective is also in line with most of the topics presented in Horizon Europe about digital innovation since we will be using new technologies and methods when needed, like the **Continuum Cloud-to-Edge** and **edge-AI**, fast networking(**6G**), mobility. The framework and methods could also be used to orchestrate the renewable energy capabilities and interactions since it will work as a network for all the smart devices to coordinate the grid of the same or different types of renewables.

The name of the project is also related to the objective of our focus, we aim at breaking the barriers created by the increasing complexity of the interactions between humans and machines. This is done with a flexible and adaptable infrastructure that will establish some guidelines and procedures to follow to make the interactions of humans of all genres, ages, disabilities and social classes more straightforward and simple, and also to provide a functions and capabilities aimed toward the end-user, such as security choices, coordination of the systems where shared choices are involved, and acting based on data and information provided to the end-users by the system.

Our project has as a primary objective to create a general framework and methods used in a distributed and decentralized system, but it also can be specialized for the requirements of the use case at hand.

Our focus is to build the framework and methodology that could be used to orchestrate a whole dynamic human-AI system capable of aiding humans in everyday activities, especially in smart cities. We also aim to build better AI with the help of the population by using engagement and involvement of people on our

smart devices and collect both direct and indirect feedback in a **Human-in-the-loop** hybrid environment, where users can use the deployed product and also enhance it and improve it. The engagement process is also a concern most of the time when the application requirements to collect data are too tedious, so we also focus on the process of involving people with the system to get better performance for the app and satisfy the needs of the users.

In comparison with similar research and other tools released that focus on the creation of a hybrid decision-support system in a specific environment, IDIoHMA is not a tool that only works in a specific environment but it is a framework(IoT framework) that should be used as the skeleton of a specialized system to obtain the functionalities and the quality provided by a framework that will implement some best practices and will be compliant with the European law for security and privacy along with the provision of the useful tools that could be used to build powerful models and improve them dynamically without sacrificing the simplicity of interactions of the end-users and the explainability and clearness of the behaviour of the AI system. Another important point and focus of this project is to abstract the low-level part of every implementation in a tested, common, open-source, stable and always up-to-date framework that is built with performance and stability in mind, and that respects the FAIR (Findable, Accessible, Interoperable and Reusable) principles. The system will be available in single node mode (where it could be deployed on a single device), or in a distributed system of devices. The framework will also respect the **Reactive** philosophy[1][7] since it is thought to be implemented in distributed and decentralized systems.

Users of the application that implements the IDIoHMA framework will be seen as agents in a **multi-agent system**[3][5], and the whole system will be modelled and treated as a **mesh network**[17][9][16], where new nodes (agents) could join the dynamic network and use the capabilities provided by the framework (get some information about something, make a decision with the help of user or all the users in the consensus environment, improve the models by interacting with the interface provided). Devices connected to the mesh network are also seen as a cluster and could be used to distribute workloads for complex tasks, as well as providing the users with the decision support capabilities with models that work and improve directly on the devices. To accomplish the tasks described, the framework will use new technologies and state of the art techniques that use virtualization (VRAN, containers and infrastructure from code) to provide a common and reusable interface to all the devices, cloud-to-edge environments to provide the monitoring and tuning infrastructure of the system that could be seen as the master of the framework, distributed and collaborative strategies to do distributed learning (federated learning, Collaborative deep reinforcement learning).

The framework has the possibility of having one or more centralized servers that gather data and monitor the proper behaviour of the system of devices. The main job that could be associated with these servers (and it is advised to do so to get more flexibility and implement a clean, always up-to-date, scalable and resilient smart environment) is to orchestrate and handle the devices in the network, this is done using methods of virtualization, the CI/CD methodology[4][6][15], smart workloads[8] and scheduling and other techniques that will be introduced in this document and thoroughly described in the reports **??**. These servers could also be used to distribute a large amount of data to the devices that require it.

Another work that tries to establish a common framework to use in a situation where a decentralized decision support system is deployed was not found since our work is completely new and aims to address common problems with a lot of software and applications that work in a distributed and heterogeneous environment. Related work was published for decision support systems in close and static environments but nothing was thought or implemented for our domain of interest. The core framework that implements a virtualized AI-enabled system composed of heterogeneous devices is seen in the literature for topics like **mesh computing** and **distributed intelligence for IoT ????**, but these topics are fresh and will eventually grow even more in the following years due to the growth of IoT connectivity, speed, and performance.

(**ONLY HERE AS AN IDEA, ABSOLUTELY NOT SURE ABOUT IT**)The skeleton code will be provided by some tools that are an integral part of the framework and form its core for the creation of blueprints that are created accordingly to model-driven-engineering techniques. The first version (WP2) of this blueprint builder is the UCM developed software called Ingenme based on the Ingenias Methodology [12], a meta-editor used to create meta-models that implements some techniques of model driven engineering. The Ingenias methodology will be used only in the beginning though and another methodology based on

different and more advanced techniques will be used. The final module will be based on methodologies that use user inputs to understand the needs of the user and change the interface of the system using these user inputs and usage, this will be done with anthologies and some hybrid techniques that use **knowledge graphs**, multi-agent methodologies that respect the **FIPA** specifications for the standards of multi-agent systems development and intercommunication.

The first thing that will be done with the IDIoHMA framework is to present an application that implements it in a smart city environment, where it gathers data that will be used to improve the performance(both decisional and the overall performance of the tools) to make a dynamic model that will change along with the evolving platform(**NOT SURE AS STATED BEFORE**) and environment. At the start of the project, the TRL will be around TRL 2-3, where the core API and some methodsD2.2D2.3 will be released and will be tested, improved and expanded from that point onward. At the end of the core project developmentD3.3D3.2 (the framework API and the methods that should be used), the TRL will be around 5-6 since it will be tested first in some specific cases of lab search, and then directly deployed on some devices and software that is already being used nowadays in Madrid.

Specific challenge	IDIoHMA answer
Truly mixed human-AI initiatives for human empowerment	1.1 Smart devices will aid end-users in everyday activities that include mobility, entertainment and support for decisions in specific environments. 1.2 The interaction between the AI systems and humans will be direct, not complex and easy to implement for localized topics. 1.3 Every day smart devices will be used to create the computation network that serves the purpose of providing end-users with useful functionalities and capabilities, along with the collection of useful data used to create better models and better interactions between the technology and the user, lightening the responsibility of the design of the developer, and obtaining better capabilities.
Trustworthy hybrid decision-support systems	1.1 Our framework is based on a consensus of decisions between end-users in a specific environment, so the final results should be trustworthy since the outcome is the one expected from a democratic decision system. 1.2 The project is completely hybrid since it uses the consensus environment to create decision aiding systems(along with other models for other use cases), the products alone will be useful to collect and provide information to the end-users to finalize the decisions with a solid base.

Table 1.2c: Specific challenges table

1.2 Relation to the work programme

IDIoHMA answers to the topic AI for human empowerment(topic identifier: HORIZON-CL4-2022-HUMAN-02-01) that is part of the general work programme **Horizon Europe Framework Programme (HORIZON)** and also implements the co-programmed European Partnership on AI, Data and Robotics. In particular, it addresses most of the clusters in the pillar II of the work programme, and in particular, it focuses on **Culture, creativity and inclusive society**; **Digital, Industry and Space**; **Climate, energy and mobility**.

The outcome of the proposal(results and impact) is expected to contribute to at least one of the specific challenges seen in table 1.2 but, while we focus on one of the objectives(**Truly mixed human-AI initiatives for human empowerment**), we also take into consideration the second objective to provide a trustworthy system.

The objectives are achievable with a team effort with a collaboration of experts of different fields (programmers and computer scientists in general for the development of the framework, SSH researchers to understand the relations, interactions and behaviour of humans with the system and the engagement, law and policy experts to keep the boundaries of the regulation, along with understanding what could and could not be done with the project).

The results that address the objectives will be measurable and open to the public. The API will be open-source and available as soon as the project will be under development, while the methods will be accompanied with some publications that will be carried out together with the development of the API to get the most out of the time available.

Scope	IDIoHMA answer
Build the next level of perception, visualisation, interaction and collaboration between humans and AI systems working together as partners to achieve common goals, sharing mutual understanding and learning of each other's abilities and respective roles.	Our framework clearly defines the relations between decentralized devices equipped with edge-AI. Every device is specialized for the activities of its users, and the whole system is linked to a network and some cloud system that is used to build and control the quality of the overall product.
Innovative and promising approaches, including human-in-the-loop approaches for truly mixed human-AI initiatives combining the best of human and machine knowledge and capabilities, tacit knowledge extraction (to design the next generation AI-driven co-creation and collaboration tools embodied e.g. in industrial/working spaces environments)	We also aim to build better AI with the help of the population by using engagement and involvement of people on our smart devices and collect both direct and indirect feedback in a **Human-in-the-loop** hybrid environment, where users can use the deployed product and also enhance it and improve it. This process of involvement is carried out by a hybrid strategy that uses some concepts of gamification, social sciences and human behaviour analysis to get the best engagement of people with the deployed system.
Reach truly mixed human-AI initiatives for human empowerment. The approaches should combine the best of human and machine knowledge and capabilities including shared and sliding autonomy in interaction, addressing reactivity, and fluidity of interaction and making systems transparent, fair and intuitive to use, which will play a key role.	The results that implement the framework will be completely flexible, especially for the end-users and the admins, since we will provide some mechanism to specialize the functionalities for the needs of the environment where the framework and methodologies of IDIoHMA are used. Reactivity of the system will be guaranteed by the high capabilities and computation network at hand, that uses the whole system of devices to build better and faster models. Intuitivity of use will be a concern of the methods and practices that we will explain along with the framework, to maximize both the flexibility of the end product and ease the interaction of humans with the interfaces to the system.
The systems should adapt to the user rather than the opposite, based on analysis, understanding and anticipation about human behaviour and expectations.	As already stated before, the whole system has the objective of easing the interaction of humans and AI devices, along with providing models that are based on consensus and democratic reason for the end-users. So the final product is dynamically changing for the population needs in the environment where it operates.
adopt a human-centred development of trustworthy AI and investigate and optimise ways of human-AI interaction, key for acceptance and democratisation of AI, to allow any user to take full advantage of the huge benefits such technology can offer, regardless of their age, race, gender or capabilities	Humans are at the centre of attention and the main objectives for IDIoHMA, the end-users of the AI systems developed will be the one that shapes the whole functions and how things should be decided, regardless of age, gender, or every type of classification of the end-users(as long as the end-users are the one who should be using the system, so additional considerations on security could be discussed). The decisions will be based especially on the consensus of the people that use the product (along with some fine-tuning with some established and clear rules) to create a dynamical decision system capable of adapting itself to the need of the users.

Trustworthy hybrid decision-support, including approaches for mixed and sliding decision-making, for context interpretation, for dealing with uncertainty, transparent anticipation, reliability, human-centric planning and decision-making, interdependencies, and augmented decision-making	As already stated in the specific objectives in table 1.2, the models that will be implemented are based upon a consensus and democratic learning, where the devices AI will be enhanced by the end-users. With the models that will be created over time, we will also be able to see the relations between groups and specific designs. For uncertainty, we address the issue by taking into account other environments other than the one where the framework is deployed, this ensures the possibility to get outlier data and treat it beforehand by predicting and handling the presence of uncertainty for similar contexts and environments. Augmented decision-making could be implemented easily in the model, as long as the base functionalities that the framework offers are implemented and tested on the devices for the decision making(also by providing continuous feedback since augmented decision making gives insight and aids the process of decision in every context, so it needs special attention from the users to get better results).
Transparency, fairness, technical accuracy and robustness will be the key, together with validation strategies assessing also the quality of the decision of the AI supported socio-technical system.	All these qualities will be addressed directly with the tools and methods provided, and the quality of all these requirements will be measured by reacting and improving the tools from the feedback and interaction of the users with our framework. The process will be smooth since the framework will improve and adapt itself to the need of the users, with no tweaking or bias toward different categories of people.
Development of methods to improve transparency, in particular for human users, in terms of explainability, expected levels of performance which are guaranteed/verifiable and corresponding confidence levels, accountability and responsibility, as well as perceived trust and fairness.	The framework and methods presented that constitute the IDIoHMA project will be centred around the objective of keeping the transparency to the users of the applications high for users, along with guaranteeing very good performance that will be provided by dynamically improving models that will change with the interactions of the users (that will be a key factor in the overall performance since the whole concept depends on the interaction of humans and AI devices). The system will be used to aid the users in the environment where they are implemented and where they are thought to operate, so trust and responsibility will always be shared with the users of the system, little to no direct action will be taken especially for important tasks where the system should only be used as an aid.
AI could also be used to empower humans in supporting them to improve responsible behaviours, where appropriate, but this should be done in full respect of the requirements ensuring trustworthy AI, including human autonomy.	IDIoHMA will be used as an aiding AI system that could be used in every situation where there is a decision to take and that decision has some type of consensus or democratic value to it. The product will be used by the people that need some kind of help with a decision, and the product itself should be never considered enough to decide since it needs a lot of feedback to work with non-trivial tasks.
multidisciplinary and transdisciplinary approaches paying particular attention to intersectional factors (gender, ethnicity, age, socioeconomic status, disability) as well as collaborative design and evaluation with users involvement	The whole project has a lot of intersections between various subjects that are really important to the logic behind the decisions taken for the development and the usage of the applications where the framework and methods are deployed. The framework is general so it needs to eventually address some problem-specific factors, this leads to cross-cutting concerns that need to be already in the framework to consider every situation where they could be necessary and, at the same time, to maintain a simple and clean infrastructure that will be easily adaptable to the situation. These concerns will be addressed in detail in 1.8.

The scope of these challenges is aligned with the scope of the work programme for RIA and specifically aimed toward the requirements of the partnership with **AI, Data and Robotics**. Our pilot is deployed in the city of Madrid**(right now I do not know, but maybe if I work on those projects I can define more clearly the impact objectives and pilot, we also need to define the pilot clearly since most of the impact importance come from the pilots and the measures that we will be using)**. We aim to address both of the objective specified in the call, that is **Truly mixed human-AI initiatives for human empowerment** and **Trustworthy hybrid decision-support systems** as introduced in table 1.2.

Our objective is more aimed toward the first objective since the core of our project is the creation of a simple and easy to implement framework for decision support systems in a decentralized environment(devices in the network where the framework is been used), the engagement of people, the collection of useful feedback, and the reaction of AI created by that feedback in a particular environment. That means that the focus of this project is the research objective of building and orchestrating a complex system (with **best practices** and methods to maintain the system always up to date and responsive to the needs of the end-users) that aids humans in the situation where it is thought for, but also can adapt itself dynamically when new and uncertain data rise from time to time. This is aided by the simplicity and particular attention to details regarding the interfaces between man and machine, thus facilitating interactions regardless of the category to which one belongs(elderly, disabled, gender identity). Other strategies will be adopted to keep and improve the flexibility and performance of the system, such as continuous testing, monitoring of the system and the interaction of humans, parameter tuning and the addition of functionalities on need.

IDIoHMA also has links with the value-chain methodology since it addresses the technological development and the production of the end products in a certain use case. In particular, our projects will facilitate the process of production and deployment of a decentralized system (with some form of centralised control and inference for the heavy computation of big data collected from the devices) aimed at making decisions in a hybrid environment of machines and humans with contained costs and better performance and reception to the end-users.

1.3 Novelty, level of ambition and foundational character

IDIoHMA will be a common and open-source framework (more information on why the project is available as open source can be found in 1.7, the idea behind this choice is that the framework itself is only an aid to bigger projects and has no value by itself) available to everyone that will act in a multi-agent environment of devices interconnected in a mesh network, where almost every device could be used to gather data, give information or other functions (actuator) and make decisions with the help of human users that will interact with the device. The framework can be used in every situation where some devices are used to do some common tasks among them and these devices could be treated as a network to compute in a distributed environment, enhance their capabilities together and build a consensus model from the implicit and explicit feedback of the users and devices. IDIoHMA is also composed of a core module developed specifically for decision support functionalities that will be used by human users in a truly mixed course of actions, where the some of the devices that have been marked as actors will be used to provide the services needed for the environment where the framework is implemented and the objectives that are being targeted.

When necessary, **Public-private partnerships** both for the pilot and the use cases will be stipulated to guarantee a swift and easy coordination and deployment of the product in a work environment, where the capabilities of IDIoHMA will be tested and managed accordingly to the needs of the stakeholders and partners. These partnerships will be really important to the project and will mark the impact of the project.

The pilot of the project 4 will be a collaboration with the Universidad Complutense de Madrid and the city itself D4.2, where the framework will be deployed in the network of smart devices around the city and will eventually expand itself with additional devices(smartphones) that install the application and will provide decision support capabilities to actions around the city, such as visiting a place, choosing groups, making decisions about the architecture around the city, etc.

An additional use case that will be deployed with a PPP and a collaboration with another European funded project(as seen in table 1.3, that is the DREAM-GO project) is the deployment of the framework in

a Smart Grid environment.

Similar research to tackle the objectives at hand have started in the past years, yet none of them was about the whole set of goals. The functionalities provided by IDIoHMA are all aimed at emerging problems that will become the leading concern in future years.

Acronym or title	objectives and purpose	interactions with IDIoHMA
GO0D MAN[13]	The objectives and purpose of GO0D MAN is to integrate and combine process and quality control for a multi – stage manufacturing production into a distributed system architecture built on agent-based Cyber-Physical Systems and smart inspection tools.	GO0D MAN framework could be used as a supplementary module with IDIoHMA in a distributed environment to aim at the zero-defect manufacturing problem. IDIoHMA could also be directly integrated in the GO0D MAN framework to provide a stable infrastructure for the devices. The two framework will be tested in a use case (**TODO**)
AI@EDGE[14]	AI@EDGE project addresses the performance and accuracy of AI-based solutions issues by introducing reusable, secure and trustworthy AI solutions on the network edge. The goal is to revolutionise communication networks in a variety of applications, including vehicles, industrial networks, aviation and in-flight entertainment, introducing the AI-for-networks and networks-for-AI paradigms. AI integration into decision-making systems and critical infrastructure still requires assuring end-to-end quality that is addressed by AI@EDGE aims.	AI@EDGE framework for closed-loop network automation and the platform that they should provide to connect to different AI-enabled networks could be used with IDIoHMA to tackle some problems that could arise during the development of the framework, especially for the Decision-support core of the project. Like GO0D MAN, IDIoHMA could also be directly integrated into the IDIoHMA framework to provide a stable infrastructure for the devices connected and a dynamic mesh network to use to widen the spectrum of the computation framework and provide a larger pool of devices to use.
DREAM-GO[18]	The main goal of DREAM-GO is to create a framework with the required methods and solutions for Smart grids to facilitate the adoption of the results in final applications, by providing grounded scientific knowledge to possible pathways for future implementation of a more efficient Smart Grids system.	A lot of concepts and the whole use case of smart grids is a clear example of how to create a network of devices that control and manage energy performance from the smart grids. IDIoHMA could be used in addition to some technologies and methodologies used in DREAM-GO in smart grids and in energy networks in general, where the collaboration and models provided should be trustworthy and capable of handling a lot of data by also sharing local information between nodes in the network to improve the energy efficiency from the various and heterogeneous sources.
BD4NRG[2]	The goal of BD4NRG is to establish a fair and secure engagement between big data and artificial intelligence (AI) technologies since the decentralisation of the energy system is becoming one of the most important topics since the advent of smart grids. BD4NRG addresses the standardisation of big data architectures for smart grids and regulatory frameworks that do not facilitate actual data sharing.	Like DREAM-GO, BD4NRG could be used as a companion to IDIoHMA to implement the network of devices capable of handling smart grids. It is more important to use a framework that is aimed toward big data mechanics since the amount of data in a large network is really an important matter when designing large systems for distributed and decentralized environments.

1.4 SSH integration

Social sciences will play a very important role for IDIoHMA since the framework will implement a core DSS module that will be used in a hybrid environment with the users of the application. The approach adopted to tackle the problems related to the cross-cutting topics connected to SSH is a formal and systematic approach that will be composed of some closed-loop methods that will enhance the quality of the final product. The tests to acquire the knowledge for this matter will be presented during the pilots and when IDIoHMA will be deployed in a testing environment where all software, hardware and users interactions will be monitored and analyzed to provide further comprehension of the difficult tasks of coordinating the framework core functionalities with actual and genuine feedback and enhance the capabilities of IDIoHMA.

An accurate analysis will be done on the feedback received and the framework will be updated periodically to fit the needs of the common user. The approach to resolving the problems detected will be formal, quantitative, measurable and logical. The final results will be the consequence of objectives approaches that will take into consideration only the data received and the discussions on the meetings, personal opinions and influences will be deemed not significant to the project.

IDIoHMA will cross the path and integrate SSH with a defined module for DSS of the framework provided, accompanied by a description and an introduction to some methods and best practices to follow to best the problems related to social sciences. The problem that will be addressed by IDIoHMA will be:

- **Engagement** of the users with the applications, since every interaction is really important for IDIoHMA and is the most important concern with the framework. The engagement of the users for all the application that use IDIoHMA is a **critical risk** since the proper functioning of the multi-agent system(both for the interconnection and the AI devices) depends mostly of these interactions, since they will provide with feedback and events useful to the framework. The contribution identified to address and dissect the problem of engagement are from sociology, psychology, behavioural and also some cross-reference to arts.
- **Problem specific** since some environments and some situations need to take into account the integration of social sciences, especially when talking about decision support systems that should take decisions and aid in the process of making decisions for the users. For the use-cases presented(and especially for the pilot presented in 2), the concerns are about the decisions taken and how they will affect the users of the software.
- **Categories at risk** especially for the parts of the framework that address some type of specific situation, e.g. the behaviour of the software and the interaction with elderly people. Also, the risk of the parts of the software that treat user data. Another bundle of categories at risk should be when the software is deployed in political system and when it involves governance and regulations.

As stated before, the problems that directly involve the framework will be addressed directly, while the problem specific and the categories at risk will be seen as abstract objects when not involved and some methods and best practices will be proposed to maintain the high quality and performance of the system.

Since the core DSS capabilites of IDIoHMA heavily relies on interdisciplinary studies, the pilots and use cases will always be conducted in parallel with meetings with the group of researchers and partners that are interested in the SSH face of the project, and these meetings will be fundamental for the success of the project and the impact. Stakeholders should also be involved during these meetings since the topics that will be discussed will be really important for the value-chain and the aftermath of the project.

1.5 Gender dimension

IDIoHMA will also address gender and categories studies (along the same route as SSH) to maintain equality in the tools and methods provided, especially for the core module of the Decision Support System(DSS) of IDIoHMA.

The Core DSS of IDIoHMA needs particular attention to maintain and respect equality since the functionality is provided by a decentralized model based on consensus and a democratic task environment, where the users will interact with the system and receive the capabilities provided by the DSS. In this context, the

possibility of getting an unequal behaviour is very high if the user base is composed mostly of one of the categories.

To account for this problem, IDIoHMA will use techniques from computer science aided by some insight from SSH, these techniques will be tested on the pilot and the use cases, where the models and the data received as feedback will be analyzed to see where the gender could be significant and where, in these contexts, the disparity plays an important role to how the system behaves and if the inequality is too much for the DSS and some categories end up being too favoured compared to the other categories. In the cases where the inequality is evident(not only for gender, even though it will be one of the main concerns of the project, but also other features, like age, disability,etc.), strategies to flatten the disparity will be implemented. These strategies will cover the following matters:

- **Equal involvement in the project experimentation and activities**: The communities that will be involved in the experimentation and the activities related to the project will be the most diverse in terms of categories. Different groups from different categories will be mixed to maximize the different types of interactions with users and IDIoHMA capabilities. The feedback of these people(implicit and explicit) will be of uttermost importance to obtain better models.
- **Analysis of specific cases of inequality**: The framework should work nonetheless in the case of some disparity in the categories ratios. Because of the variety and the flexibility of the network, extreme or specific instances should be taken into consideration and handled carefully. IDIoHMA will handle these cases with care and additional attention to the maintenance and the objective of equal possibilities and just decisions from the software.
- **Categories specific issues** and especially **gender specific issues**: Since some environments will be composed almost entirely of a single category (like the workplace that requires physical strength), these issues will be addressed by some methods and guidelines to avoid getting into a difficult situation and using the framework to the maximum of its capabilities.
- **Categories specific needs** and especially **gender specific needs**: Like the specific issues for some categories, the needs are also crucial when designing a system that will be used in a heterogeneous environment, where some categories could have special needs that need to be taken into account. IDIoHMA will also address these needs directly (by providing modules that facilitate the process of integration for these situations) and with some guidelines to follow.
- **Monitoring, logging and enhancing the framework**: The important part of the framework will be monitored constantly to find unwanted behaviour, information about anomalies will be logged, aggregated and analyzed to find the best ways to enhance the framework.
- **Reporting**: For every deployment of the framework, reports about how it is behaving will be done every time the experiments and test bench involves a group of users of different categories and in different quantities. These reports will also serve as the feedback to understand how to proceed with the project to make it more stable in case of deployment in environments with issues of disparity.
- **Dissemination and sharing insight**: The tools provided will maintain a gender-neutral language, and the products and deliverables released will be free of categories-specific targets (while some tests will be done on specific situations to account for extreme cases). The framework will be open-source, everyone will be able to use it without discrimination. Events will have balanced participation between speaker roles and participants and will also be available to the public (**TODO**).

The workflow used to detect when the system is being unjust and the disparity among the users it too great can be seen in figure[1], where the virtual cluster (formed by users and devices connected to the network, all the devices will be seen as nodes and will act accordingly for the purpose that they have been bestowed upon) will control the models, the feedback and the data to see if some significant inequality is present. If the significance to the variance of the normal measures and the normal feedback is different, the models will be updated to fit for a better equality and the framework will change some functionalities to account for the disparity.

Open source and version control will also play an leading role in the design and development of the tools of IDIoHMA since everyone can tackle their problems directly. In particular, IDIoHMA will have a section of community modules expandable by the developers that want to share their solutions. This strategy also

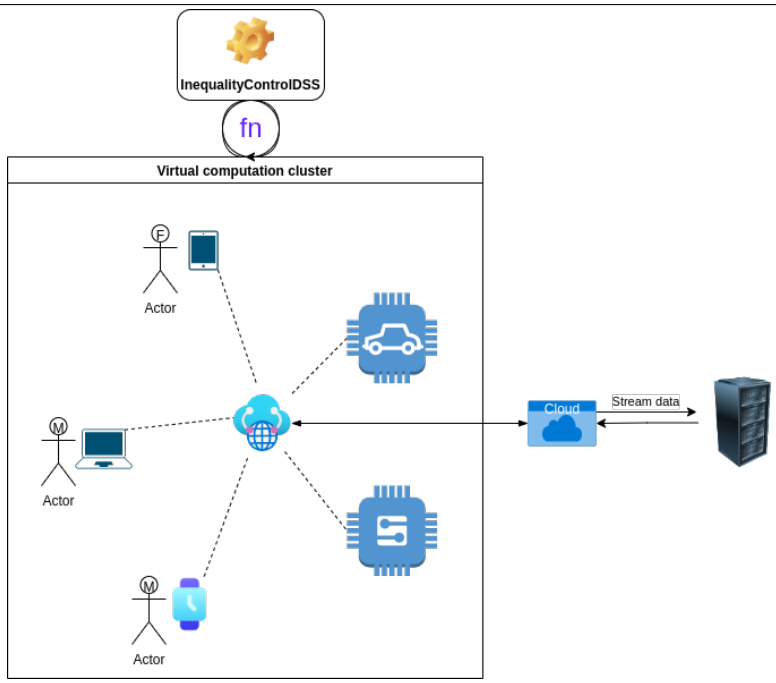

Figure 1: gender inequality detection

serves as a way to evade some problem-specific situations where the core tools end up favouring some categories over equality(even if the modules were tested and enhanced, the possibility of encountering some outliners is not impossible). In this way, developers that meet some difficulties with inequality can change some parts of the dynamic modules, add their modules and expand the tools to provide a better fit for their problem-specific issues and needs.

Additional monitoring and log aggregation will be done if the cluster is connected to a central system, this will be able to work with the stream data provided and report the anomalies that could occur in case of disparity among categories.

The inequality control is a part of the **monitoring** sub-module of the core DSS module of the IDIoHMA framework. This module will be introduced in [1.6] and will be analyzed when the **WP?** [3] is described .

1.6 Research methods and personal challenges

The idea about IDIoHMA comes from many sources and national projects, and the objectives of the projects were thought to satisfy most of the missions in the pillar II of Horizon Europe and a particular attention to the work programme requirements for AI, data and robotics. The methodology will take into account the partnerships and the project will have some tasks related to the coordination and cohesion with **[HORIZON-CL4-2021-HUMAN-01-02]-[European coordination, awareness, standardisation & adoption of trustworthy European AI, Data and Robotics(CSA)]**, since the research will involve the coordination of various projects that will be .

The project is also motivated by the upcoming necessity to design complex systems and establish a network between the resources to a connected environment capable of exchanging information and coordinating the devices in a virtual environment. These complex systems should also be capable of exchanging information among them, and the data shared should have the same interpretation, since the final results of the cooperation of the computation network systems are subject to how the communication internet-work is done and promoted.

TODO add deliverables about webpage, the ontological-knowledge graph based structure generator, the modules of the IDIoHMA framework, additional submodules introduced in this section,

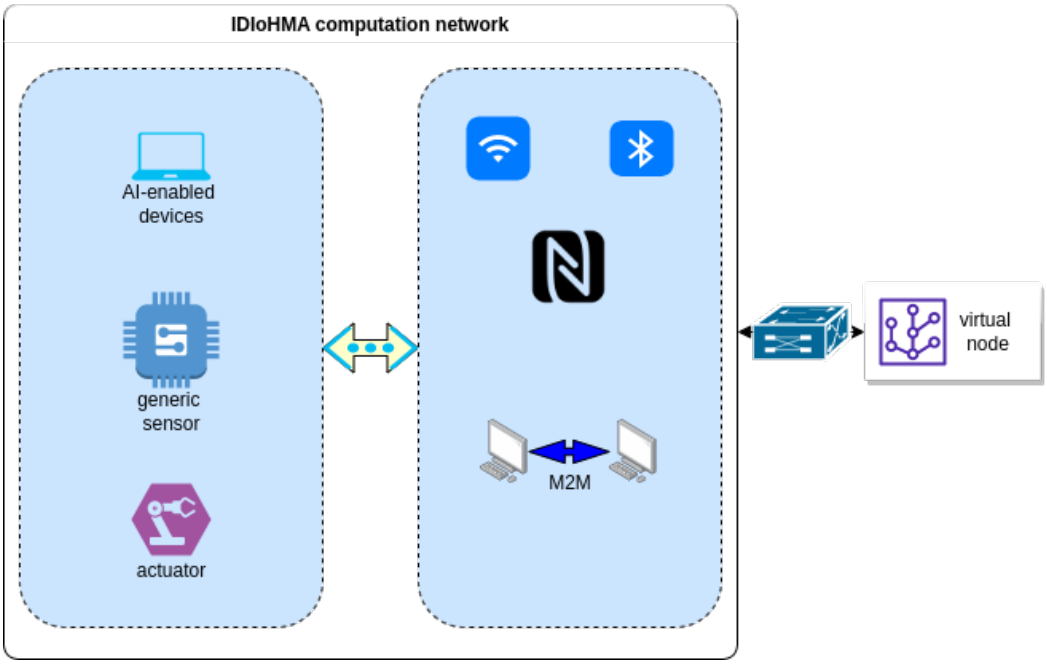

Figure 2: IDIoHMA abstract infrastructure

performance reports, etc.

To establish a good and flexible intracommunication and intercommunication network, techniques from ontological analysis, ontological design, knowledge graphs, information theory and virtualization will be used and tested to get the best results.

IDIoHMA framework will be composed of two core modules:

- **base** module: An asynchronous, event-driven, multi-agent network application framework that implements a distributed design for decentralized applications where the environment is composed of heterogeneous devices in a dynamic mesh network. This module integrates the allocation of tasks for every device; the communication and event generation in the network; the abstraction and virtualization of the resources of the network by allocating some tasks to a subset or the whole set of devices in the network; the monitoring of the network and how it behaves.
- **DSS**(Decision Support system) module: A machine learning framework for the distributed and decentralized environment of IDIoHMA, it implements a distributed decision support system. It sits on top of the **base** module and uses its capabilities of it to its fullest potential. The users of the application that will implement IDIoHMA will be able to interact with the decision capabilities of the DSS module and will contribute to the enhancement of its performance to get better decision support.

The **base** module is a composed structure of sub-modules used to implement the primary capabilities of IDIoHMA, this sub-modules are:

- **networking**: this module will handle the network building, settings and low level configuration to make the devices consistent with the framework. This module will also handle the dynamic settings of the networks creation and expansion to build the mesh network of devices.
- **communication**: this module also has the objective of creating events to send intra-network and inter-network, by providing a middleware and specific methods to interchange information between devices or networks.
- **virtualization**: this module will handle the creation and the correct validation of the device's interfaces and virtualization. This module is a fundamental part since it will be the main component used in the entering phase for devices that become part of the IDIoHMA network and will establish the interfaces to heterogeneous nodes in the network. It will guarantee the interoperability of the devices and the abstraction of the proprietary hardware that sits in every device. This will bring the capacity of endlessly

expanding the computation network of IDIoHMA.

- **allocation**: this module will handle the allocation of tasks and resources for the devices in the network. The main function of this module is the smart workload allocation of the devices, where the nodes of the computation network will handle the intelligent management of resources by themselves. Other capabilities are single task allocation(requests, questions, event generation). The allocation will always be deployed with the multi-agent network in mind.
- **monitoring**: **TODO expand** This sub-module is also composed by logging and error handling parts. It also has the task of sending logs and reports to a central server if available.
- **handler**: This module will handle the dynamic load and unload of modules. This module will also be involved in the update of the modules and the CI/CD pipelines to get the most recent software for the devices in the IDIoHMA network.

Software-wise, the development will aim at a distributed application that will be formed of micro-services that will talk to each other in a virtualized environment, where the whole set of micro-services provided by the devices intra-connected will be seen as a single virtual computation cluster (or virtual device) from the outside. This virtual device will provide the same capabilities as a common device(with more options since it is formed by a whole network of devices). This abstraction of the intra-network of devices guarantees the possibility of scaling out with more nodes interconnected in an unlimited, expanding network of connected components that will provide information and resources to inter-network virtual devices. The developers that implements their application and use the IDIoHMA base module should take into account that the paradigms to use to get the best results are **actor** models, **Reactive** design, **Service oriented architectures** when implementing and deploying the application and **micro-services** when programming the for the single devices capabilities.

This scheme of abstraction and expansion for virtual devices is limitless and will guarantee the potential for future growth for the project in larger systems, like smart grids and such. This strategy is also aimed towards the developer that do not want to get too much into the details of programming a network for a dynamic set of heterogeneous devices that could lead to greater complexity really quickly.

Every virtualized and abstracted computation device (the computation network) should have one or more **Facade devices** that will act as the interface for the interaction of the virtual device with the outside (other virtual devices or clients of the service provided). We will research for methods to guarantee a set of devices that will be used in this way, but the advice is to have an external server (in the cloud, a micro data center) that will be able to handle all the incoming and outgoing traffic. This server could also act as the monitoring device that controls the correct work of the computation network and help the devices with allocation, communication with the outside and inside virtual devices, log aggregation and other features related to the capabilities of the computation network. When in single-node mode(one device that will constitute the virtual device), the Facade is the device itself and the interface with the outside will be configured on the device for the capabilities that it posses(decided both by implicit configuration and explicit configuration done by the user).

When the project will start, the capabilities described and the configuration will be more clear since the pilot, the refinement process and the functionalities expansion and adaptation will be the key milestones to understand if the IDIoHMA framework maintain its potential during the deployment and testing of it. We also expect at least 3 other projects that will use the IDIoHMA framework, we would like to see if IDIoHMA could be used in the following fields and topics: **smart grids**(**pilot?**) since one of our use cases is smart grids and the framework was thought to be used in this topic; **clinical decision support** since the DSS is built on purpose for these cases, it will also serve as a test case for situation where the feedback and the features of the data to use for the decision model are equally important; **Smart cities**(**pilot?**) where the users are the citizens, the devices could give support to people with some type of disability, or could get the feedback on some infrastructure in the city and how to improve it. These projects will take advantage of the decentralized capabilities and the core DSS module.

TODO add additional details on the methodology with dates, work packages deadlines, deliverables

More details on the implementation and configuration of the system will be explained in WP?3.

One of the most important objectives of this project will be to create a **core DSS** module that will be available to the public and will be one of the main module of IDIoHMA. This module will be composed of methods, techniques and design choices that will use the capabilities of IDIoHMA.

The core DSS is also composed by sub-modules that handle the several parts needed to get the decision support system, these sub-modules fully **rely on the base module** These sub-modules are:

- **gathering**: this sub-module deals with the collection of data, events and resources. It will run on every device and will be used to ask for data to a device or to the network, it will also handle event hearing and the requests for resources to the computation network.
- **sharing**: this sub-module will take care of the sharing of data, resources and event generation in the network.
- **consume**: this sub-module will consume inputs and data from several sources, it will also contain methods for the pre-processing of data, streams and events to get them ready to be used by the virtual devices.
- **design**: this sub-module manages the configuration of the decision models, **TODO further methodology for this since the [19] is interesting for the design of decision support systems**
- **decision**: this sub-module handles the decisions taken and generates events, data and commands to send over the network to other devices(specific devices when some of them are the main target of the commands, like actuators).
- **training**: this sub-module contains the functionalities capable of training the DSS models. The training will be done with a hybrid training method that uses a combination of techniques from the **what-if** and **goal seeking** analysis, combined with statistical inference and the consensus model, that will take the part of the **human in the loop** that will progressively improve the overall results.

The decision models used for the system will be a combination of many models' insights and will be unique to maximise the use of the consensus environment. The details and motivation for the chosen strategy will be discussed in the reports and in the WP?3. The overall strategy will change during the development and experimentation phases since we will adapt the framework to fit most situations while maintaining high performance and flexibility.

The plans for the future are to expand the framework AI codebase of IDIoHMA by adding more modules for **machine learning** and **distributed learning**, **federated learning**, **multi-agent AI** and **game theory**. The framework will also be changed in the module and sub-module structure since some functionalities of the core DSS (like the gathering, the sharing and the consuming sub-modules) could be generalized for other AI infrastructures, or even for some algorithms for parallel and distributed computing, so these sub-modules should be part of the base module or be in another core module for computation. This consideration will be implemented and tested as soon as the project reach (**TODO one of the first milestones where the pilots and testing use cases are being implemented**).

Additional modules and personal objectives not related to AI(directly) that will be developed in the future but are not discussed in this proposal will be: a module for **Graphs processing** that will include algorithms for **graph embeddings**, **graph clustering**, **subgraph isomorphism**, **temporal subgraph isomorphism**[11][10] and **Dynamic knowledge graphs**.

The **Dynamic knowledge graphs** sub-module is one of the most important modules that are in plan for deployment since they will contribute to a consistent WoT(web of things) and other important issues about the future society. It could be also used as the basis for the blueprint creator since the model generator that we want to build will sit on top of ontological aspects and the dynamic characteristics of the network, and the knowledge graph will be inferenced and built from the inputs and feedback of the user of the system.

Almost everything of IDIoHMA will follow the open science practices every time it is possible to do so, the framework will be completely open-source, most of the code for the use cases will be completely open-source, the research will be published in journals and will also be available on research platform and as reports on the CORDIS portal and on the website of IDIoHMA. The framework will be available as soon as the base module is ready(the DSS module will be available after a testing period).

Reports about milestones and work packages will be published regularly on CORDIS and will also be available in a remote repository reachable from the website.

The data that could be published will be published when possible. Obviously, when the data is confidential (to the users and to the system to not get into some problems with the security of the system), the data will not be shared.

The reproducibility of the results obtained for the base framework will be guaranteed. Scripts, generators and documentation for IDIoHMA will be available when the base module is released and will be expanded during the development and testing phase of the project (and after that after every update of the framework).

The documentation that will be published will also contain all the guidelines and the best practices to implement to get the most performance with the app, especially for the engagement of the recipients.

The citizen will be part of the pilots and some use-cases. Some specialized actors will be part of the specific use cases (for smart grids and the clinical use case). These people will be the most important part of the project since the interaction of these users will shape the quality and performance of the final results. For this reason, the campaign and the experimentation in real-life situations will be the main sink for the funds received to produce the best possible results.

1.7 Research management of data and outputs

The data generated and collected and the code released(along with scripts, documentation and code of conducts) will always respect the FAIR principle.

Data collected will be of many types, but experimental text and numerical data will be the main source of information that will be collected. Some synthetic data will also be produced to test the models in a confined lab environment, and this data will be produced from generators created from data from the fields of the implementation, e.g. for smart grids, the data used will be that of smart grids project and results from other European Projects or whatever is open and available to the public (and is also significant)**TODO reference to the data used, unique identifiers, trusted repositories**.

The IDIoHMA framework API will fall under the Creative Commons license  , it will be open source and free to use in every case, as long as appropriate credits are given, a link to the license is provided, and changes made are specified.

For the use cases and the pilots, the code and the data used will fall under the same license when possible. If the partners and the consortium are under some boundaries, especially when the cooperation is done under the **Public-private partnership**, the information available to the public will be mostly about reports, disclosed resources and results.

The data available to the public will always be anonymized when necessary (confidential data especially). When possible, unique identifiers will be used to get consistent datasets. Data that needs to be persistent will be kept in redundancy in duplicated places and RAID data storage (micro-data center, cloud, etc.)(**TODO add preservation costs**)

The metadata used will be mostly problem specific ontologies and knowledge graphs used to create the infrastructure generator of IDIoHMA.

1.8 Interdisciplinary nature

The best outcomes of this project will be born from the coordination of different disciplines and the interdisciplinarity of the project details. As stated in 1.4, the IDIoHMA project aims to address the topic objectives and to build a decentralized computation framework that will be used to guarantee these objectives and also used as a standalone computation framework for software with AI capabilities that needs to be in a decentralized environment and is also thought to expand dynamically with new devices that run the same software and are near each other or are linked in some way(in the same network, directly connected and communication protocols with embedded systems like SPI, UART, I2C, USB, etc.).

The use cases of decision support systems are mostly from the fields of smart cities, mobility, clinical analysis, resource management and many more not related directly to computer science, so the interdisciplinarity of the project is rooted in its definition. The only way to test the project capabilities to improve

performance and flexibility is a collaboration of many fields that will work together to bring a useful tool to many situations.

The most important part of the DSS for every application is the engagement of users since the core DSS is based on a hybrid approach of interaction between the consumers and the tools provided. To maintain a high engagement with every app, the need to coordinate, improve and expand the methods related to IDIoHMA is fundamental and can only be obtained from field experience acquired from experts in the topic of the use case and the experiments in the real-life implementation and use.

2 Impact

2.1 Expected impact

2.2 Measures to maximize impact

Dissemination and exploitation of results

Communication activities

2.3 Summary

3 Implementation

3.1 Project work plan

Work package description

Work package number	**WP1**		**Starting month**	1
Work package title	**MANAGEMENT WORK PACKAGE**			
Participant number	**1**	2	3	
Short name	**UoC**	UoP2	UoP3	
Person-months	**12**	3	2	

Objectives

This work package has the following objectives:

1. To develop ....

SPECIFIC NEEDS

Complexity

of distributed and decentralized systems that should provide AI capabilities, where the devices are heterogeneous and interconnected with different protocols and new technologies. In particular, the complexity of the low-level software to make the network work for all the devices, and hardware that will be used to deploy the parts of the dynamic network.

Support

to the situations where some decisions are involved, and these decision depend heavily on human interaction and decision making.

EXPECTED RESULTS

Framework

available to the public and freely reusable.

Standardization

of techniques and the good practices to implement and have a useful distributed AI-enabled system.

Novel algorithmic model

that will be the base for AI algorithms that will be implemented on the platform where IDIoHMA is deployed.

DSS

module that will implement the decision support capabilities and will be integrated directly with the main framework

Successful large-scale demonstrator

where the framework will be used in a smart grid and will be expanded to a whole network of smart grids.

D & E & C MEASURES

Exploitation: Patenting the algorithmic model.

Dissemination towards the scientific community and distributed contexts: Scientific publication with the results of the large-scale demonstration and additional test case and laboratory case for smart cities and clinical contexts.

Communication towards citizens: In the case of smart cities, demonstration of the use of the system will be done. For smart-grids, the final product will be presented to the workers and users of the system, and to the population interested to explain the capabilities and usage for the common citizen that is interested in the technology.

Exploitation of the support system : Patenting the support system; Licencing to major smart grids companies and operators. Also licencing to smart cities companies.

Dissemination towards the industry and participation: Participating at conferences; Developing a platform of material compositions for industry; Participation at EC project portfolios to disseminate the results as part of a group and maximise the visibility vis-àvis companies, especially for smart-grids.

TARGET GROUPS

OUTCOMES

IMPACTS

2. To apply this ....
3. etc.

Description of work

Description of work carried out in WP, broken down into tasks, and with role of partners list. Use the `\wptask` command.

Task T1.1: Test (M1-M12) *Leader:* **UoC**. *Contributors: UoC*
Here we will test the WP Task code.

Task T1.2: Integrate (M6-M9) *Leader:* **UoC**. *Contributors: UoC*
In this task UZH will integrate the work done in T1.1.

Task T1.3: Apply (M9-M12) *Leader:* **UoP3**. *Contributors: All other*
Here all the WP participants will apply the results to...

Role of partners
Participant short name will lead Task T1.2.
UoC will..

Deliverables

D1.1 Report on the definition of the model specifications. **(M36)**

D1.2 Report on Feasibility study for the model implementation. **(M12)**

D1.3 Prototype of model implementation. **(M24)**

Work package number	**WP2**		**Starting month**	1
Work package title	**BASE FRAMEWORK DEVELOPMENT WORK PACKAGE**			
Participant number	1	**2**	3	
Short name	UoC	**UoP2**	UoP3	
Person-months	3	**12**	6	

Objectives

This work package has the following objectives:

1. To develop ....
2. To apply this ....
3. etc.

Description of work

Description of work carried out in WP, broken down into tasks, and with role of partners list. Use the `\wptask` command.

Task T2.1: Test (M1-M12) *Leader:* **UoC**. *Contributors: UoC*
Here we will test the WP Task code.

Task T2.2: Integrate (M6-M9) *Leader:* **UoC**. *Contributors: UoC*
In this task UZH will integrate the work done in T2.1.

Task T2.3: Apply (M9-M12) *Leader:* **UoP2**. *Contributors: All other*
Here all the WP participants will apply the results to...

Role of partners
Participant short name will lead Task T2.2.
UoC will..

Deliverables

D2.1 Report on the definition of the model specifications. **(M36)**

D2.2 Report on Feasibility study for the model implementation. **(M12)**

D2.3 Prototype of model implementation. **(M24)**

Work package number	**WP3**		**Starting month**	1
Work package title	**DSS DEVELOPMENT WORK PACKAGE**			
Participant number	1	**2**	3	
Short name	UoC	**UoP2**	UoP3	
Person-months	3	**12**	6	

Objectives

This work package has the following objectives:

1. To develop ....
2. To apply this ....
3. etc.

Description of work

Description of work carried out in WP, broken down into tasks, and with role of partners list. Use the `\wptask` command.

Task T3.1: Test (M1-M12) *Leader:* **UoC**. *Contributors: UoC*
Here we will test the WP Task code.

Task T3.2: Integrate (M6-M9) *Leader:* **UoC**. *Contributors: UoC*
In this task UZH will integrate the work done in T3.1.

Task T3.3: Apply (M9-M12) *Leader:* **UoP2**. *Contributors: All other*
Here all the WP participants will apply the results to...

Role of partners
Participant short name will lead Task T3.2.
UoC will..

Deliverables

D3.1 Report on the definition of the model specifications. **(M36)**

D3.2 Report on Feasibility study for the model implementation. **(M12)**

D3.3 Prototype of model implementation. **(M24)**

3. Implementation

Work package number	**WP4**			**Starting month**	1
Work package title	**TEST WORK PACKAGE**				
Participant number	1	2	**3**		
Short name	UoC	UoP2	**UoP3**		
Person-months	3	8	**12**		

Objectives

This work package has the following objectives:

1. To develop ....
2. To apply this ....
3. etc.

Description of work

Description of work carried out in WP, broken down into tasks, and with role of partners list. Use the `\wptask` command.

Task T4.1: Test (M1-M12) *Leader:* **UoC**. *Contributors: UoC*
Here we will test the WP Task code.

Task T4.2: Integrate (M6-M9) *Leader:* **UoC**. *Contributors: UoC*
In this task UZH will integrate the work done in T4.1.

Task T4.3: Apply (M9-M12) *Leader:* **UoP3**. *Contributors: All other*
Here all the WP participants will apply the results to...

Role of partners
Participant short name will lead Task T4.2.
UoC will..

Deliverables

D4.1 Report on the definition of the model specifications. **(M36)**

D4.2 Report on Feasibility study for the model implementation. **(M12)**

D4.3 Prototype of model implementation. **(M24)**

Work package number	**WP5**		**Starting month**	1
Work package title	**DISSEMINATION WORK PACKAGE**			
Participant number	1	2	**3**	
Short name	UoC	UoP2	**UoP3**	
Person-months	3	8	**12**	

Objectives

This work package has the following objectives:

1. To develop ....
2. To apply this ....
3. etc.

Description of work

Description of work carried out in WP, broken down into tasks, and with role of partners list. Use the `\wptask` command.

Task T5.1: Test (M1-M12) *Leader:* **UoC**. *Contributors: UoC*
Here we will test the WP Task code.

Task T5.2: Integrate (M6-M9) *Leader:* **UoC**. *Contributors: UoC*
In this task UZH will integrate the work done in T5.1.

Task T5.3: Apply (M9-M12) *Leader:* **UoP3**. *Contributors: All other*
Here all the WP participants will apply the results to...

Role of partners
Participant short name will lead Task T5.2.
UoC will..

Deliverables

D5.1 Report on the definition of the model specifications. **(M36)**

D5.2 Report on Feasibility study for the model implementation. **(M12)**

D5.3 Prototype of model implementation. **(M24)**

List of work packages

Table 3.1d: List of work packages

Work package number	Work package title	Lead participant no.	Lead participant name	Person-months	Start month	End month
WP1	MANAGEMENT WORK PACKAGE	1	UoC	17	1	36
WP2	BASE FRAMEWORK DEVELOPMENT WORK PACKAGE	2	UoP2	21	1	36
WP3	DSS DEVELOPMENT WORK PACKAGE	2	UoP2	21	1	36
WP4	TEST WORK PACKAGE	3	UoP3	23	1	36
WP5	DISSEMINATION WORK PACKAGE	3	UoP3	23	1	36
	TOTAL			105		

List of deliverables

[1]

Table 3.1e: Deliverable list

Deliverable number	Deliverable name	WP no.	Lead participant name	Nature	Dissemination Level	Delivery date (proj. month)
D1.2	Report on Feasibility study for the model implementation.	WP1	UoP3	R	PU	12
D2.2	Report on Feasibility study for the model implementation.	WP2	UoP3	R	PU	12
D3.2	Report on Feasibility study for the model implementation.	WP3	UoP3	R	PU	12
D4.2	Report on Feasibility study for the model implementation.	WP4	UoP3	R	PU	12
D5.2	Report on Feasibility study for the model implementation.	WP5	UoP3	R	PU	12

Continued on next page

[1] If your action taking part in the Pilot on Open Research Data, you must include a data management plan as a distinct deliverable within the first 6 months of the project. This deliverable will evolve during the lifetime of the project in order to present the status of the project's reflections on data management. A template for such a plan is available on the Participant Portal (Guide on Data Management).

D1.3	Prototype of model implementation.	WP1	UoP2	R	PU	24
D2.3	Prototype of model implementation.	WP2	UoP2	R	PU	24
D3.3	Prototype of model implementation.	WP3	UoP2	R	PU	24
D4.3	Prototype of model implementation.	WP4	UoP2	R	PU	24
D5.3	Prototype of model implementation.	WP5	UoP2	R	PU	24
D1.1	Report on the definition of the model specifications.	WP1	UoC	R	PU	36
D2.1	Report on the definition of the model specifications.	WP2	UoC	R	PU	36
D3.1	Report on the definition of the model specifications.	WP3	UoC	R	PU	36
D4.1	Report on the definition of the model specifications.	WP4	UoC	R	PU	36
D5.1	Report on the definition of the model specifications.	WP5	UoC	R	PU	36

List of milestones

Table 3.1f: List of milestones

Milestone number	**Milestone name**	**Related WPs**	**Estimated date**	**Means of verification**
M1	Completed simulator development	1	24	Software released and validated
M2	Final demonstration	WP 4	36	Application of results

Critical risks for implementation

Table 3.1g: Critical risks for implementation

Description of Risk	**WPs involved**	**Proposed risk-mitigation measures**
The dedicated chip sent to fabrication is not functional.	WP 4	Resort to Software simulations

Table 3.4a: Summary of staff effort

Partic. no.	Partic. short name	WP1	WP2	WP3	WP4	WP5	Total person months
1	UoC	**12**	3	3	3	3	24
2	UoP2	3	**12**	**12**	8	8	43
3	UoP3	2	6	6	**12**	**12**	38
Total		17	21	21	23	23	105

3.2 Management and risk assessment

3.3 Consortium as a whole

3.4 Resources to be committed

Summary of staff efforts

'Other direct cost' items (travel, equipment, other goods and services, large research infrastructure)

Participant no. 1 (UoC)	Cost (EUR)	Justification
Travel	2500	3 pairwise meetings for 2 people, 2 conferences for 3 people, 3 internal project meetings for 3 people
Equipment	3000	CAD workstation for chip design
Other goods and services	60000	Fabrication of 2 VLSI chips
Total	65500	

Participant no. 2 (UoP2)	Cost (EUR)	Justification
Other goods and services	40000	Fabrication of prototype PCBs
Total	40000	

Participant no. 1 (UoC)	Cost (EUR)	Justification
Large research infrastructure	400000	Synchrotron

Participant no. 3 (UoP3)	Cost (EUR)	Justification
Large research infrastructure	400000	Synchrotron

Bibliography

[1] Jamie Allen. *Reactive design patterns*. Simon and Schuster, 2017. 4

[2] S Čaušević, R Snijders, G Pingen, P Pileggi, M Theelen, M Warnier, F Brazier, and K Kok. Flexibility prediction in smart grids: Making a case for federated learning, 2021. 11

[3] Ali Dorri, Salil S Kanhere, and Raja Jurdak. Multi-agent systems: A survey. *Ieee Access*, 6:28573–28593, 2018. 4

[4] Paul M Duvall, Steve Matyas, and Andrew Glover. *Continuous integration: improving software quality and reducing risk*. Pearson Education, 2007. 4

[5] Jacques Ferber and Gerhard Weiss. *Multi-agent systems: an introduction to distributed artificial intelligence*, volume 1. Addison-Wesley Reading, 1999. 4

[6] Martin Fowler and Matthew Foemmel. Continuous integration, 2006. 4

[7] David Harel and Amir Pnueli. On the development of reactive systems. In *Logics and models of concurrent systems*, pages 477–498. Springer, 1985. 4

[8] Windsor W Hsu, Alan Jay Smith, and Honesty C Young. Projecting the performance of decision support workloads on systems with smart storage (smartstor). In *Proceedings Seventh International Conference on Parallel and Distributed Systems (Cat. No. PR00568)*, pages 417–425. IEEE, 2000. 4

[9] KC Karthika. Wireless mesh network: A survey. In *2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*, pages 1966–1970. IEEE, 2016. 4

[10] GIORGIO LOCICERO. Temporal networks and applications. 17

[11] Giorgio Locicero, Giovanni Micale, Alfredo Pulvirenti, and Alfredo Ferro. Temporalri: a subgraph isomorphism algorithm for temporal networks. In *International Conference on Complex Networks and Their Applications*, pages 675–687. Springer, 2020. 17

[12] Juan Pavón and Jorge Gómez-Sanz. Agent oriented software engineering with ingenias. In *International Central and Eastern European Conference on Multi-Agent Systems*, pages 394–403. Springer, 2003. 4

[13] Ricardo Peres, Andre Dionisio Rocha, Joao Pedro Matos, and Jose Barata. Go0dman data model-interoperability in multistage zero defect manufacturing. In *2018 ieee 16th international conference on industrial informatics (indin)*, pages 815–821. IEEE, 2018. 11

[14] Roberto Riggio, Estefanía Coronado, Neiva Linder, Adzic Jovanka, Gianpiero Mastinu, Leonardo Goratti, Miguel Rosa, Hans Schotten, and Marco Pistore. Ai@edge: A secure and reusable artificial intelligence platform for edge computing. In *2021 Joint European Conference on Networks and Communications 6G Summit (EuCNC/6G Summit)*, pages 610–615, 2021. 11

[15] Pilar Rodríguez, Alireza Haghighatkhah, Lucy Ellen Lwakatare, Susanna Teppola, Tanja Suomalainen, Juho Eskeli, Teemu Karvonen, Pasi Kuvaja, June M Verner, and Markku Oivo. Continuous deployment of software intensive products and services: A systematic mapping study. *Journal of Systems and Software*, 123:263–291, 2017. 4

[16] Syed Yasmeen Shahdad, Asfia Sabahath, and Reshma Parveez. Architecture, issues and challenges of wireless mesh network. In *2016 International Conference on Communication and Signal Processing (ICCSP)*, pages 0557–0560. IEEE, 2016. 4

[17] Sjors Van Berkel, Dániel Turi, Andrei Pruteanu, and Stefan Dulman. Automatic discovery of algorithms for multi-agent systems. In *Proceedings of the 14th annual conference companion on Genetic and evolutionary computation*, pages 337–344, 2012. 4

[18] website. DREAM-GO. http://dream-go.ipp.pt/#home. [Website]. 11

[19] Xuan F Zha, Ram D Sriram, Marco G Fernandez, and Farrokh Mistree. Knowledge-intensive collaborative decision support for design processes: A hybrid decision support model and agent. *Computers in Industry*, 59(9):905–922, 2008. 17