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DELIVERABLE

Final Application Design and Mockups

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Executive Summary

The main aim of the deliverable entitled "Final application design and mock-ups" is to define the design phase of the services that will be used and implemented within the scope of the project.

It defines the technical design specifications of the Life gaiasense Smart Farming (SF) application to be used by the advisors, the agronomists and the farmers and in particular, two distinct versions of the service:

a) The gaiasense web-based application
b) The gaiasense mobile-application.

In addition, it demonstrates the integration with already implemented services as well as the way information will be shared among the different services. In an illustrative manner, both examples of the design of the services are provided and the technologies that will be utilised on the implementation level are described.

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Definitions, Acronyms and Abbreviations

Acronym	Title
CE	Circular Economy
NP	NEUROPUBLIC AE PLIROFORIKIS & EPIKOINONION
SF	Smart Farming

1. Introduction

1.1. Project Summary

The main aim of the LIFE GAIA Sense project is to demonstrate the applicability of gaiasense, an innovative "Smart Farming" (SF) solution that aims at reducing the consumption of natural resources, as a viable means for the protection of the environment and the support of Circular Economy (CE) models.

More specifically, during the project a total of 18 demonstrators across Greece, Spain and Portugal, covering 9 crops (olives, peaches, cotton, pistachio, potatoes, table tomatoes, industrial tomatoes, grapes, kiwi, wallnut) under different terrain and microclimatic conditions will be launched. During the demonstrator pilots the efficiency of the gaiasense asan innovative method based on high-end technology, suitable for replication, accessible to and affordable by Farmers either as individuals or collectively through Agricultural Cooperatives, will be assessed.

Moreover, LIFE GAIA Sense seeks to promote resource efficiency practices in SMEs of the agricultural sector and eventually, contribute to the implementation of the Roadmap to a Resource Efficient Europe. This project will demonstrate a method on the optimisation of the farmers decision making on the use or avoidance of certain inputs (irrigation, fertilizers, pesticides etc.), without risking the annual production. The potential of the resource consumption reduction side of CE will be estimated based both on qualitative and quantitative assessments taking also into account the resources' efficiency in agricultural sector.

1.2. Document Scope

This document presents the technical design specifications of the Life gaiasense Smart Farming (SF) application to be used by the advisors, the agronomists and the farmers. Given that the targeted users demonstrate different needs from a SF application, two versions of the service are specified:

- The **gaiasense web-based app** is expected to be utilised by the agronomists and the advisors through resource rich devices (e.g. desktop and laptop personal computers). This web-based app will provide access to detailed data (both historical and real time) for the prevailing environmental conditions on the targeted parcels (fields). In addition, scientific based indications on the associated hazards with regards to irrigation and pest management will also be available. Moreover, various events (e.g. phenological stages, irrigation actions, sprays applied) will be visualised to support specialists formulate the respective advice that will be mediated to the farmers.
- The **gaiasense mobile app** is expected to be utilised by the farmers through mobile devices (e.g. smart-phones, tablets). Users like that, are expected to be on the move while performing various tasks (e.g. visiting different farms and applying various cultivation practices). Hence, the information needed by their side, should be first filtered to the most crucial aspects and then presented accordingly. At the same time the app will also operate as a mediator for accepting feedback from the farmer to further enhance the overall information richness of the backend system.

Both applications will be based on the **gaiasense cloud services** which will serve as a common back-end information management set of services that provide access to the necessary data both to **gaiasense web-based and the mobile apps** in support of their overall functionality.

This document builds on information about the functional requirements collected within the frame of action A1 that have been utilised in order to draw the basic design principles for the development of the two software applications. A first version of the mockups had been presented to agronomists in face2face meetings. The agronomists have evaluated the design and have made suggestions regarding the different types of information that are of interest for the different users groups. The suggestions have been incorporated in the final design of the mock-ups.

2. The gaiasense Smart Farming Applications - Summary

In terms of the technical specifications of the two applications a requirements analysis methodology has been employed aiming to determine the needs or conditions that should be met by the services to be developed. As it is indicated in [1] requirements analysis and documentation forms a critical element for the success or failure of a software development project. Requirements should be measurable, testable, traceable, related to identified business needs or opportunities, and defined to a level of detail sufficient for system design. Towards this scope the external entities (actors) of the specified system are initially identified and the respective use cases are defined which allow the specification of the associated "functional" and "non-functional" requirements are defined.

The external entities (actors) expected to interoperate with the two applications are :

- System Admin,
- Farmer &
- Agronomist.

As far as the Use cases senarios are concerned the following are defined:

1. Identification of the end-user
2. On-demand retrieval of environmental measurements for a specified area.
3. Visualisation of IoT stations on a geo-map
4. Display detailed results produced from the scientific models about pest management and irrigation
5. Display warnings and advice produced from the scientific models about irrigation, pest management and extreme weather.
6. Display events from the fields.
7. Provide cultivation related events to the back-end system

The software requirements to be specified are divided into 2 categories, functional and non-functional, and are recorded according to the VOLERE standard [3]. The VOLERE standard defines a set of types of each requirement as it is presented in the Table below:

Functional	Functional	FUNC
	Data	DATA
Non-functional:	Look and Feel Requirements	L&F
	Usability Requirements	USE
	Performance Requirements	PERF
	Security	SEC

These types are utilised for the classification of the requirements that will follow. In addition, a priority indication that measures the importance of each requirement is assigned to each requirement while the version is available to check if the claim is updated.

Based on the aforementioned, the overall framework of the gaiasense smart farming is set and described and two smart farming applications are introduced. In figure 2, the gaiasense infrastructure is presented in the form of a functional view. It is evident that it follows a layered architectural design approach based on which the main flow of information is realised from the bottom layers to the higher layers.

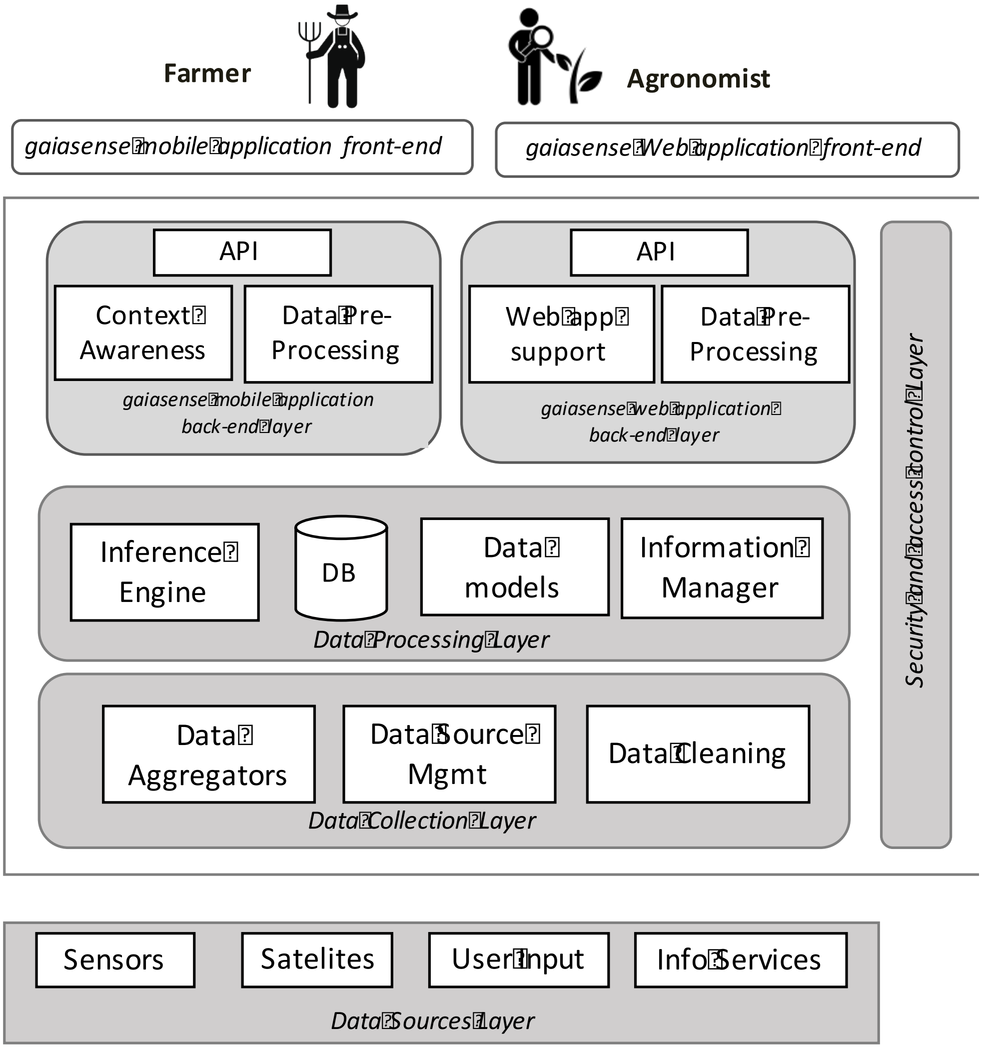

Figure 1. Functional view of the gaiasense framework layered architecture

The **"Data Sources Layer"** includes all the information sources that provide data to the gaiasense framework. The **"Data Collection Layer"** includes the components which are necessary for gathering data from the various heterogeneous sources, and prepare them to be integrated within the gaiasense framework. The **"Data Processing Layer"** provides the necessary functionality for persisting the various measurements but also for extracting additional higher level knowledge through inference algorithms of scientific models. The **"Mobile application back-end layer"** and the **"Web application back-end**

layer" maintain all the necessary components for supporting the interactions with the end-users through the respective GUIs.

In more details, the "**gaiasense mobile app**" will be "parcel" oriented, meaning that the central information entity that based on which the app will be designed upon the fields that the farmer is operating at. The **"gaiasense web app"** will target as end-users mainly the advisors, agronomists, and the researchers.

The "gaiasense" smart farming solution already provides to the end-users a set of services that will be integrated with the proposed architecture. In particular, the **"Intelligent Management Crop – (iCM)**" which is a multifunctional platform able to properly manage a group of producers or a single farm. This service has been created to assist farmers to comply with regulatory frameworks such as the Multi-Compliance Rules and the requirements arising from the various Quality Systems i.e Agro[1] , Globalgap[2], PDO / PGI[3], Organic Agriculture[4]. It provides the ability to access and manage a set of information and files relating to Regulatory Frameworks and the various Quality Systems in the form of a Producer Log-Book / Output Register. The reports issued by this application help the producer monitor the crop and evaluate the results from previous years. It also allows correlations between, specific cultivation practices or inputs and the product produced (quantity and quality product). Apart from monitoring, ICM is a very powerful tool for drawing conclusions about the agricultural practices and products used (fertilizers, water etc) as well as for decision-making regarding the optimization of the economic result. The agronomists who have access to the required information over the internet, are given the opportunity to have an overview of the parcels and provide instructions according to the Regulatory Requirements as well as the requirements of the Quality Systems very efficiently. In this way, full and continuous monitoring of the Quality Systems is achieved by recording all processes and minimizing the time spent by the visiting agronomist on field visits and observations.

The online application called "**Field Collect**" is an innovative tool useful for farm advisors and producers. It was implemented with the purpose of detailed planning and control of the trapping process but also of monitoring the population and insect spreading within a crop. Producers can capture the entomological attack directly on the field with the help of a smartphone and exploit this data to effectively control the damage caused by plant's enemies while at the same time reducing the amount of pesticides released on the ground. An additional menu of the application is the recording of the phenological phase of crop at the time of in-situ control. Furthermore, Field Collect has been integrated with the recording of soil samples taken from points within the field, as well as with irrigation measurements.

Having defined the core functional modules of the gaiasense smart farming solution the respective data model utilised for translating the heterogeneous information elements under a uniform way is introduced. The "Parcel" is the central information entity of the proposed system. The "Parcel" class is characterised by a set of attributes which correspond to the various physical properties of the actual field where the cultivation is taking place. Indicative properties are the parcel "name", the "area" covered, the current "cultivation type", a user-friendly name ("toponym"), etc.

The "Parcel" is associated with a set of additional core information Entities each one dedicated to model information relevant to the thematic areas of the provided services. In terms of irrigation, the

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[1] http://www.elgo.gr/index.php/el/quality-assurance-of-agricultural-products/supervision-of-private-certification-bodies-2/760-total-system-management-agricultural-production

[2] https://www.globalgap.org/uk_en/

[3] http://www.minagric.gr/index.php/en/citizen-menu/pdo-pgi-tsg-products-menu

[4] https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming

"Irrigation advice" and the "Irrigation event" classes are modelling all the relevant information elements related to the irrigation conditions, activities and provided advice. In a similar manner, the relevant classes are specified for modelling weather and pest management information elements.

The various technologies utilised for the realisation of the described services are recognised such as HTTP- REST-API, JSON, Scripts implemented in Python 2.7, Relational database system: PostgreSQL 11.2 , Implementation of scientific models: Java 8, Implementation of Data Management: Java 8
Java 8, REST-API , NodeJS 10.15, REST-API , Javascript, AngularJS, ReactJS, PHP 7.1 .

The physical deployment of the various components of the gaiasense framework is illustrated in figure 4. The IoT sensing stations will reside at the pilot fields in Greece, Portugal and Spain. Data collected from the fields will be maintained and processed in NEUROPUBLIC S.A. data center located within the company's premises in Piraeus Greece. (https://www.neuropublic.gr/en/products-services/services/cloud-services/)

The back-end services of the two applications (gaiasense mobile & web based applications) that the end-users will interact with will also be hosted in NEUROPUBLIC S.A. server systems. The front-end of the two applications will be deployed to end-users' devices.

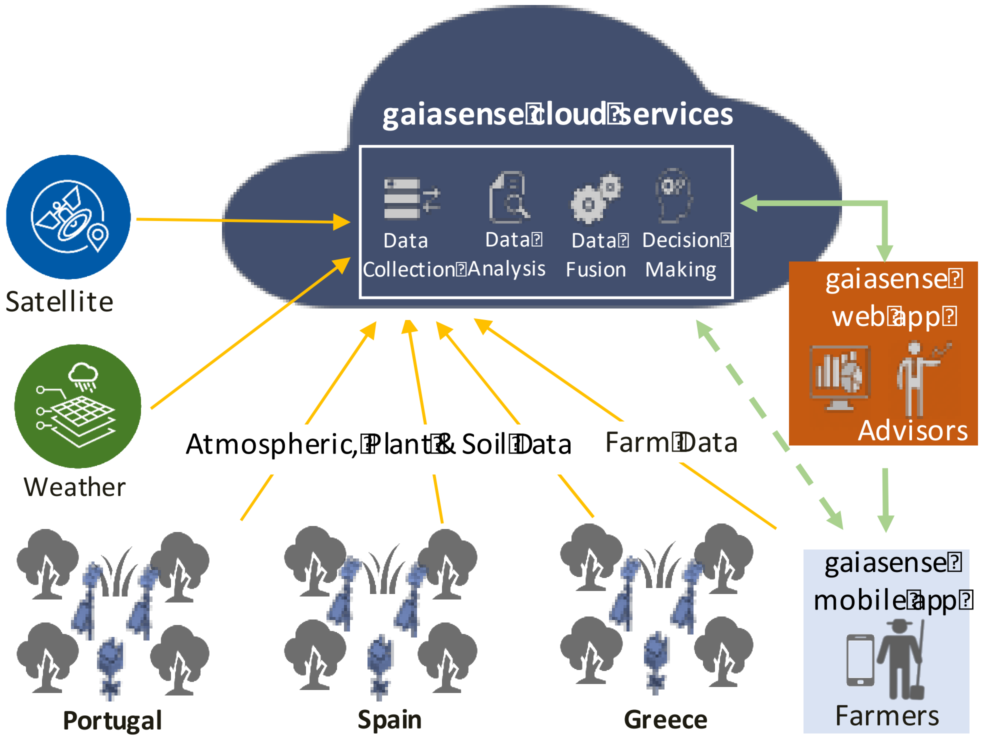

Figure 2. Deployment view and information flow for the gaiasense ecosystem.

An initial specification of the REST API calls was defined which will facilitate the interaction between the front-end part of the applications and the respective back-end. For the REST calls to follow, the user needs to have been previously authenticated (e.g. username/password) with the system and an associated hash token to have been created which is would then be transferred in the HTTP HEADER of each call.

Finally a first version of the mockups had been presented to agronomists in face2face meetings. The agronomists have evaluated the design and have made suggestions regarding the different types of information that are of interest for the different users groups. The suggestions have been incorporated in the final design of the mock-ups.a number of web and mobile applications mockups were presented.