INTERNET OF FOOD & FARM

D2.4 ANNUAL IMPLEMENTATION AND PERFORMANCE MONITORING REPORT

WP 2

December 28th, 2017

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PROJECT SUMMARY

The internet of things (IoT) has a revolutionary potential. A smart web of sensors, actuators, cameras, robots, drones, and other connected devices allows for an unprecedented level of control and automated decision-making. The project Internet of Food & Farm 2020 (IoF2020) explores the potential of IoT-technologies for the European food and farming industry.

The goal is ambitious: to make precision farming a reality and to take a vital step towards a more sustainable food value chain. With the help of IoT technologies higher yields and better-quality produce are within reach. Pesticide and fertilizer use will drop, and overall efficiency is optimized. IoT technologies also enable better traceability of food, leading to increased food safety.

Nineteen use-cases organised around five trials (arable, dairy, fruits, meat, and vegetables) develop, test, and demonstrate IoT technologies in an operational farm environment all over Europe, with the first results expected in the first quarter of 2018.

IoF2020 uses a lean multi-actor approach focusing on user acceptability, stakeholder engagement and the development of sustainable business models. IoF2020 aims to increase the economic viability and market share of developed technologies, while bringing end-users' and farmers' adoption of these technological solutions to the next stage. The aim of IoF2020 is to build a lasting innovation ecosystem that fosters the uptake of IoT technologies. Therefore, key stakeholders along the food value chain are involved in IoF2020, together with technology service providers, software companies and academic research institutions.

Led by the Wageningen University and Research (WUR), the 70+ members consortium includes partners from agriculture and ICT sectors, and uses open source technology provided by other initiatives (e.g. FIWARE). IoF2020 is part of Horizon2020 Industrial Leadership and is supported by the European Commission with a budget of €30 million.

EXECUTIVE SUMMARY

In order to demonstrate the effectiveness of IoT solutions in a large spectrum of different agricultural domains and applications, IoF2020 has carefully selected 5 trials comprising 19 Use Cases (UCs), set in different regions of Europe. This is a key aspect to reflect the diversity of the agri-food domain, and to perform evaluations in conditions which are close to real scale and operational ones.

Each use case has delivered a Progress report after their first iteration of technical implementation and testing, stating and explaining the current status of development, the successfulness of implementation, and the achieved performances of the IoT systems/solutions. The Use Case Progress reports are grouped and published jointly at the end of each year (iteration) of project implementation, as it is the case with this first year.

The main goal of this document is to provide an overview and a first evaluation of the progress of each of the 19 Use Cases regarding their first year of implementation. The information provided by the Use Cases cover a broad range, from technological inputs to business aspects, passing through pure management/organizational elements and dissemination material. To accurately measure the progress of a project is always a challenge. There are many factors to account for in a progress update, such as the type of measurements, the frequency with which the data is collected and the system of record. The methodology adopted in this report is a mix of qualitative and quantitative methods, enabling further exploration of the collected data.

The results analysis has proven that most of the UCs (85-90%) have implemented their activities as planned in D2.2 Trail Implementation Plan, further showing the valuable effort of the UCs in providing high quality results. The number of deployed components (both IoT and not) is growing rapidly producing a highly significant quantity of data that will be used as baseline values to measure the improvements of the next three years. As well, in the project, the number of UCs collaborations has increased both within the same trial as between different trials to better validate their IoT cases and to widen their activity range. On the other hand, Use Cases are still facing challenges to define concrete business models. These challenges will be tackled by the WPs in the first months of 2018.

Finally, considering that IoF2020 is based on the lean multi-actor methodology, the UCs were asked to provide inputs about what should be improved in the coming months to enhance the annual translation from the initial deployment (MVP1) to the next release of the new and improved MVP (MVP2, early 2019. Several UCs consider that including more end-users and/or new demonstration sites would allow them to increase the number of experiments and/or to have more trustworthy validation of their solutions/technologies.

TABLE OF CONTENTS

1. INTRODUCTION

The D2.4 “Annual Implementation and Performance Monitoring Report” aims to identify and thus evaluate each of the 19 Use Cases’ current status of development, by evaluating their technical improvements, the successfulness of their implementations and the achieved performances of IoT systems/solutions. D2.4 is of crucial importance for WP2 because it allows a first thorough overview of the UCs’ status and improvements after one year from the project’s start. As well, this report is highly strategical in directing and formulating new strategies for the future of the project in order to maximize its impact, based on the lessons learnt from the UCs’ activities and results from this first year.

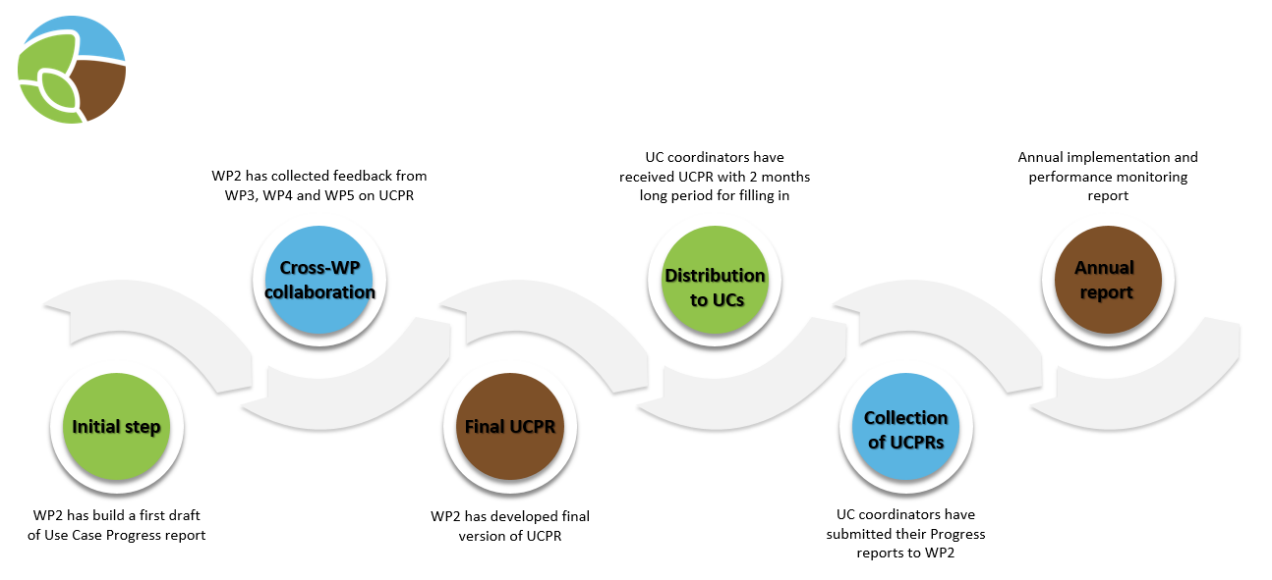
D2.4 structure is based on D2.2 “Trial Implementation Plan”. In D2.2 the UCs defined and set up their tasks for the whole length of the project, including all the activities foreseen per each task, the partners involved and the duration of the tasks. The D2.4 monitors that the foreseen activities of the UCs, included in the work plan for year one, have been actually performed. Besides monitoring, the main objective of D2.4 is to evaluate the first-year results of the UCs activities. This is done both by inquiring if all the activities have been executed, highlighting possible underperforming UCs and by analyzing the impact of the UCs activities in the agri-food sector, from the economic, environmental, and social point of view. The final list of KPIs measuring the three mentioned impacts is now present in the deliverable for most of the UCs thanks the close collaboration with WP4.

The first part of the deliverable is dedicated to the description of the Progress report template that was distributed to the UCs in order to collect the needed information. This section is followed by the specification of the methodology used to build the Progress report template. The third chapter includes the results analysis based on the inputs provided by the UCs through the 19 submitted progress reports. Due to the confidentiality of the data provided by the UCs, the 19 progress reports (around 400 pages) are included in the more extended confidential version of the D2.4. If the reader is interested in obtaining more information about a specific UC, it is suggested to directly contact the coordinator of the UC of interest. The contact details of the UC coordinators can be found on the project website (www.iof2020.eu). Finally, the last chapter of the deliverable is consisting of the overall conclusions, including suggestions that could improve the impact of the 19 UCs in the next three years and hopefully even longer.

2. APPROACH & METHODOLOGY

2.1. USE CASE PROGRESS REPORT TEMPLATE CREATION METHODOLOGY

As previously mentioned the Use Case Progress Report template's goal is to identify and evaluate the improvements of the 19 UCs throughout the first year of implementation. As it is normal for identifying improvements, it is necessary to have a starting point on which to measure the changes. The starting point for the Use Case Progress Report is the Use Case Work Plan template that was used for D2.2 "Trial Implementation Plan". The UCWP template was divided into 10 chapters that are now reflected in the 11 chapters of the UCPR.

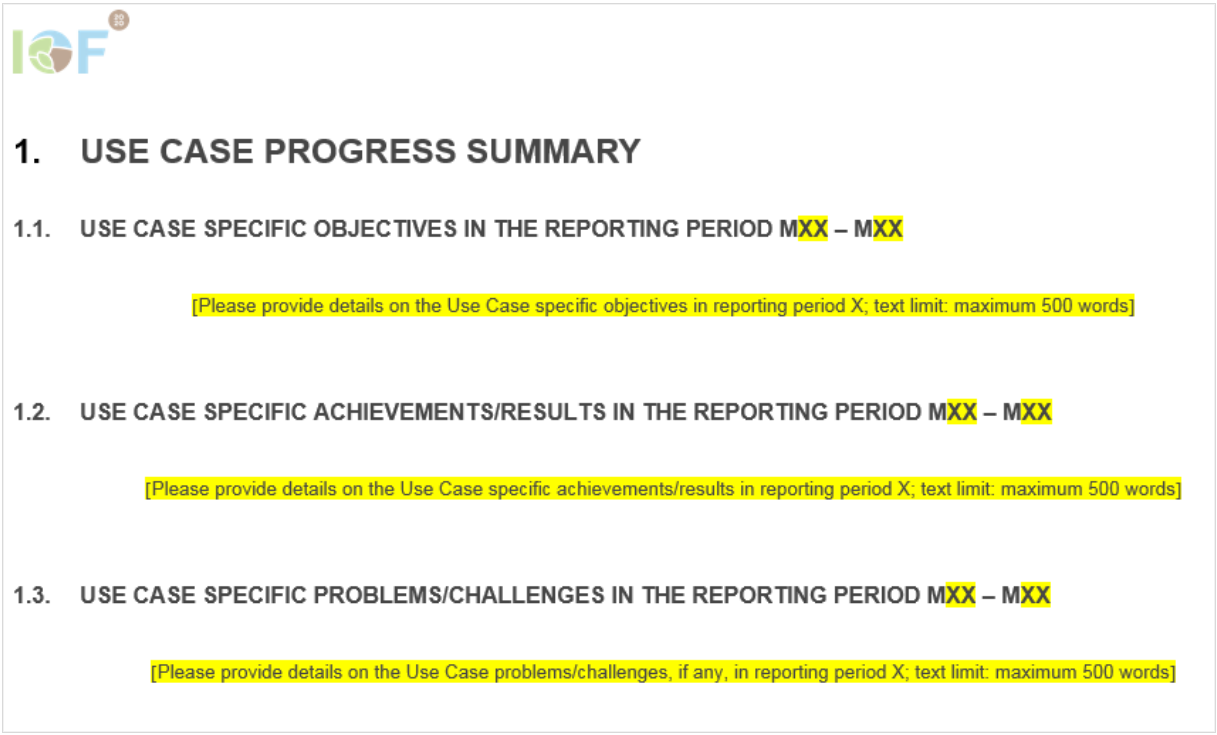


As for the UCWP the UCPR template was developed in collaboration with the other WPs in order to collect a broad range of information that could be useful not only to WP2. For instance, in this report there was the necessity to include technical information regarding the reporting period that could be analysed as well by WP3 and provide an important source of knowledge about the current technological status of the UCs' implementations (chapter 3). Chapter 3's information is further strengthened by D2.3 "Installation, Customization and Integration Report" (as well, M12), where more technical information about the UCs' installations is included, together with plenty of dissemination material. Likewise it was of crucial importance, in the UCPR template, to follow up the progress of the business models of each UC. This chapter provides very useful information both to WP2 and WP4. Finally in collaboration with WP5, the chapter dissemination material has been developed to ask the UCs the various type of dissemination activities performed in the first reporting period.

The rest of the chapters have been developed based on the UCWP template to gather as much information as possible regarding the UCs progress related to the activities, tasks and plans initially included in the UCWP.

2.2. METHODOLOGY FOR FILLING IN THE USE CASE PROGRESS REPORT TEMPLATE

The Use Case Progress report has an easy-to-understand structure, beginning with the Use Case Progress summary chapter, where UC coordinators should explain specific objectives, achievement/results, and problems/challenges for the certain reporting period which in this case is from month 1 until month 11, when the first year of project implementation is ending. Giving the text limitation of maximum 500 words, WP2 believes that amount of text is sufficient for descriptive, clear explanations.



1. USE CASE PROGRESS SUMMARY

1.1. USE CASE SPECIFIC OBJECTIVES IN THE REPORTING PERIOD MXX – MXX

[Please provide details on the Use Case specific objectives in reporting period X; text limit: maximum 500 words]

1.2. USE CASE SPECIFIC ACHIEVEMENTS/RESULTS IN THE REPORTING PERIOD MXX – MXX

[Please provide details on the Use Case specific achievements/results in reporting period X; text limit: maximum 500 words]

1.3. USE CASE SPECIFIC PROBLEMS/CHALLENGES IN THE REPORTING PERIOD MXX – MXX

[Please provide details on the Use Case problems/challenges, if any, in reporting period X; text limit: maximum 500 words]

Figure 1 Use Case Progress Summary

Further on, for a clearer understanding and analysis of the finalized work plan, in accordance with UCWP, WP2 has extracted all the tasks that were planned for the first reporting period, including the involved partners and the third parties, as it is shown in the Figure 2 Work Plan ProgressFigure 2.

2. WORK PLAN PROGRESS

[Please, provide a description of conducted tasks in Reporting Period MXX – MXX]

Task 1	**Start month**	MX	**Duration**	XM	**Total PM**	XX
Title	*[Please provide the task name]*					
Partners involved					**Person months**	
Partner 1	*[Please provide organization name]*				*[Please insert PM]*	
Partner 2						
Partner 3						
Partner n	*[Please, add or remove rows for partners, if needed]*					
Third parties involved: *[Please provide names of third parties involved in task]*						
Goal: *[Please give a short description of the task goal]*						
Activities Description *[Please describe the activities in detail. At least 10 lines per activity]*						
Subtask No.	**Description**			**Realization**		
Subtask 1.1	*[Please, if there are subtasks, provide the subtask name and brief description]*			*[Please, provide description of conducted activities and outcomes for the subtask realization; text limit minimum 100 words]*		
Subtask 1.2						
Subtask 1.n	*[Please, add or remove rows for subtasks, if needed]*					

**Please copy paste the table if there are more tasks within the Use Case.*

Figure 2 Work Plan Progress

To be able to track status of implementation, the template foresees four different subchapters dealing with actors (users) involved (Figure 3), deployed components (Figure 4), communication standards and formats (Figure 5), and gathered data (Figure 6), for the first reporting period. In the subchapter dedicated to actors (users) involved, the UC coordinator should provide details on involved actor name, main features provided by the actor, main data input/output actions, and main user interface(s) used in the first reporting period. On the other hand, for deployed components, name of the technology, technology supplier (brand) and model, number of deployed units per site and deployment site(s) name (in accordance with the UCWP) should be stated. In case of more deployment sites, additional specification should be provided: in which site components function better, by inserting asterisk next to the site number. For the communication standards and formats used, only interface name and used standard(s) should be stated. And finally, for the gathered data in this reporting period, we need information on data gathered, used measurement technique, location, used crops/animals for the task, defined frequency of data collection, task number and associated data model/format.

3. STATUS OF IMPLEMENTATION

3.1. ACTORS (USERS) INVOLVED IN THE REPORTING PERIOD MXX – MXX

Actor Name	Main features provided to the actor	Main data input/output actions	Main User interface(s) used in RP MXX - MXX

*Please, add or remove rows if needed.

Figure 3 Status of implementation - actors involved

3.2. DEPLOYED COMPONENTS IN THE REPORTING PERIOD MXX – MXX

Name	Supplier (brand) + Model	Number of Deployed Units per site	Deployment Site(s)
[Please name deployed technology]	*[Please provide deployed technology supplier/brand and model]*	*[Please insert the number of used units]*	*[Please refer to No. from Area/Facilities Deployed table (see Section 5.7 of UCWP)]*[1]

*Please, add or remove rows if needed.

Figure 4 Status of implementation - deployed components

3.3. COMMUNICATION STANDARDS AND FORMATS USED IN THE REPORTING PERIOD MXX – MXX

Interface Name	Standard(s)	Notes

*Please, add or remove rows if needed.

Figure 5 Status of implementation - communication standards and formats

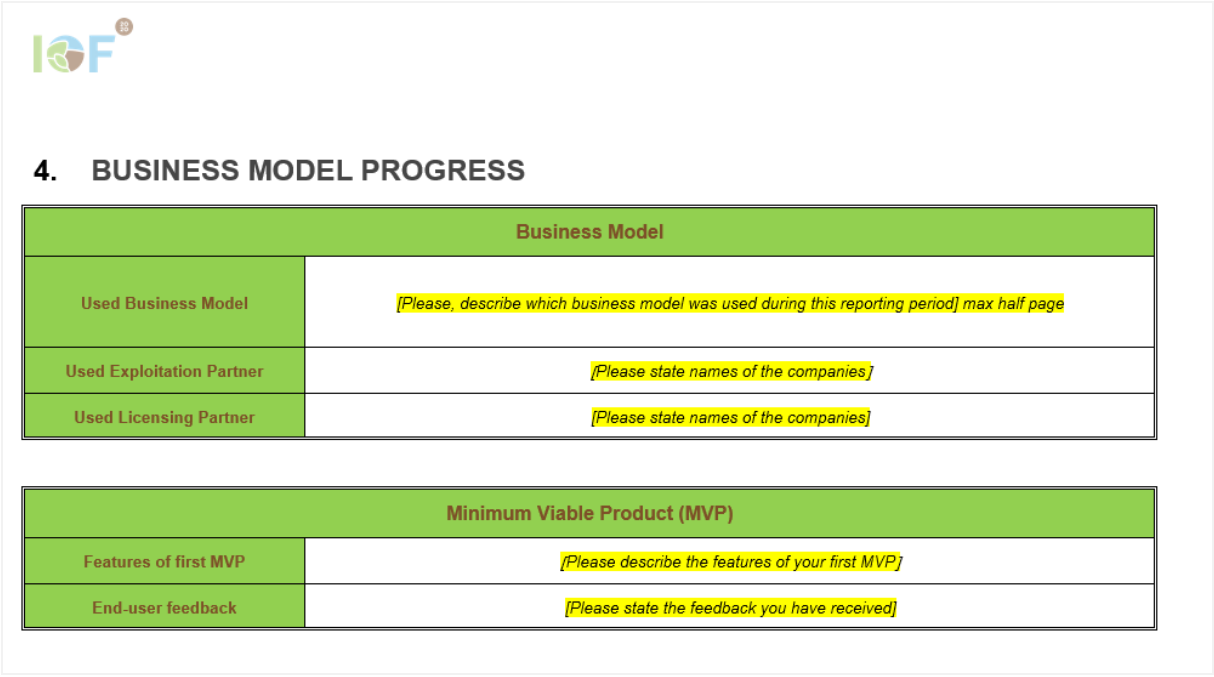
3.4. GATHERED DATA IN THE REPORTING PERIOD MXX – MXX

Gathered data in the Reporting Period MXX - MXX						
Data	Measurement Technique	Deployment Site(s)	Crops/ animals used for task	Frequency of Data Collection	Task No.	Associated data model/ format
		[Please refer to No. from Area/Facilities Deployed table (see Section 5.7 of UCWP)]			[Please refer to the Task number from the section 4 of the UCWP]	[e.g. for each reading: weight measured (kg) – serialized in a custom JSON frame + ISO 8601 timestamp]

*Please, add or remove rows if needed.

Figure 6 Status of implementation - gathered data

As clearly defined business models are highly important, we are aiming to follow the progress of its development (Figure 7) by asking for a description of the used business model within each use case, along with the description of the first MVP features and the end-user(s) feedback.



4. BUSINESS MODEL PROGRESS

Business Model	
Used Business Model	*[Please, describe which business model was used during this reporting period] max half page*
Used Exploitation Partner	*[Please state names of the companies]*
Used Licensing Partner	*[Please state names of the companies]*

Minimum Viable Product (MVP)	
Features of first MVP	*[Please describe the features of your first MVP]*
End-user feedback	*[Please state the feedback you have received]*

Figure 7 Business model progress

In general, a KPI is a measurable value that shows the effectiveness in achieving key objectives. The overall goal of the KPI measurement is to assess the impact of all IoF2020 use cases in terms of their economic, environmental, and social impact and to quantify this impact into an economical value. Thus, each impact criteria will be reviewed and translated into a revenue gain or cost decrease in agricultural value chains. The analysis of KPIs across the chain will uncover the added value of IoT solutions for engaged actors and stakeholders. Therefore, the use case impact is tracked through subchapters as shown in Figure 8, Figure 9 and Figure 10. All the tables are cumulative enabling project progress track measured in % from the beginning of the project. It is very important to define starting values, current and target values for each predefined KPI. As added value, column *Lessons learned* is inserted so we could collect information on gained knowledge.

5. USE CASE IMPACT

5.1. ECONOMIC IMPACT

[Please note that the table is cumulative, that is, it should always show all progress from the beginning of the project]

[In case new economic impact occurred, please elaborate on them, and add KPIs in the table accordingly]

Economic KPIs	Starting value	Current value	Target value	Progress [%]				Lessons learned
				M11	M23	M35	M47	
	[Please refer to the value from Section 8 of the UCWP]	*[Please add value from this Reporting period]*	*[Please refer to the value from Section 8 of the UCWP]*					

**Please, add or remove rows if needed.*

Figure 8 Use Case Impact - economic impact

5.2. ENVIRONMENTAL IMPACT

[Please note that the table is cumulative, that is, it should always show all progress from the beginning of the project]

[In case new environmental impact occurred, please elaborate on them, and add KPIs in the table accordingly]

Environmental KPIs	Starting value	Current value	Target value	Progress [%]				Lessons learned
				M11	M23	M35	M47	
	[Please refer to the value from Section 8 of the UCWP]	*[Please add value from this Reporting period]*	*[Please refer to the value from Section 8 of the UCWP]*					

**Please, add or remove rows if needed.*

Figure 9 Use Case Impact - environmental impact

5.3. OTHER IMPACT (SOCIAL IMPACT)

[Please note that the table is cumulative, that is, it should always show all progress from the beginning of the project]

[In case new other impact (social impact) occurred, please elaborate on them, and add KPIs in the table accordingly]

Social KPIs	Starting value	Current value	Target value	Progress [%]				Lessons learned
				M11	M23	M35	M47	
	[Please refer to the value from Section 8 of the UCWP]	*[Please add value from this Reporting period]*	*[Please refer to the value from Section 8 of the UCWP]*					

**Please, add or remove rows if needed.*

Figure 10 Use Case Impact - other (social) impact

Turning to the definition of possible collaboration with other use cases, it is essential to identify and outline the collaboration opportunities with other use cases for enhancing cross-sectoral collaboration. If such potential is recognized, use case coordinators should determine what sharing components or approaches (i.e. common hardware solutions were used in both UCs, common software features were necessary, common technologies were/are used, etc.) or integration of data/services (i.e. data or services that were available by another UC or as general development and that benefited one UC or vice-versa) are dividable with which use case, as demonstrated in the Figure 11. Likewise, in all previous tables, adding or removing of table rows is optional.

6. COLLABORATION WITH OTHER USE CASES

Use Case Name and Number	Shared components or approaches identified[2]	Integration of data/services identified[3]

*Please, add or remove rows if needed.

Figure 11 Collaboration with other Use Cases

The deliverables and milestones are defined for record of work progress, accomplishments, and comparison with the project schedule. Deliverables (Figure 12) are in correlation with task number from the UCWP and their nature should be specified by using the following nomenclature: R – document, report; DEM – demonstrator, pilot, prototype; DEC – website, patents filling, press and media, videos; OTHER – software, technical diagram. Moreover, delivery date and means of verification should be defined as well.

7. DELIVERABLES AND MILESTONES

7.1. DELIVERABLES IN THE REPORTING PERIOD MXX – MXX

Del. No.	Deliverable name	Task No.	Nature[4]	Delivery date (dd/mm/yyyy)	Means of verification[5]	Comments

*Please, add or remove rows if needed.

Figure 12 Deliverables and milestones - deliverables

For the achieved milestones in examined reporting period (Figure 13), UC coordinators should provide a mean of verification, a clear statement of achievement (yes/no) and an achievement date.

7.2. MILESTONES IN THE REPORTING PERIOD MXX – MXX

Mil. No.	Milestone name	Means of verification	Achieved Yes/No	Achievement date (dd/mm/yyyy)	Comments

*Please, add or remove rows if needed

Figure 13 Deliverables and milestones - milestones

By knowing that risk management is the identification, assessment, and prioritization of risks (defined in ISO 31000 as the effect of uncertainty on objectives) followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events (Hubbard, 2009) or to maximize the realization of opportunities, it is clear why initially, in the UCWP, WP2 needed defined foreseen risks. Now, UCs report about occurred risks in the first reporting period (Figure 14), linking them with task concerned, describing proposed risk-mitigation measures. At the same time, in case that unforeseen risks arise, there is a table shown in Figure 15 with the same questions, but only for previously undefined and unforeseen risks.

8. RISK MANAGEMENT

8.1. FORESEEN RISKS

Description of Risk	Task concerned	Proposed Risk-Mitigation Measures	Comments
[Insert risk description]	*[Insert Task No. in accordance with the UCWP]*	*[Insert mitigation measure]*	

**Please, add or remove rows if needed.*

Figure 14 Risk management - foreseen risks

8.2. UNFORESEEN RISKS

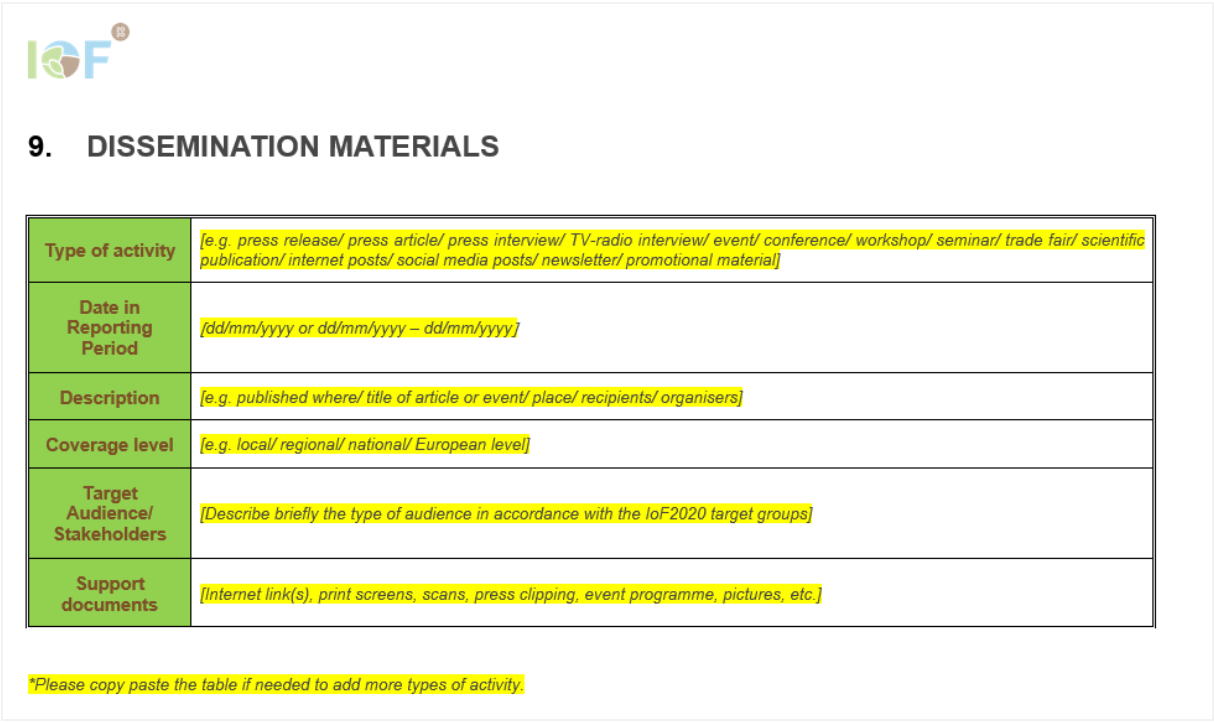
Description of Risk	Task Concerned	Proposed Risk -Mitigation Measures	Comments
[Insert unforeseen issue description]	*[Insert Task No. in accordance with the UCWP]*	*[Insert mitigation measure]*	

**Please, add or remove rows if needed.*

Figure 15 Risk management - unforeseen risks

Following the structure of UCWP, we have developed a chapter in the UC Progress report that deals with dissemination materials. In order to collect all relevant details, the given table (Figure 16) can be copy-pasted for adding more types of activities (e.g. describing press releases, press

articles, press interviews, TV-radio interviews, events, conferences, workshops, seminars, trade fairs, scientific publications, internet posts, social media posts, newsletters, promotional materials etc.). It is important to define the date of the reporting period, to provide a short description, the coverage level, the target audience or stakeholders, and finally the support document(s), meaning link(s), print screens, scans, press clipping, event program, pictures etc. For this purpose, UCs can use Basecamp, the project official project management and team communication platform.



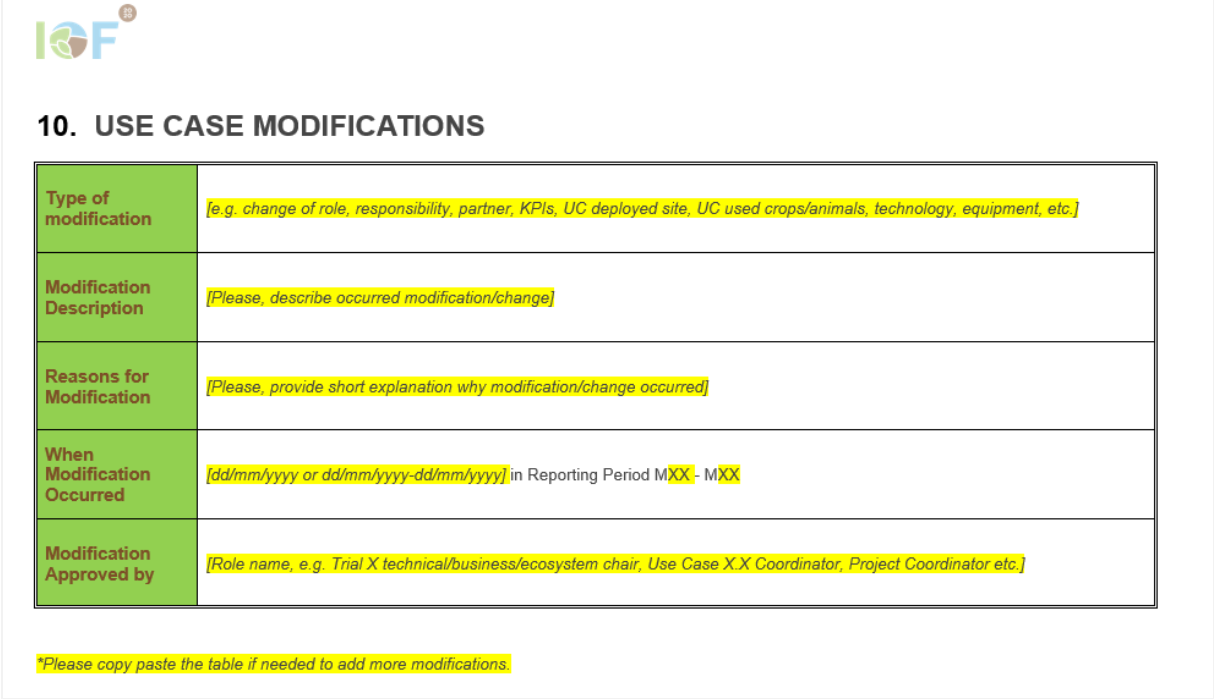
9. DISSEMINATION MATERIALS

Type of activity	*[e.g. press release/ press article/ press interview/ TV-radio interview/ event/ conference/ workshop/ seminar/ trade fair/ scientific publication/ internet posts/ social media posts/ newsletter/ promotional material]*
Date in Reporting Period	*[dd/mm/yyyy or dd/mm/yyyy – dd/mm/yyyy]*
Description	*[e.g. published where/ title of article or event/ place/ recipients/ organisers]*
Coverage level	*[e.g. local/ regional/ national/ European level]*
Target Audience/ Stakeholders	*[Describe briefly the type of audience in accordance with the IoF2020 target groups]*
Support documents	*[Internet link(s), print screens, scans, press clipping, event programme, pictures, etc.]*

**Please copy paste the table if needed to add more types of activity.*

Figure 16 Dissemination material

Every ongoing project is a living thing and subjected to possible adjustments. To be able to track all the kind of modifications, not only through monthly Trial level meetings, UC Progress report chapter on Use Case modifications (Figure 17) is giving clear overview of reporting period modifications by stating type of modification (e.g. change of role, responsibility, partner, KPIs, deployed site, used crops/animals, technology, equipment etc.), its description, reasons for its appearance, date and responsible for modification authorization (e.g. Trial technical/business/ecosystem chair, Use Case coordinator, Project Coordinator etc.).



10. USE CASE MODIFICATIONS

Type of modification	*[e.g. change of role, responsibility, partner, KPIs, UC deployed site, UC used crops/animals, technology, equipment, etc.]*
Modification Description	*[Please, describe occurred modification/change]*
Reasons for Modification	*[Please, provide short explanation why modification/change occurred]*
When Modification Occurred	*[dd/mm/yyyy or dd/mm/yyyy-dd/mm/yyyy]* in Reporting Period MXX - MXX
Modification Approved by	*[Role name, e.g. Trial X technical/business/ecosystem chair, Use Case X.X Coordinator, Project Coordinator etc.]*

**Please copy paste the table if needed to add more modifications.*

Figure 17 Use Case modifications

The final chapter of the Use Case Progress report (Figure 18) is dealing with plan(s) for improvement. By describing the noticed gap(s) in technology, the needs for more end-user(s), the needs for additional deployment site(s), WP2 will better understand the needs of each Use Case for improving the MVP1 throughout the second year of implementation (commonly called strategy towards MVP2),. Moreover, it can help us analyze which type of activity(ies) or action(s) will help enhancing the UC performances.

11. PLAN(S) FOR IMPROVEMENT

Step(s) towards MVP2	[Please describe your strategy to improve MVP1 in year 2 (strategy towards MVP2); text limit minimum 10 lines]
Noticed gap(s) in technology	[Please list and describe any noticed gap(s) in technolgy; text limit minimum 10 lines]
Need for more end-user(s)	[Please specify if you need more end-user(s); text limit minimum 5 lines]
Need for additional deployment site(s)	[Please specify if you need additional delpoyment site(s); text limit minimum 5 lines]
Other	[Please, feel free to add description of activity(ies)/action(s) that, in your opinion, will enhace UC performance; text limit minimum 10 lines]

Figure 18 Plan(s) for improvement

3. RESULTS ANALYSIS

Each Use Case has delivered a Progress report after the first iteration of technical improvements and testing stating and explaining the current status of development, the successfulness of the implementations, and the achieved performance level of the IoT systems/solutions. These Progress reports are published jointly since it is the end of the first reporting period of the project implementation. By analyzing the collected Progress reports we were able to understand and examine technical and business aspects of Use Cases, evaluate their progress of deployment and readiness for the second year of deployment. Results are presented by Trial, except collaboration between Use Case, business models and plans for improvement.

In order to help the reader to identify the UCs throughout the results analysis, a list of all the 19 UCs is here inserted:

- Trial 1: The Internet Of Arable Farming
    - UC1.1: Within Field Management Zoning
    - UC1.2: Precision Crop Management
    - UC1.3: Soya Protein Management
    - UC1.4: Farm Machine Interoperability
- Trial 2: The Internet Of Dairy Farming
    - UC2.1: Grazing Cow Monitor
    - UC2.2: Happy Cow
    - UC2.3: Herdsman +
    - UC2.4: Remote Milk Quality
- Trial 3: The Internet Of Fruit
    - UC3.1: Fresh Table Grapes Chain
    - UC3.2: Big Wine Optimization
    - UC3.3: Automated Olive Chain
    - UC3.4: Intelligent Fruit Logistic
- Trial 4: The Internet Of Vegetables
    - UC4.1: City Farming Leafy Vegetables
    - UC4.2: Chain-integrated Greenhouse Production
    - UC4.3: Added Value Weeding Data

- UC4.4: Enhance Quality Certification System

- Trial 5: The Internet Of Meat
  - UC5.1: Pig Farm Management
  - UC5.2: Poultry Chain Management
  - UC5.3: Meat Transparency And Traceability

Trial 1

Arable farming is by far the largest agricultural sector in the EU in terms of acreage and number of primary production holdings variety of arable crops is grown in EU, with regional differences. Wheat and maize are dominant in almost every region, and so, having the largest acreages in the EU. Other important arable crops are oilseed rape, potatoes, sugar beet, protein crops and field grown vegetables like onions. They serve different demands in the EU; human and animal consumption, bio-fuels, and compounds for the bio-based economy. The EU has developed modern production, processing, and distribution chains for these different uses of arable crops. In those terms, Trial 1 has included multi-actors, but mainly: technology providers, conventional farmers, organic farmers, agricultural support, organizations etc.

Number of deployed components is shown in the Figure 19, and it mainly consist of soil sensor, climate sensor, plant sensor, RGB camera, IoT gateway, cloud, LoRa Networks, soil electrical conductivity sensor, soil FDR moisture sensor, weather sensors, yield monitor system, protein content sensor, tractors with VD03 navigation controller and data modem.

In terms of communication standards and platforms in the Trial 1 are used SDI-12, Bluetooth, SPI/I2C, HTTP, JSON/HTTPS, OAuthV2, NGSI/HTTP, LPWA, MQTT and ADAPT.

Generated data varies in each Use Case, but measures: air pressure, air relative humidity, reflectance in wavelength (different nm), transmitted PAR, incident PAR, air T, soil T, soil water potential, RGB image, water stress, leaf area index, green fraction, nitrogen uptake, evaporation piration, water availability, soil electrical conductivity, soil moisture and weather data, yield data, protein % content. In this reporting period, in the UC 1.4 personnel is testing the ADAPT plug-ins based on internal test data.

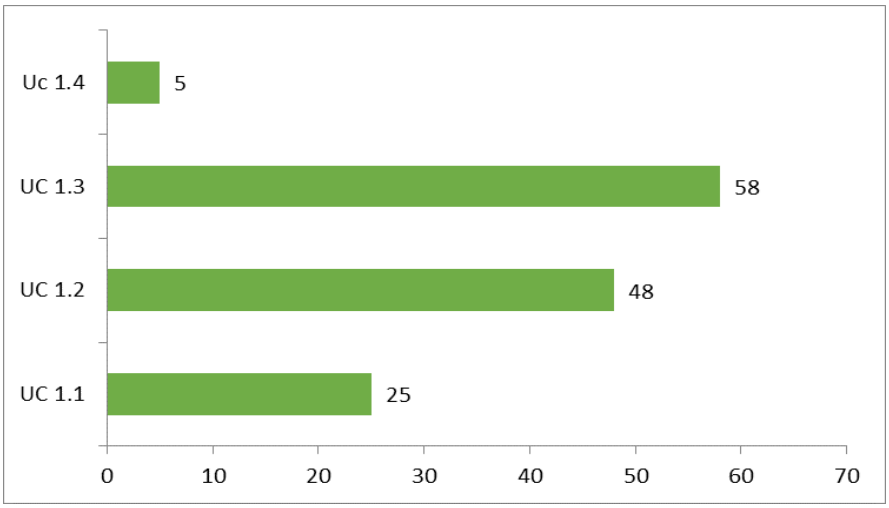


Figure 19 Trial 1 No. of deployed components

Weak aspect of Trial 1 is unsatisfactory amount of defined KPIs regarding impact. The UC 1.1, UC 1.2, and UC 1.3 do not have defined indicator nor values, on the other hand, the UC 1.3 provided a defined list of its indicators with measured values for their both sites – in Italy and Austria.

Trial 1 has faced various foreseen risks, but with well-planned and well-structured mitigations measures, most of the processes are running smoothly. The UC 1.2 had mostly technical risk in relation with unavailability and autonomy of the IoT systems and LoRa network adaptation of the IoT sensor. Additionally, UC 1.2 states that their risk is also an insufficient business model definition. The UC 1.3 has faced the missing farmers' partnership in ongoing season risk, UC platform partner unavailable in Italy site, connectivity/Compatibility and failing to meet KPIs. Lack of control regarding software platforms and lack of equipment ownership are two major risks of the UC 1.4. Regarding unforeseen risks, UC 1.3 has reported occurrence of two risks in relation with incomplete data collection of yield sensors due to technical reasons and due to organizational reasons.

Only two modifications occurred in Trial 1, and both in the UC 1.3 – change of UC coordinator and engagement of an extra deployment site.

Trial 2

The Trial 2 has various actors involved mostly including technology providers, farms and farmers, survey respondents, government representatives. The number of deployed components vary, and the distribution is shown in the Figure 20. Depending on the Use Case topic, types of deployed components are various, such as tracking systems cloud and web-apps, cow tags and receivers, milking robot, feeder wagon and neck collars. UC 2.4 is in setting up phase and have a low progress rate.

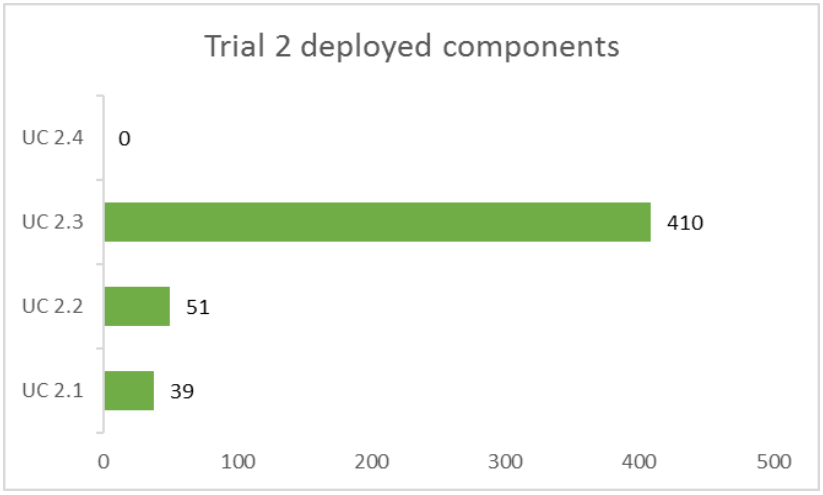


Figure 20 Trial 2 No. of deployed components

Regarding the communication standards and the platforms, except UC 2.4, Trial 2 Use Cases are using the following types of communication protocols: Sigfox, Bluetooth, GPS communication protocol GNSS-GLONASS, SNT Cloud interface, API, Wi-Fi/GPRS, ZigBee/Wi-Fi/Mobile, Hard wired/ZigBee/Wi-Fi.

Trial 2 gathered data in the first reporting period is a unique catalogue of information that enables detailed analysis of significant measurements that provides insights for decision making. Depending on the Use Case, some of the collected parameters are outdoor and indoor location of the cow, status of the barn (empty/not empty), milk yield, number of inseminations and antibiotics treatments, conductivity, fat, protein, temperature, cell count, ration mix, quantity, time of feed, activity, eating and rumination.

In the first reporting period, KPI catalogue was built to ensure proper progress track, nonetheless, not all Use Cases were able to define their indicators neither the base values. In the Trial 2, UC 2.3 does not have defined environmental KPIs and UC 2.4 social KPIs. UC 2.1 has managed to define all their KPIs, moreover they have all starting, current and target values, but for the most of KPIs in the first reporting period they stated that the progress measuring did not start yet, being this the first year of implementation. UC 2.2 has set all the indicators and values with notable progress. Except environmental KPIs, UC 2.3 has established economic and social indicators and their values. Finally, UC 2.4 is lacking social KPIs, but also current values of defined indicators. In the next period, it is crucial to set and track all the predefined indicators.

Considering the foreseen and unforeseen risks in the first reporting period, Trial 2 Use Cases were affected by several of them. The types of foreseen risks can be divided into two broad groups:

- **market related risks** - high dairy sales price per unit, low response to the customer survey, lack of demo sites, lack of benchmarked performance for trial farms, limited staff resources,

- **technical risks** - algorithm and insight accuracy, reliability issues of system hardware, not reliable test data, sub-optimal test environment, robust performance of technology, inability to integrate all data streams.

In significantly lower amount, unforeseen risks occurred only in two Use Cases of Trial 2 and have mostly a technical character. In UC 2.1 there is a risk of incorrect classification of cows due to location definition, also there is a risk of cow tracker physical loss. On the other hand, UC 2.4 has is facing the risk of lacking proper IoT elements in their UC.

When it comes to the detected modifications in the first reporting period, no major modification occurred in UC 2.1 (one-year duration extension). Technical modification occurred in UC 2.4 due to lack of IoT aspect of their Use Case.

Trial 3

The goal of this Trial is to test, develop and disseminate architectures, methodologies, and strategies, allowing the seamless integration of heterogeneous IoT technologies into a coherent system, for creating a sustainable Fruit Sector. Therefore, the Fruit Trial (Trial 3) has included sheer number of actors in their Use Cases – farms, farmers, technology providers, service provides as a customer, physiological stations, universities, IoT technology and software provider, wineries, agronomic engineers etc. Number of deployed components vary depending on Use Case goals and tasks, but overall distribution per Use Case is shown in the Figure 21 Trial 3 No. of deployed components.

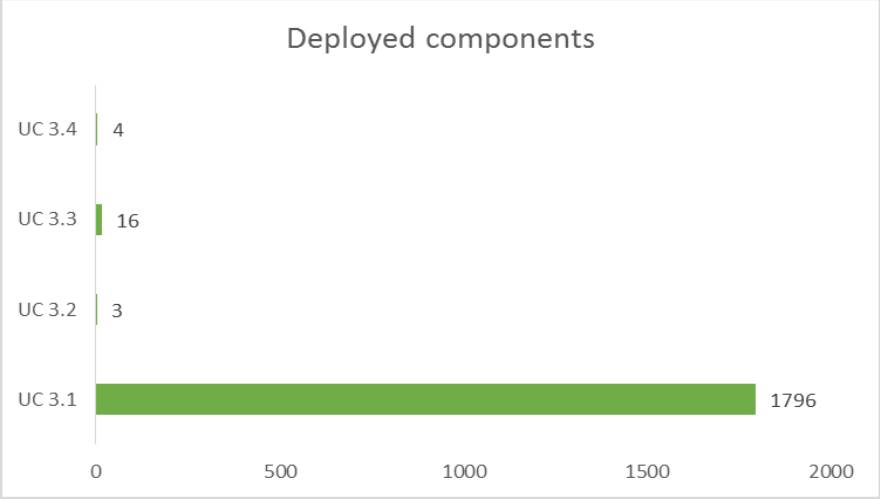


Figure 21 Trial 3 No. of deployed components

Like the deployed number, also the type of deployed components has variations in each Use Case. For example, UC 3.1 has: post-harvest equipment, blow (more than 1200 which explains the total high number), DSS, overall cloud service, GPRS field data logger with solar panel, Wi-Fi field data logger with solar panel, irrigation control system with solar panel, rain gauge (crop and field sensors), barometer (crop and field sensors), analog thermo-hygrometer sensor(crop and field sensors), digital

thermo-hygrometer sensor(crop and field sensors), visible solar radiation sensor(crop and field sensors), PAR sensor(crop and field sensors), leaf wetness sensor (crop and field sensors) anemometer sensor (crop and field sensors), FDR sensor (crop and field sensors), EC sensor (crop and field sensors), drill &drop sensor(crop and field sensors), atmometer sensor (crop and field sensors), stem psychrometer sensor (crop and field sensors), basic IoT board (BIB), customized pendants with NFC tag and QR Code, WSN Platform, irrigation automation, agriculture analysis and control portal. Additionally, UC 3.2 is using different components in vineyard and winery. In vineyard they have deployed temperature and hygrometry sensor, as well as fixed inspection sensor Prototype #1, but in winery only temperature and hygrometry sensor are in use. More, UC 3.3 has WSN Platforms, NIR sensor in olive mill, agriculture analysis and control portals and weather forecast. And in UC 3.4's first prototype, IoT Platform (demo environment), interface, customer and depot locations, and test report with RTI movement data are in use.

In relation to the type of communication standards various platforms are in use in the Trial 3, such as: in the UC 3.1 GPRS, Wi-Fi, MODBUS, digital output, analog output, Sigfox and NFC NTAG213, in the UC 3.2 HTTP REST, MQTT, CoAP, DTLS, LoRa, Ethernet, Wi-Fi, ADSL (Asymmetric digital subscriber line), in the UC 3.3 only SOA -WEB Service and finally in the UC 3.4 GLN, GRAI, MQTT, Oauth and Sigfox.

Concerning gathered data, the biggest focus in Trial 3 is given to the following parameters: air temperature, air humidity, wind velocity and direction, rain precipitation, atmospheric pressure, visible solar radiation, PAR, leaf wetness, soil water content and temperature, soil electrical conductivity, water evaporation rate, status of solenoid valves, data for: pest recognition, disease marker, treatment activities, treatment monitoring, data from DSS, metadata for deterministic model, metadata for DSS, soil moisture (VWC), leaf wetness, water flow, water pressure, vigor, barometric/ atmospheric pressure, vine image from fixed inspection sensor, and geolocation data from the prototype 1vs. actual geolocation.

Key performance indicators are not defined in the UC 3.1. In the UC 3.2 all three groups of impact have defined indicators, but there are no measurements of current values in this first reporting period, only starting and target values. The UC 3.3 also has defined indicators with reported progress of 0%. Last, the UC 3.4 for majority of defined indicators does not have starting values.

Detected foreseen risks occurred in all Trial 3 Use Cases, and mostly are in relation with: table grape quality, post-harvest treatments, issues with timeline (late sensor delivery), exceeded costs for IoT system development and data logger, low cost FTIR reader not precise enough, climatic conditions (e.g. frost), workers cooperation during the busy harvesting season, no functional operation of the sensors nodes in vineyard due to destruction by tractors, stole or break on, low coverage in some locations for the IoT devices communication, business objectives not valid for addressing the targeted group of stakeholders, technology features cannot satisfy the business requirements, acceptance by

EPS customers in terms of data ownership and privacy. However, only one unforeseen risk occurred, in the UC 3.2 (weather station vendor did not performed adaption in its stations).

In Trial 3 no modifications were detected or reported during the first reporting period.

Trial 4

The common aim of the trial is to increase crop productivity and to improve the products quality. In this context, a secure and environmental-friendly farming must exist, and the energy, water and nutrients demand related to outdoor growing systems(mainly water) or closed indoor systems (artificial light, water, etc.) must be ensured to meet the physiological needs of the crops and Use Cases within Trial 4 are performing tasks to reach these goals by, inter alia, different actors involvement, like: technology providers, food logistic and supplier, farmers, IC farmers, contractors, users, auditors, inspectors, R&D etc.

As shown in previous cases, number of deployed components vary. In the Trial 4, number of deployed components per Use Case is shown in the Figure 22 Trial 4 No. of deployed components.

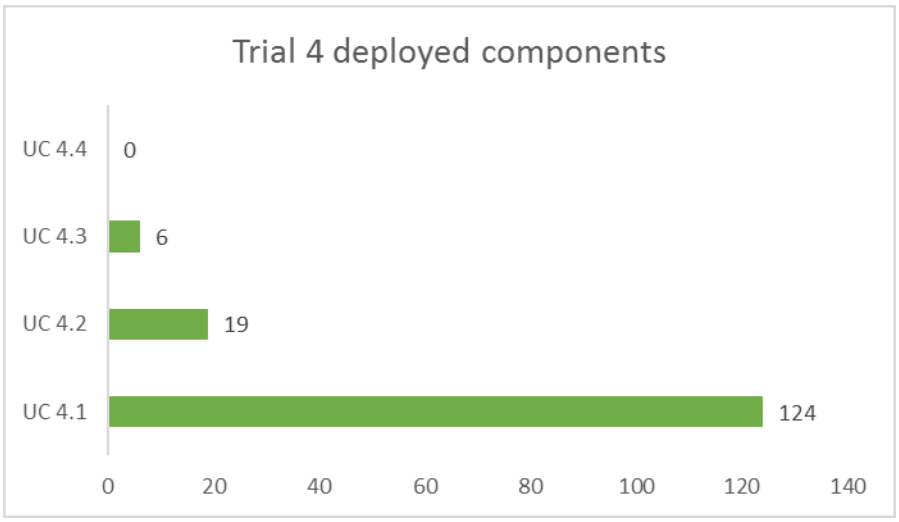


Figure 22 Trial 4 No. of deployed components

Regarding the deployed components type in Trial 4, the main represented components are: temperature and humidity sensors, multi-channel light sensor, camera, IR camera, microcontroller, Linux computer, ArtNet to DMX/RDM converter, dynamic LED lighting modules, WLAN router, POE Ethernet switch, water content sensor, EC sensor, sun calibration quantum sensor, self-powered pyranometer, CO2monitor, server, computer, mini-computer, camera, crop monitoring, crop monitoring Cloud service, FIWARE, IC weeding machine, Farm Management system, cloud IoT database, sensors and smart phones for manual inputs, plug and play harvest. In the first reporting period, UC 4.4. has reported that has 0 deployed components, as they are facing a 6 months delay in their

schedule due to the change of the technical partner in the UC, as well due to lack organizational and management skills.

Communication standards used in Trial 4 are: IP over Ethernet, ArtNet, DMX, Wi-Fi, Ethernet, USB, RS-232, SDI-12. The UC 4.4 does not have any communication standard nor platform, for time being. Type of gathered data includes: plant weight, images, system set point data (climate, irrigation, and nutrients), temperature, humidity, plant properties, field data, setting data, substrate water content, corridor temperature, corridor humidity, CO_2 flow, tube CO_2 concentration, active power heating, outlet pressure, proportional valve, inlet pressure, outlet pressure, inlet blower outlet, outlet blower outlet, inlet temperature CO_2, outlet temperature CO_2, inlet temperature blower, outlet temperature blower, smokes temperature, pressure valve, proportional valve heating, side ventilation, top ventilation, aero thermal heating set point, ventilation set point, biomass heating set point, CO_2 enrichment set point, CO_2 storage set point, radiation set point, humidity (humidification) set point, humidity (dehumidification) set point, irrigation water, plant hanging weight, bag hanging weight, greenhouse solar radiation, substrate water content, substrate electrical conductivity. At this point, UC 4.4 does not have any gathered data.

Use Cases within Trial 4 have identified their KPIs, but like in other Trials, many of them were not able to measure progress being this the first year of deployment. UC 4.1 did not define social indicators, and UC 4.4 does not have starting nor target values.

Only two Use Cases have reported risks in the first reporting period (UC 4.1 and UC 4.2). Risks are related to timing of realization, lack of promised features and discontinuity of FIWARE, lack of data model, lack of data from commercial farmers, lack of data from handling industry, competitor might develop better solution. In the category of unforeseen risks, one occurred in the UC 4.3 and it concerns misfit of yield monitor.

In the first reporting period, Trial 4 was affected with 3 modifications regarding UC coordinator substitution (UC 4.1 and UC 4.2), and one change of technology provider partner (UC 4.4).

Trial 5

The Meat trial aims to implement, experiment, and disseminate the use of IoT technologies to improve the meat value chain through new knowledge-based livestock production systems: addressing animal production, health and welfare requirements, traceability aspects and producing internationally competitive meat products improving both meat industry profit and animals' health and welfare. To be able to perform all the mentioned activities, the involvement of key actors is a necessity and that is why Trial 5 UCs have included farmers, farm managers, relevant experts, veterinarians, slaughterhouse management, technology providers.

The number of deployed components per Use Case is shown in the Figure 23 Trial 5 No. of deployed components. The following types of components have been collected: mini-PC, flow meters, electronic

feeding stations, RFID for normal feeding station, temperature sensors, humidity sensors, light meters, animal scale, silo scale, water Consumption sensor, environmental sensor node, smart bracelets, integral farm controller, farm and slaughterhouse gateway, slaughterhouse web service, cloud services and EPCIS prototype.

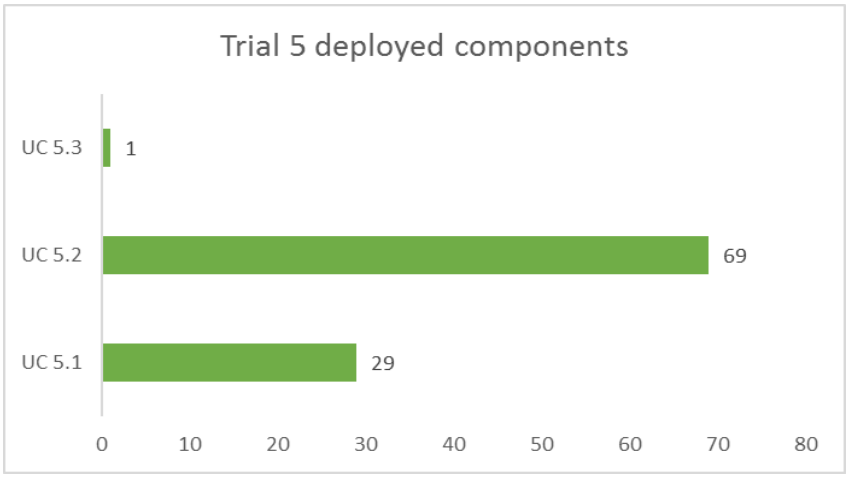


Figure 23 Trial 5 No. of deployed components

Ethernet gateway, LLRP1 (over-IP), LF and HF, Exafan proprietary protocol, wireless 802.11g, transport protocol RS485, wireless, 802.15.4, MQTT, Wi-Fi, standard web service REST, NGSI, GS1 EPCIS 1.2 are communication protocols and formats used by Use Cases in Trial 5, all for the purpose of data collection: pen and barn characteristic, batch characteristics, health, water consumption, feed consumption, daily growth, climate, ind. feed consumption, ind. weight, ind. water intake, ind. feeding behavior, ind. drinking behavior, temperature, humidity, luminosity, manipulation data, animal weight, silo weight, water consumption, slaughterhouse data. In this reporting period UC 5.3 does not have any gathered data.

Regarding impact indicators, UC 5.3 did not define any yet, and UC 5.1 is lacking social KPIs. For the defined KPIs, Use Cases still did not start to measure values (UC 5.1 and UC 5.2).

For the first reporting period, all the three Use Cases in the Trial 5 have detected risks, but at the same time acted with mitigation measures to minimize and reduce it or, in the best-case scenario, completely overcome the risks. The UC 5.1 has identified the main risk factor in the task of coordination and planning is to establish an efficient cooperation with UC 5.3 and other parties in the project. Also, in the task of support test farmers, the recognized risks were insufficient number of farmers willing to cooperate, dropping out of farmers and low quality provided data - this risk has occurred. The UC 5.2 reported technological risk - connection between the different IoT devices and platforms of the Use Case as well as the possibility of occurrence of the different models developed during the project which are not useful for poultry producers. Similarly, UC 5.3 stated that risks are: delayed or poor farmers inputs and requirements, poor or delayed IoT and sensor data requirements,

unrealistic planning, change of staff, untrained staff or staff not available when needed, intended innovative solution does not match real-world requirements, and that market research or validation might show other results than expected. When it comes to the unforeseen risks all the three Use Cases were affected with the following: the UC 5.1 has difficulties to get raw data from external sensor companies, the UC 5.2 delays due to amendment process of FIWARE FOUNDATION and FICODES, the terms and agreements of FILAB might not provide desired confidentiality for the UC data collection and sniffing attacks received in the app that receives data from the gateways, the UC 5.3 has difficulties in finding suitable stakeholders.

In terms of modifications, UC 5.1 has switched from entire males to castrated males in organic farming and instead of searching for entire boars on all farms, the criterion is left out for the organic farm. Additionally, in the UC 5.2 has changed architecture.

IoF2020 Collaboration between Use Cases

IoF2020 endorses, nurtures, and supports the cross-use case collaboration and since the very beginning of the project it was aiming to recognize and facilitate the collaboration between them. Moreover, IoF2020 wants to avoid collaboration barriers that can be easily imposed by project structures in such large initiatives like the IoT LSPs. Furthermore, WP3 has a task 3.5 related to facilitation and boosting collaboration and synergies between Use Cases in order to avoid a separation of work if there is already a suitable partner involved that can overtake the identified needs. At this project stage, according to received input from Progress reports, WP2 was able to identify already existing close collaborations between Use Cases, shown in the Figure 24. So far, only UC 2.3, UC 4.1, and UC 4.4 did not detect any Use Case for collaboration.

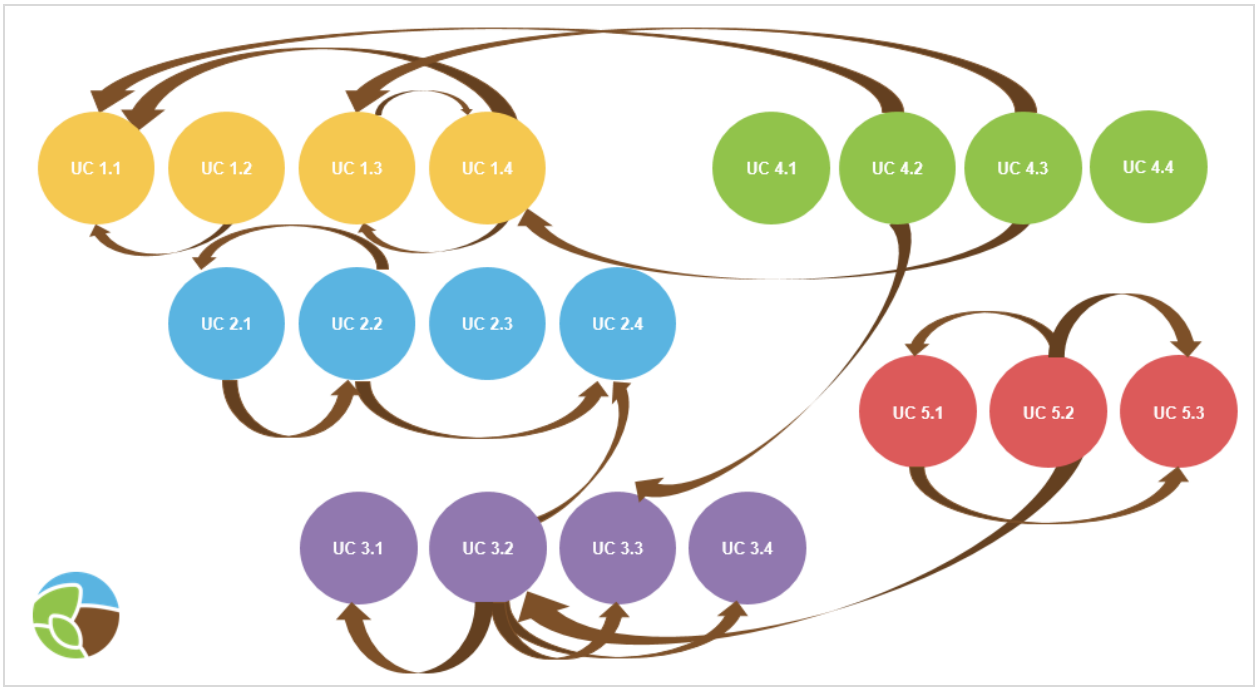


Figure 24 UCs collaboration

IoF2020 Business models

IoF2020 aims to broadly demonstrate how every actor in the agri-food ecosystem can gain and prosper by incorporating IoT technologies into their processes and business models. IoF2020 will greatly accelerate the adoption and the large-scale take-up of these innovative IoT solutions by demonstrating the most promising ones in 5 major sectors of agri-food domain. All IoF2020 Use Cases should establish their business models to be ready for the market uptake. Nonetheless, at this early stage of project, and at the end of first reporting period, all Use Case business models received through Progress report were analyzed. Shortly, we can state that further development of above mentioned models is a necessity. Most of the Use Cases (UC 1.1, UC 1.3, UC 3.2, UC 3.3, UC 3.4, UC 4.2, UC 4.3, UC 4.4, UC 5.1, UC 5.2) do not have defined a final model, or are in the phase of business model preparation or need assistance and support of WP4. Other nine Use Cases (UC 1.2, UC 1.4, UC 2.1, UC 2.2, UC 2.3, UC 2.4, UC 3.1, UC 4.1, UC 5.3) have a set up plan for making a business models that could be further developed in next project phases.

IoF2020 Plans for improvement

To be able to understand the needs of the Use Cases, WP2 has built a particular chapter within the Progress report to collect data regarding UCs step(s) towards MVP2, noticed gap(s) in technology, need for more end-user(s), need for additional deployment site(s) and section for stating another need (e.g. description of an activity(ies)/action(s) that will enhance UC performance. The Use Cases UC 2.3, UC 3.1, UC 3.2, UC 4.3, UC 4.4, and UC 5.3 have stated that at the moment of inquiry they do not have any needs at all.

For the steps towards MVP2, depending on development level of Use Case, we have collected various statement regarding technological improvement. Nonetheless, the Use Cases 2.3, 3.1, 3.2, 3.3, 4.3, 4.4, 5.3 did not provided any strategy description.

Regarding gaps in technologies, Use Cases 1.1, 2.3, 3.1, 3.2, 4.1, 4.3, 4.4 and 5.3 have stated that they did not detect any gap while operating. On the other hand, the UCs have reported the following:

- UC 1.2 – Finalize IoT system energy management and LoRa connectivity;
- UC 1.3 - Data gathering of prescription map can be carried out only when there is a communication with a standard format of file and where is open data gathering for this purpose;
- UC 1.4 - Might have issues with other platforms due to usage of ADAPT Plug-in, based on Microsoft technology;

- UC 2.1–Sigfox coverage is not sufficient, technology will not work as the data cannot be sent to the cloud. Also, the data transmission rate is legally limited, meaning that the frequency of position updates is limited;
- UC 2.2 - Platform is built in house to support challenges other platforms could not handle;
- UC 2.4 – Missing the IoT element;
- UC 3.3–Farmers have not installed any IoT device yet;
- UC 3.4 – The prototype need to have a higher accuracy in order to meet customer needs;
- UC 4.2 – Limited access to the FIWARE community accounts;
- UC 5.1–Might need to consider – reliable digital water meter for pen level measurements, reliable weighting system for individual level measurement, reliable environmental sensors (CO2, ammonia);
- UC 5.2–Need to consider technology for transport (LoRa/Sigfox)

Questions regarding the needs for more end-users has shown that only two Use Case have the necessity for additional input – UC 2.1 and UC 5.1. The UC 2.1 needs more end-user feedback in order to evaluate developed technology and application and to be able to include farmers (dairies) preferences during technology development. The UC 5.1 aims to include veterinarians, feed suppliers, genetics firms, additional slaughterhouses, farm advisors, FMIS and sensor companies.

Considering the needs for additional deployment site(s) only two Use Cases have expressed a demand toward expansion. UC 2.1 is looking for five dairy farms and UC 5.1 needs one additional organic farm and potentially a conventional one (as a backup), while UC 1.2 still needs to decide if to cooperate with UC 1.1 to widen their sites.

In the section dealing with `other` (activities that should enhance performance) several Use Cases have stated their future needs. The UC 1.3 (Italian site) wants to evaluate a collaboration with Kneveland in order to investigate data gathering system for prescription map during planting operation. On the other hand, the UC 1.4 aims to include manufacturers that are not in IoF2020 consortium yet since they believe that machinery connectivity will make the dashboard to monitor farm really advanced. In relation to the UC 2.4, they want to investigate the implementation motion and temperature sensors on its control and calibration samples to verify whether the samples are handled (shaken) and heated according to protocols. The UC 4.1 has a need to extend the access to their FIWARE community account for the rest of the project duration.

4. CONCLUSIONS

D2.4, Annual Implementation and performance monitoring report, is a collection of 19 Use Case progress reports that displays the current status of the Use Cases' activities. All the Use Cases have submitted their progress report, but the quality of the information provided is not equal among them. 80% of the Use Cases have produced a progress report including detailed information about their implementation status, showing that much has been done during the first year. On the other hand, three Use Cases (2.4, 4.4 and 5.3) have shown delays in their activities and will need an ad hoc support in the coming months to close the gap with the other Use Cases.

The 19 reports have been analysed and the results have shown that the number of components installed has drastically increased if compared with the Use Case work plans submitted at the end of June, reaching more than 2700 components installed in 77 different demo-sites. As well, the number of components installed highly variate from Use Case to Use Case, depending it on the type of activities performed. In collaboration with WP4, the final list of concrete KPIs has been developed to measure the economic, environmental and social impact of each of the 19 Use Cases. Year 1 will represent the baseline value for the Use Cases' KPIs, over which to measure the improvements in the coming three years. The list will be continuously updated during the year, by both WP2 and WP4.

Furthermore, the progress reports have shown that the Use Cases are increasing the number of collaborations with in their trial, as well as between trials. This is very much endorsed and pushed by the IoF2020 project board, considering that the cooperation among Use Cases will lead to better and more validated IoT technologies in the agri-food sector.

On the other hand, it has been noticed that there is a lack of concrete business models for most of the 19 Use Cases. Often the Use Cases find it difficult to define their specific business model due to the fact that many of the developed technologies are completely new and innovative in the market, thus it is not an easy task to target specific customers. WP4 and WP2 will closely collaborate with the Use Cases, in the coming two months, to ensure that 19 concrete business plans will be developed before IoF2020 First General Meeting in Almeria at the end of February.

Moreover, considering that IoF2020 is based on the lean multi-actor methodology, the UCs were asked to provide inputs about what should be improved in the coming months to enhance the annual translation from the initial deployment (MVP1) to the next release of new and improved MVP (MVP2, early 2019). Several UCs consider that including more end-users and/or new demonstration sites would allow them to increase the number of experiments and/or to have more trustworthy validation of their technologies.

To conclude, the progress reports submitted by the 19 Use Cases clearly prove that IoF2020 project has a disruptive innovative potential to bring new and market driven IoT technologies into the agri-food

sector and that the majority of the Use Cases are performing their activities on time and at a very high quality showing great responsibility and technical skills.