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DELIVERABLE

Initial Smart Farming Application

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Executive Summary

This document presents the functionality and the implementation details of Smart Farming (SF) applications to be used by the advisors, the agronomists and the farmers in the context of the LIFE GAIA Sense project and beyond. This document can be considered as complementary to the initial design specifications of the SF applications contained in deliverable entitled **“Final Application Design and Mockups”** [1]. The requirements and the design principles that were specified on that document are the guidelines for the implementation of the actual software services that are described in this document.

As it will be further analysed, two applications have been developed:

- The **“gaiasense web-based application”** that provides access to detailed current and historic environmental information of selected parcels (fields) along with scientific based indications on the associated hazards with regards to irrigation and pest management.
- The **“gaiasense mobile application”** tailored to the needs of users that are on the move while performing various tasks (e.g. farmers visiting different fields and applying various cultivation practices) hence only crucial information summaries are presented to small-mobile devices.

Both applications are based on the gaiasense (<http://www.gaiasense.gr/en>) - cloud based - information management system that provides to both the web-based and mobile applications, access to the necessary data in support of their overall functionality.

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Definitions, Acronyms and Abbreviations

Acronym	Title
AB	Advisory Board
ALs	Action Leaders
CE	Circular Economy
M2M	Machine2Machine
NP	NEUROPUBLIC AE PLIROFORIKIS & EPIKOINONION
SF	Smart Farming
KPI	Key Performance Indicator
SF	Smart Farming
API	Application programming interface
REST	Representational State Transfer
NDVI	Normalized difference vegetation index
JSON	JavaScript Object Notation
IoT	Internet of Things
iCM	Crop management system

1. Introduction

1.1. Project Summary

The main objective of the LIFE GAIA Sense project is to demonstrate Gaiasense, an innovative “Smart Farming” (SF) solution that aims at reducing the consumption of natural resources, as a way to protect the environment and support Circular Economy (CE) models.

More specifically, this project will launch 18 demonstrators across Greece, Spain and Portugal covering 9 crops (olives, peaches, cotton, pistachio, potatoes, table tomatoes, industrial tomatoes, grapes, kiwi) in various terrain and microclimatic conditions. They will demonstrate an innovative method, based on high-end technology, which is suitable for being replicated and will be accessible and affordable to Farmers either as individuals or collectively through Agricultural Cooperatives.

Moreover, LIFE GAIA Sense aims 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 how the farmer will be able to decide either to use or avoid inputs (irrigation, fertilizers, pesticides etc.) in a most efficient way, without risking the annual production. The focus is on the resource consumption reduction side of CE, and the results will be both qualitatively and quantitatively, considering the resources’ efficiency in agricultural sector.

1.2. Document Scope

This document presents the functionality and the implementation details of the following two Smart Farming (SF) applications:

- The **“gaiasense web-based application”** that provides access to detailed current and historic environmental information of selected parcels (fields) along with scientific based indications on the associated hazards with regards to irrigation and pest management.
- The **“gaiasense mobile application”** tailored to the needs of users that are on the move while performing various tasks (e.g. farmers visiting different fields and applying various cultivation practices) hence only crucial information summaries are presented to small-mobile devices.

This document also provides an overview of the gaiasense (<http://www.gaiasense.gr/en>) - cloud based - information management system that provides to both the web-based and mobile applications access to the necessary data in support of their overall functionality.

2. Initial smart farming application - Summary

As it was analysed in the document “**Final Application Design and Mockups**” the gaia sense framework (figure 1) follows a layered architectural design approach where the main information flow is realised from the bottom layers to the higher layers. For the needs of the LIFE GAIA Sense project two applications have been developed, on top of this architecture, leveraging on the provided data collection and processing infrastructure.

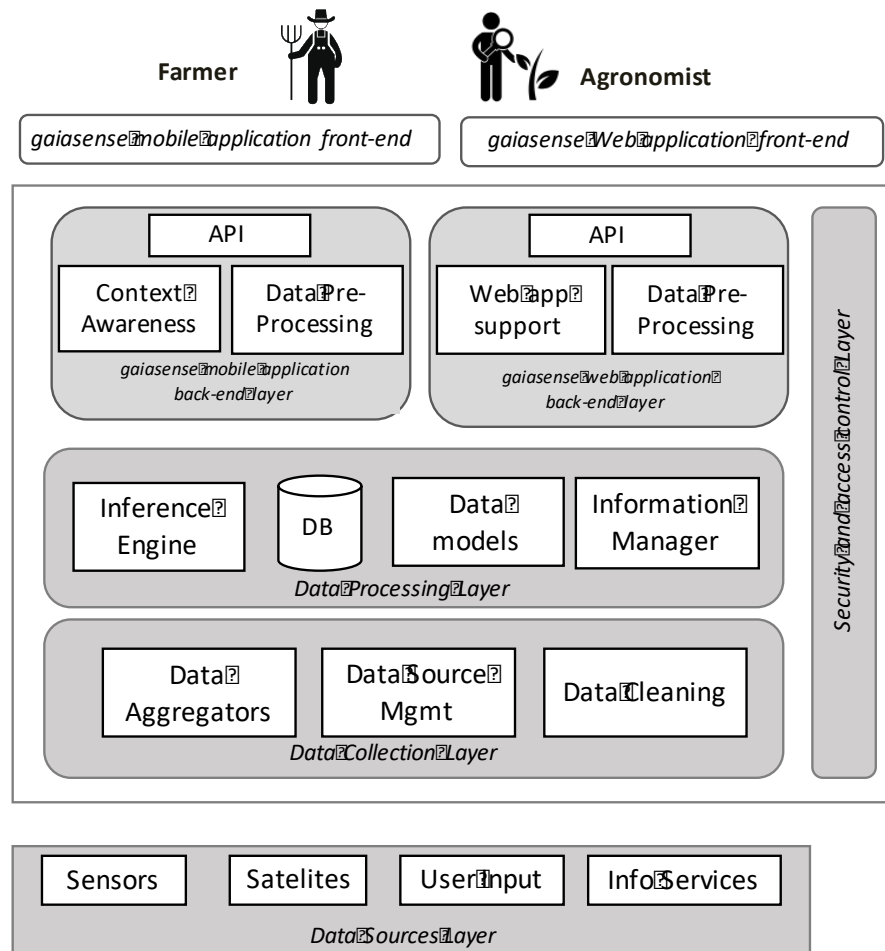


Figure 1. Functional view of the gaia sense framework layered architecture

The **gaia sense web-based application** is tailored to the needs of the agronomists and the advisors and is accessible through resource rich devices (e.g. desktop and laptop personal computers). This web-based app provides access to current and historic environmental conditions on the targeted parcels (fields) along with scientific based indications on the associated hazards with regards to irrigation and pest management. The user will be able to be informed about the potential pest or insect infestations through the scientific models that will be integrated within the “Data Processing Layer”. This helps the user to enhance and optimize the process of making timely decisions and precision applications in the crop. Finally, the user will have a complete overview on the field activities during a growing season though the necessary intuitive visualisations about irrigation and plant protection works carried out, the phenological stages of the plants, and harvest related info.

The **gaia sense mobile application** is tailored to the needs of the farmers and is optimised for utilisation through mobile devices (e.g. smart-phones, tablets). This category of users is expected to be on the

move while performing various tasks (e.g. visiting different farms and applying various cultivation practices). The application is “parcel” oriented meaning that the central information entity that the application is designed upon is the field that the farmer is cultivating. The application visualises only the information necessary to the farmer avoiding complicated details about the underlying scientific models. The focus is on the simplified and user friendly representation of the respective outcomes. This implies that a relative minimalistic approach is followed, especially when compared with the information richness of the “gaia sense web-based application”.

Both applications follow an incremental development approach where initially a set of core functional services are provided that are constantly improved according to user recommendations and feedback. Improvements are expected to both user-experience aspects of the service but also on the advanced knowledge extraction elements of the provided services

For the needs of the LIFE GAIA Sense project, a set of additional, existing services will be configured appropriately in order to be utilized and integrated with the newly developed applications. These services are:

The “Intelligent Management Crop – (iCM)” is a multifunctional platform that can properly manage a group of producers or a single farm. This service has been created to assist farmers to comply with regulatory frameworks i.e. Multi-Compliance Rules and the requirements arising from the various Quality Systems i.e. Agro, Globalgap, PDO / PGI, Organic Agriculture. Particularly, 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 the 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 existing version of the iCM system, developed by NP, was only capable to handle information originating from agricultural fields located in the geographical area of Greece. Given that the LIFE GAIA Sense pilot fields are also located outside Greece (Portugal and Spain) it was necessary to implement additional software modules and translations in order to make the iCM available to non-Greek agronomists and farmers.

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. Growers have the ability to record the entomological attack directly on the field with the help of a smartphone and exploiting this data to control effectively the damage caused by plant’s enemies while 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 insitu 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.

One of the core objectives of the LIFE GAIA-Sense project is the development of pest, irrigation and fertilization prediction models. The scientific models are initially expressed as computational

algorithms, then they are coded as software components which are integrated within the gaia sense framework and made available to the end-users through the LIFE GAIA Sense applications.

The specified architecture (Figure 1) adopts an approach where each model is considered as an autonomous and self-contained software module.

Figure 2, illustrates in a conceptual manner the parallel utilization of different pest and disease estimation models along with the flow of information from the deployed sensors to the farmer.

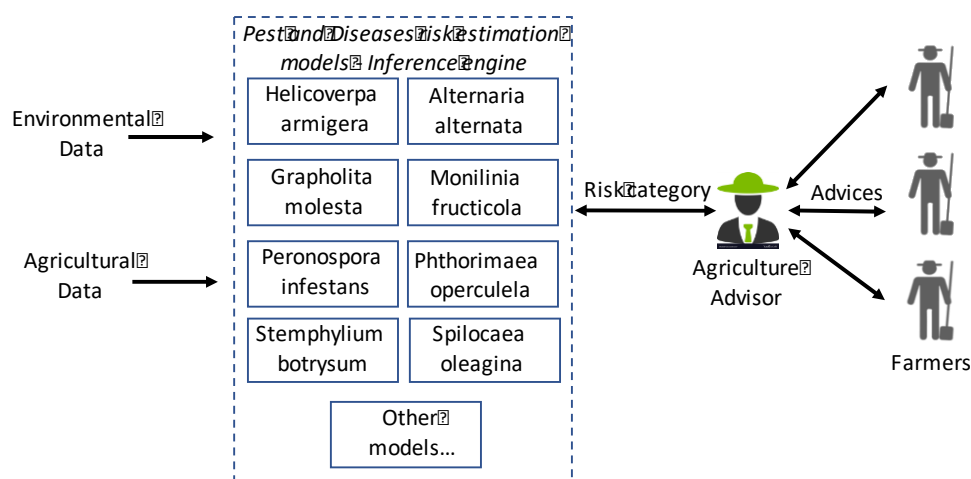


Figure 2. Integration of pest management scientific models and conceptual flow of information

Figure 3 presents the respective information flow environmental data monitoring, processing of information through the proper irrigation model, extraction of irrigation needs and generation of the final irrigation advice.

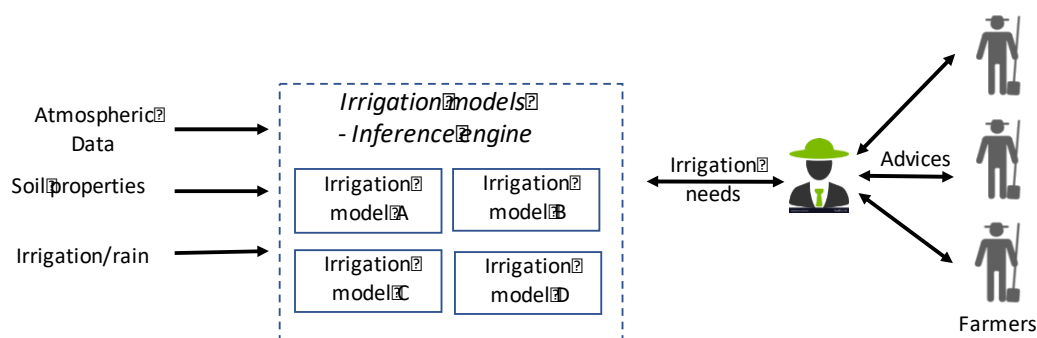


Figure 3. Integration of irrigation scientific models and conceptual flow of information

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, PostgreSQL 11.2 , Java 8, REST-API , NodeJS 10.15, REST-API , Javascript, AngularJS, ReactJS, PHP 7.1 .

The data collected from the fields are maintained and processed in NEUROPUBLIC S.A. data center located at 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 (gaia sense mobile &

web based applications) used by the farmers and farming advisors are also hosted in NEUROPUBLIC S.A. server systems.

The **gaia sense web application** is accessible on-line through the Internet while the overall services are offered through the web browser. Users can access the application at:

- <https://gaia sense.neuropublic.gr> (Greek language)
- <https://gaia sense.neuropublic.gr/gaiaexmon/views/login.php?lang=en> (English Language)

Upon successful login, a list of the IoT stations are presented that the user (e.g. advisor) authorised to view. Each telemetric station (gaiatron) is associated with an area of cultivated parcels. The gaiatrons are listed on the left of the screen where also an indicative name of the associated area is presented. Upon selecting a station the respective measurements are presented in a table format. In order to make the presentation of the measured data more intuitive the “gaia sense web application” supports the visualisation of data in the form of graphs. In addition, this page support the visualisation of selected events related to irrigation, pest management, harvests, plants phenological stages, etc. Also, there is the “GeoMap” option where a google-map is presented with gaia sense pins located at the places where stations are installed.

The **gaia sense mobile application** is accessible through mobile devices like smart-phones and tablets. However, the application is also accessible through desktop devices. Users can access the application at:

- <https://gaia sense.neuropublic.gr/iot/index.php>

Upon successful login, the user is redirected to the landing page of the application which a dashboard where the most recent and important warnings are presented related with pest management and/or irrigation warnings. In addition, various Key Performance Indicators (KPIs) that are the outcome of a real-time calculation of the overall inputs (pesticides and irrigation) applied to the farmer’s parcels can be presented, but also the total amount of harvested quantities. Moreover, list of parcels that are administered by the user is presented and the user is able to view the respective polygon on a google-maps. When selecting the menu item, entitled “Field”, a graph is presented visually rendering selected indicative data types over a predefined period of one month. In the same page the user is able to select from the dropdown menu the “Forecast” option and to view a graph with predicted values of Temperature, Wind speed, Humidity and Temperature. When selecting the item, entitled “Remote”, earth observation related metrics are presented. The “Irrigation” menu item presents environmental information that are related to the irrigation process of the parcel (e.g. soil moisture, rain events, and irrigation events). At the profile page the user is able to submit information about an irrigation action that has taken place to one of the parcels that he/she administers. The “Pests mgmt” menu item presents a table containing the potential pests and diseases that are threatening the selected parcels and the calculated warning level. At the profile page the user is able to submit information about a pest management action (e.g. spraying with a pesticide) that has taken place to one of the parcels that he/she administers.

The first fully functional versions for both of these two applications are already released and the services are in use by selected users. Feedback from the users will be utilized by the development team in order to further improve and optimize the usability of the applications. In addition, the scientific



models and algorithms that are the core entities for processing the collected data in order to provide pest management, irrigation and fertilization advice are expected to further be refined and integrated within the backend system. The final outcomes on the LIFE GAIA Sense applications design and development will be documented at the deliverable entitled "Final Smart Farming Application" to be released at the end of this year.