D2.4 -INITIAL BUSINESS MODELS REPORT

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Document History

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0.3	2018-01-11	Alessandra Bagnato (SOFTEAM)	Integrated contributions to section 4 & Updated Table 2. Value Proposition Plan from ROB, FRAUNHOFER, SLAB, TTTECH
0.4	2018-01-12	Alessandra Bagnato (SOFTEAM)	Fine tuning of contributions to section 4 & Updated Table 2. Value Proposition Plan from ROB, FRAUNHOFER, SLAB, TTTECH
0.5	2018-03-15	Alessandra Bagnato (SOFTEAM)	Integrated contributions to section 4 & Updated Table 2 From DigiSky
0.6	2018-05-28	Alessandra Bagnato (SOFTEAM)	Integrated contributions to section 4, SLAB added Security and safety perspective to each value proposition
0.7	2018-06-25	Alessandra Bagnato (SOFTEAM)	Integrated TTTECH &SLAB reviewers comments
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2018-06-04	Regina Krisztina Bíró (SLAB)	Minor comments and modifications inserted
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Executive Summary

The present document is a deliverable of the CPSwarm project, funded by the European Commission's Directorate-General for Research and Innovation (DG RTD), under its Horizon 2020 Research and innovation program (H2020), reporting the results of the activities carried out by WP2 - Use cases, requirements engineering and business models. The main objective of the CPSwarm project is to develop a workbench that aims to fully design, develop, validate and deploy engineered swarm solutions. More specifically, the project revolves around three vision scenarios; Swarm Drones, Swarm Logistics Assistant and Automotive CPS. The scenarios were outlined in the proposal and are refined within the engineering efforts alongside the project, driven by WP2.

WP2 manages and undertakes the work of carrying out the vision scenario and use case definition of the project and the iterative engineering of requirements, which focuses on the engineering process of initial requirements and reengineering after the end of each iteration cycle. The purpose of this work package is thus to maintain a continuous discovery and analysis of user centric requirements, needs and prospects, to be used in the design, development, implementation and validation of the CPSwarm workbench. WP2 T2.2 Objective is to define innovative business models and strategies in the field of CPS design with the ambition to create value for CPSwarm Project partners by creating value for the CPSwarm customers.

The main objective of this deliverable is to describe the business models of derived by CPSwarm use cases considering the results already described in D2.1 *Initial vision scenarios and use case definition*.

Within this first version of the Business Model Deliverable we firstly concentrated CPSwarm end user partners' contexts (ROB, TTTECH, DIGISKY) to have a complete vision on the market potential of our solutions within our own consortium. Then we extended and refined thorough the help of the whole consortium our identified value propositions to suit general real end users' needs outside the consortium.

The content of this deliverable will be continuously updated and refined through an iterative process that will lead to the production of a total of a final of this document at M35.

Table of Contents

1 Introduction

This deliverable documents the results of Task 2.2 Business Models at M18 of the project.
This document describes the identified business models that will use the identified workbench workflow, adapting it to the different environments involved in the CPSwarm project. The WP 2 T2.2 Objective is to define innovative business models and strategies in the field of CPS design with the ambition to create value for CPSwarm Project partners by creating value for the CPSwarm customers.

The **main objectives** of the activities that were performed by Task T2.2 so far are listed in the following:

- Definition of the **Value Proposition** (What core value do we deliver to the customer? Which customer needs are we satisfying?)
- Definition of the **key partners** (Who are our key partners/suppliers? What are the motivations for the partnerships?)
- Definition of **Key activities** (What key activities does our value proposition require? What activities are the most important in distribution channels, customer relationships, revenue stream…?)
- Identification of **Customer Relationship** (What relationship that the target customer expects we plan to establish? How can we integrate that into your business in terms of cost and format?)
- Delineation of **Customer Segment** (Which classes are we creating values for? Who is our most important customer?
- Definition of **Key Resource** (What key resources does our value proposition require? What resources are the most important in distribution channels, customer relationships, revenue stream, etc.?
- Identification and description of **Distribution Channel** (Through which channels will our customers want to be reached? Which channels work best? How much do they cost? How can they be integrated into our and our customers' routines?
- Delineation of **Revenue Stream** (For what value are your customers willing to pay? What and how do they recently pay? How would they prefer to pay? How much does every revenue stream contribute to the overall revenues?)
- Delineation of **Cost Structure** (What are the biggest costs in our business? Which key resources/ activities are the most expensive?)

The results of this deliverable will be continuously updated and refined through an iterative process that will lead to the production a final release of this document at M35. The development of this deliverable was coordinated by SOFTEAM with contribution of ROBOTNIK (ROB), DiGiSky (DIGISKY), TTTech (TTT), FRAUNHOFER (FIT), University of Klagenfurt (UNIKLU), ISMB, LAKE and Search-LAB (Slab).
The outcome of this deliverable will be used for deliverable D2.6: *Final Business Models*.

1.1 Related documents

ID	Title	Reference	Version	Date
D2.1	Initial Vision Scenarios and Use Case Definition	D2.1	V1.0	M4
D3.1	Initial System Architecture Analysis & Design Specification	D3.1	V1.0	M6
D2.6	Updated Lessons Learned and Updated Requirements Report	D2.6	V1.0	M14
D2.8	Validation Framework Specification	D2.8	V1.0	M18
D2.7	Final Lessons Learned and Requirements Report	D2.7	V1.0	M26
D9.5	Initial Exploitation Plan	D9.5	V1.0	M24

2 Approach and Methodology

As stated in all the WP2 previous deliverable and as depicted in Figure 1, the development cycle for the CPSwarm Workbench starts from the top left with a scenario thinking methodology accompanied by collecting other kinds of input such as related work, documents, standards or available technologies. Once some (partial) understanding of the context has been reached, requirements are derived from it. These requirements, especially in the beginning, take the form of user requirements, i.e. what the user needs from the system. When the system starts to take a concrete shape, these user needs are transformed into technical requirements, i.e. what the system must offer or how the architecture should look like.

In long-term iterations, system design, integration of technologies and knowledge as libraries take place that are then implemented in an incremental manner and later, validated. The results from the validation are then fed back into the scenarios and collection of available knowledge base. New findings, corrections and additions are then incorporated into the existing documents and requirements as well as ideas for innovations are updated. This way, the cycle starts again, affecting all technical developments, which, in the end, are validated again. This methodology allows for step-wise knowledge acquisition and development allowing for adjustments alongside conception and development.

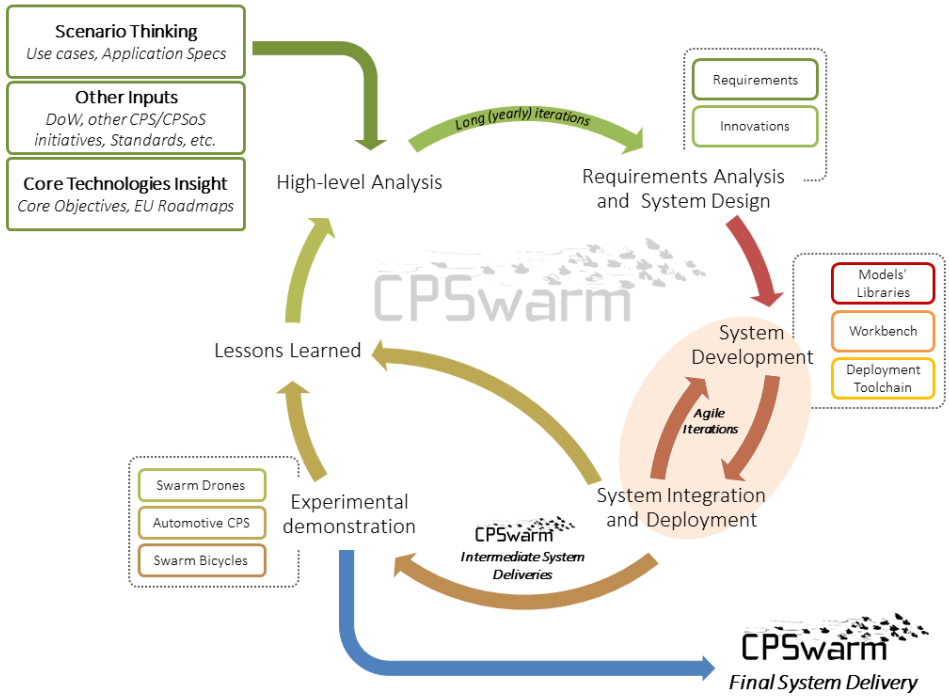

Figure 1: The CPSwarm Workbench development lifecycle.

The work reported in this deliverable is located throughout the whole development cycle and proceed with brainstorming at each of its steps. The document's structure reflects the following flow:

- **Chapter 3** Depicts the Brainstorming approach through Business Model Canvas used by the team with the first elements included in the Canvas during the first Workshop held in Bonn on 15th November 2017.

- **Chapter 4** Analysis the final elements agreed to be included in the CPSwarm of Business Model Canvas at M18 of the project.

- **Chapter 5** Concludes the document with summary tables on all the findings.

3 Brainstorming Approach

The chapter introduces the Business Model Canvas brainstorming tool we used to describe, evaluate, and ideate the initial CPSwarm business models. This chapter will give a first overview of the brainstorming discussions through the visual Canvanizer interface and more details on the various described items will be given in Chapter 4.

The first Brainstorming Workshop was one day long and was held in Bonn on 15th November 2017. This workshop was followed up by various telcos. We found the Business Model Canvas approach very helpful for brainstorming and to help the team with different background to agree and discuss together.

The following list and questions helped us brainstorm the precise idea for the next business model innovation as we analysed the following questions.

Key partners
Who are the key partners/suppliers to support our value propositions?
What are the motivations for the partnerships?
Key activities
What key activities does your value proposition require?
What activities are the most important in distribution channels, customer relationships, revenue stream, etc.?
Value Proposition
What core value do you deliver to the customer?
Which customer needs are you satisfying?
Customer Relationship
What relationship does the target customer expect you to establish?
How can you integrate that into your business in terms of cost and format?
Customer Segment
Which classes are you creating value for?
Who is your most important customer?
Key Resource
What key resources does your value proposition require?
What resources are the most important in distribution channels, customer relationships, revenue stream, etc.?
Distribution Channel
Through which channels do your customers want to be reached?
Which channels work best? How much do they cost? How can they be integrated into your and your customers' routines?
Cost Structure
What are the biggest costs in your business?
Which key resources/ activities are the most expensive?
Revenue Stream
For what value are your customers willing to pay?
What and how do they recently pay? How would they prefer to pay?
How much does every revenue stream contribute to the overall revenues?

3.1 Business Model Canvas Approach

For our brainstorming, we used the Business Model Canvas, approach described by Business Model Canvas by Alexander Osterwalder (cf. Ref [9] [10]).
We used a web site dedicated from Canvanizer to brainstorm. The dedicated web site at https://canvanizer.com/canvas/wQY5d0p2P4ZXL uses the Business Model Canvas by Alexander Osterwalder in the teams to brainstorm about the ideas. One of the various resources available on this site is the Business Model Canvas as a free poster under Creative Commons Share Alike 3.0 Unported License. Figure 2 reproduces the generic Business Model Canvas.
This chapter will give a first overview of the brainstorming discussion to the visual Canvanizer interface while more details on the various described items will be given in Chapter 4.

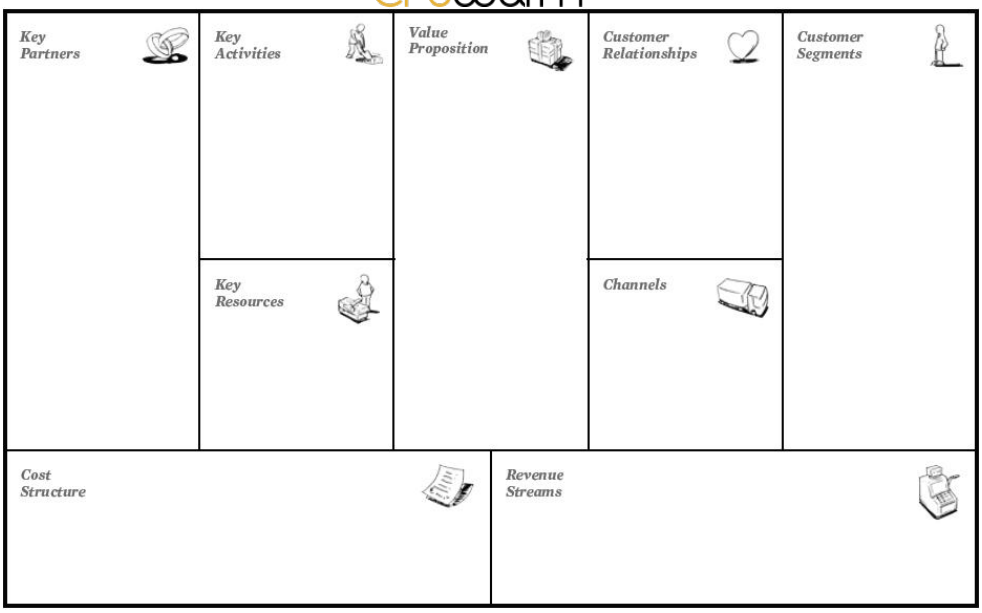

Figure 2 Generic Business Model Canvas

3.1.1 Value Proposition Shell

With the Value Proposition Shell depicted by Figure 3 we analyse the core value that we deliver to the customer and which customer needs we are satisfying.
We started this analysis from our own end user's business base and context (TTT, DGSKY, ROB). The identification of the value propositions focused on the following three main questions:

- What value will we bring to our end users' customers with the new CPSwarm solutions?
- What extra feature from our system will our end users' customers gain from the new CPSwarm solutions?
- What do our end users' customers aim to achieve with our system?

Figure 3: Business Model Canvas Value Proposition Shell

3.1.2 Key Partners Shell

Figure 4 reproduces the generic Business Model Canvas Key partners Shell (cf. Ref [11]). The "Business Model Canvas Key Partners Shell" defines the key partners/suppliers and the motivations for partnerships.

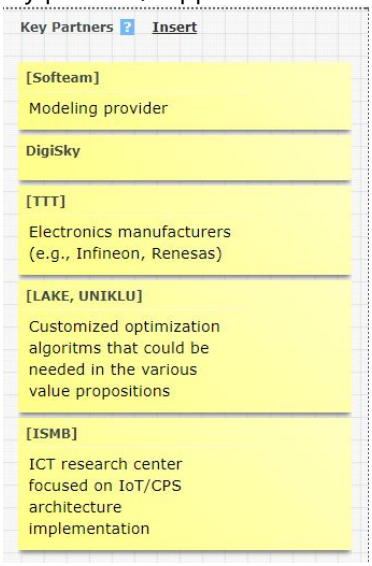

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Figure 4: Business Model Canvas Key partners Shell

3.1.3 Key Activities Shell

Figure 5 reproduces the generic Business Model Canvas Key Activities Shell. The key activities foreseen and identified by partners are highlighted in there.

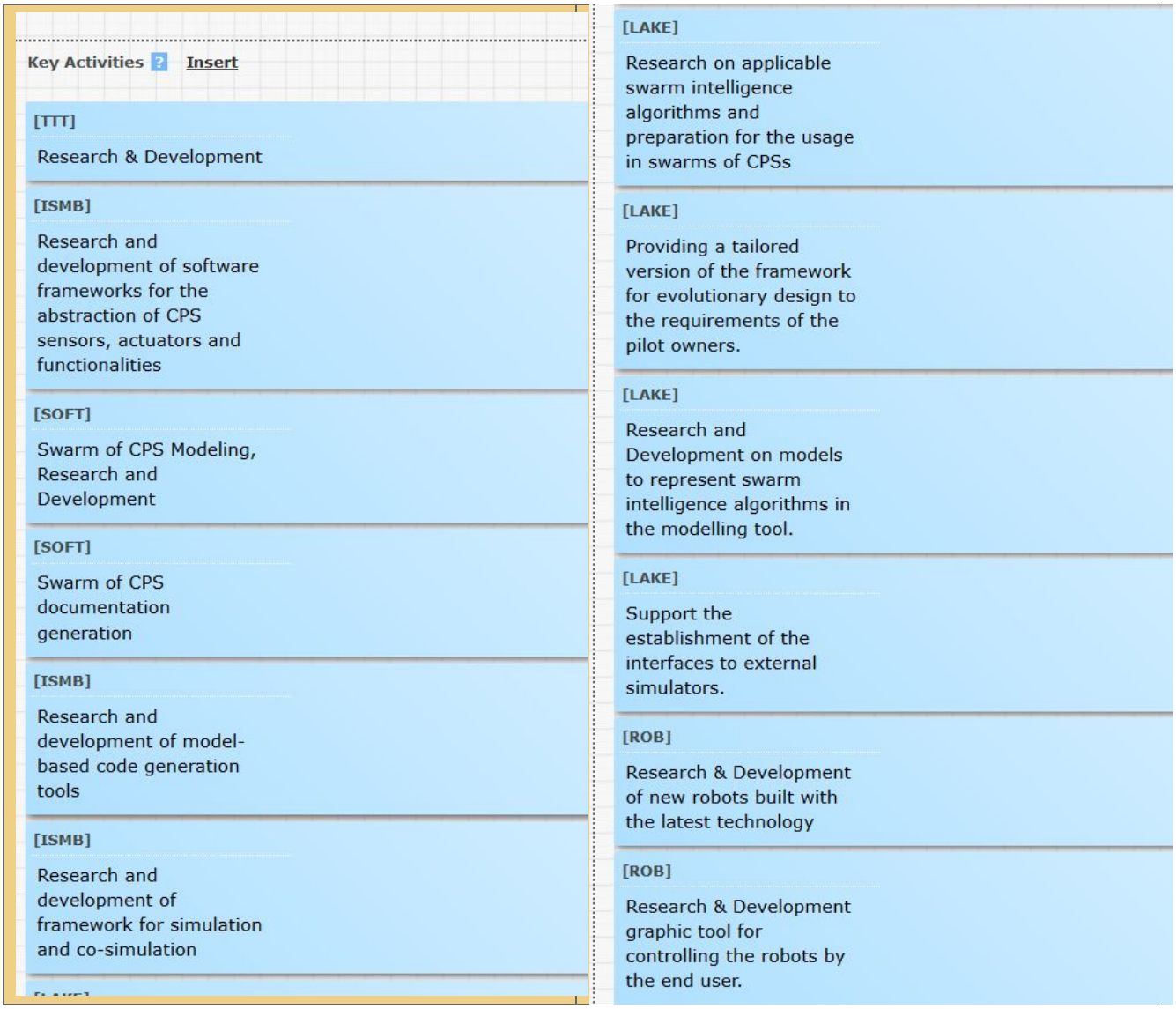

Figure 5: Business Model Canvas Key Activities Shell

3.1.4 Customer Relationship Shell

Figure 6 reproduces the Customer Relationship Shell.

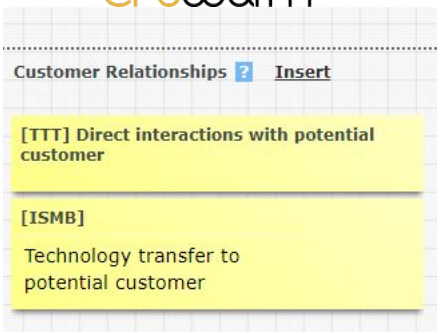

Figure 6 Customer Relationship Shell

3.1.5 Distribution Channel Shell

Within this shell we identified the distribution channel as a chain of businesses or intermediaries through which our CPSwarm value propositions will pass until it reaches the end consumer. It can include wholesalers, retailers, distributors and even the internet itself. The identified channels can be broken into direct and indirect forms, with a "direct" channel allowing the consumer to access the CPSwarm value proposition product (e.g. in place deployment, direct sales fairs) from the consortium, and an "indirect" channel allowing the consumer to buy the good from a wholesaler or retailer (e.g. Sales Distribution network).

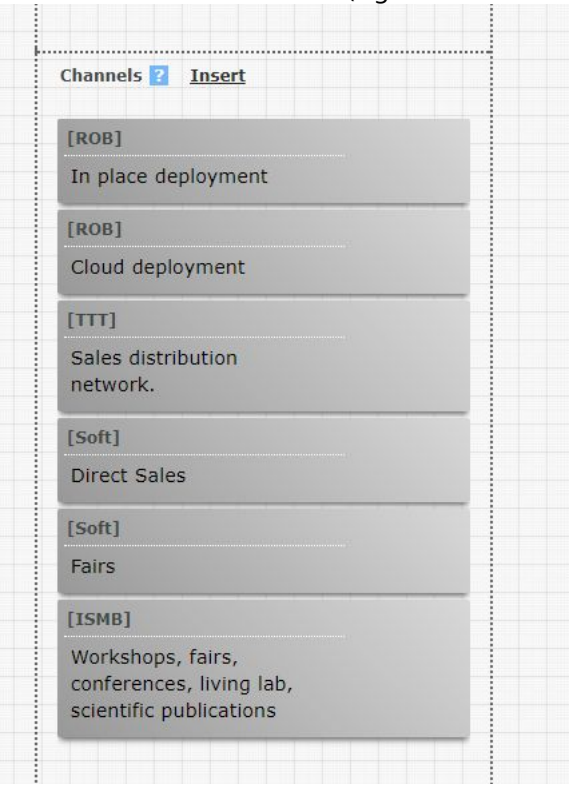

Figure 7 Distribution Channel Shell

3.1.6 Revenue Stream Shell

This paragraph includes the CPSwarm organization's identified sources to receive money selling the value propositions identified during the brainstorm.

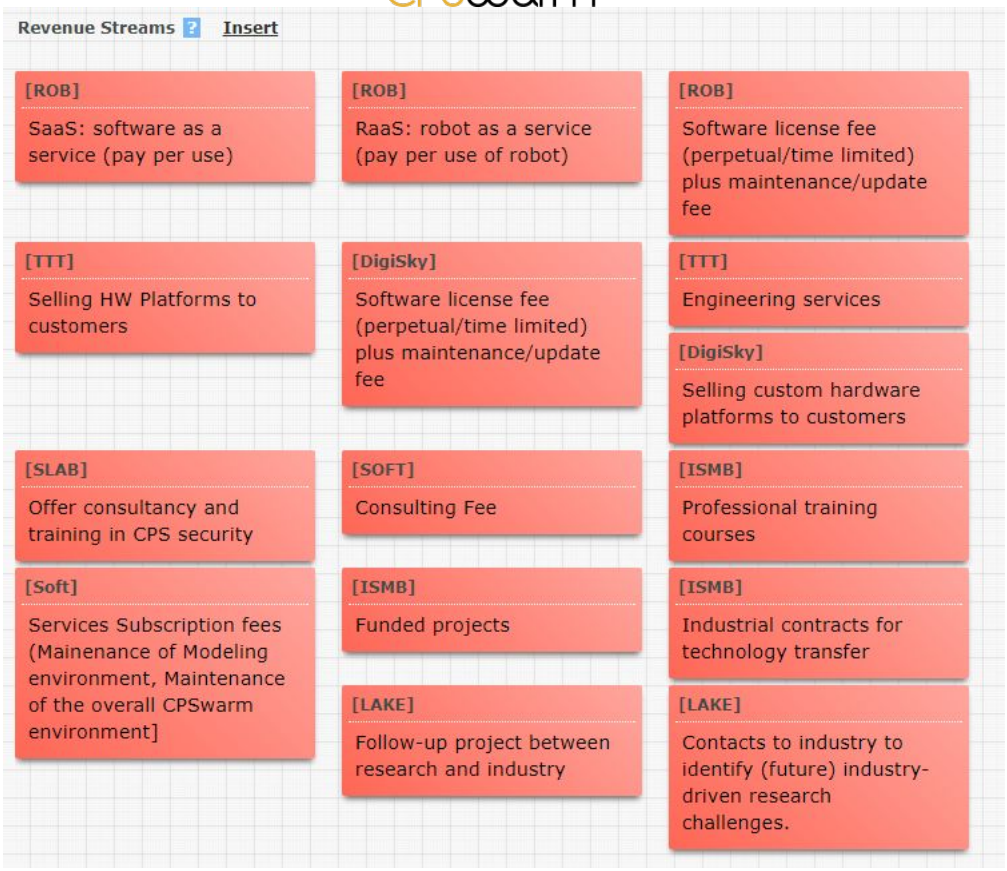

Figure 8 Revenue Stream Shell

3.1.7 Cost Structure Shell

This paragraph includes the CPSwarm organization's identified costs for the value propositions identified during the brainstorm.

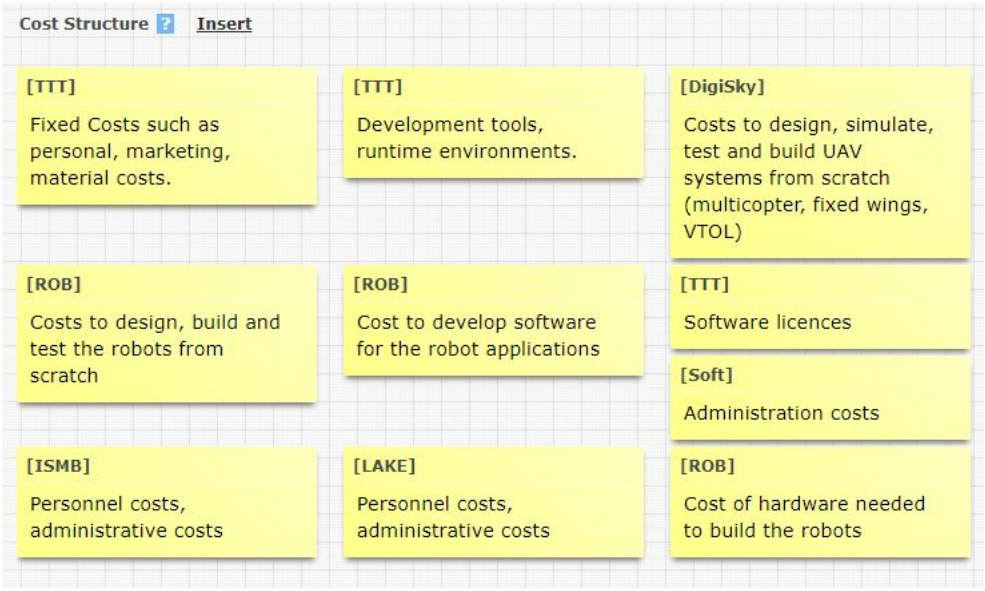

Figure 9 Cost Structure Shell

4 Analysis of Business Model Canvas elements

This chapter describes the final Business Canvas elements selected by the project partners for all the categories after the first brainstorming outlined in Chapter 3. We evolved our work and identified the following value propositions that will create value for CPSwarm consortium' customers:

- Configure the own fleet of robots [ROB]
- Offer a tool to optimize [ROB]
- Adapt the use case application to their specific warehouse [ROB]
- Remote deployment through secure channels [SLAB]
- Automotive Platforms [TTT]
- Optimize the inspection/detection times [DigiSky]
- Process knowledge for IoT / CPS solutions [FIT]
- Large-scale IoT Deployment Tool [FIT]
- Central Configuration and Control Toolchain ("FIT-C-Cube" or "FIT-C3") [FIT]
- Modelio CPSwarm Modelling Tool [SOFT]

4.1 Value Propositions

Within this first version of the Business Model Deliverable we firstly concentrated CPSwarm end-users partners' contexts (ROB, TTT, DigiSky) to have a complete vision on the market potential of our solutions within our own consortium. Then we extended and refined thorough the help of the whole consortium our identified value propositions to suit general real end users' needs outside the consortium. The following paragraphs highlight the identified ones and their innovation and uniqueness explanation.

4.1.1 Configure the own fleet of robots

This value proposition is led by ROB and it will allow us to offer customers the possibility to configure their own fleet of robots for their own purposes or their own use cases.

Trying to manage a fleet of robots is hard if each robot can only be commanded one by one. Some applications with a big number of robots need usually some centralized management of the fleet to make it easier monitoring and controlling tasks.

CPSwarm Toolchain and Architecture will be oriented to the manager and customers to make this task easier. This configuration of multiple robots is not available yet on the market.

4.1.2 Offer a tool to optimize the logistic oriented to human assistance

This value proposition is led by ROB and it will allow us to offer a tool to optimize the logistic oriented to human assistance.

Mobile robots are increasingly used in logistics scenarios. The missions of the robots in these scenarios usually consist of transporting ware staff from one place to another. The time in which the robot can complete a mission is a factor to optimize in any scenario. For this reason, offering a tool capable of optimizing the time spent on the missions of each robot would be an important key value for customers in this field.

In CPSwarm Logistic Scenario missions are defined usually robot by robot but CPSwarm can help in managing missions for multiple robots to configure missions faster. This configuration of missions for multiple robots is not available yet on the market.

4.1.3 Adapt the use case application to their specific warehouse

This value proposition is led by ROB and it will allow us to offer the customers the flexibility to adapt the use case application to their specific warehouse.

The scenarios of logistics applications of each company are usually warehouses or specific facilities that rarely have anything in common between them. For this reason, specific solutions are usually applied, directly oriented to give a solution on the concrete scenario. Offering a tool to adapt the use case of the application to any scenario would save resources both for the client and for our company.

In CPSwarm Logistic Scenario where customers have their particular and specific scenarios and environments, usually visiting the scenarios location in person and helping customers with their configuration is a must. With CPSwarm we could offer the option to the customers of a Logistic company to configure and model the scenarios and environment by themselves or remotely. This dynamic configuration of a dynamic environment for multiple robots is not available yet on the market.

4.1.4 Large-scale IoT Deployment Tool through secure channels

This value proposition is led by FIT, SLAB and DigiSky and it will allow to offer a tool for secure large-scale over-the-air (OTA) software deployment in IoT systems. The tool will optimize the inspection/detection times compared to standard UAV/rover approach.

Deploying new software versions and configurations to drones and other CPS remotely can significantly speed up deployment times - but such solutions can only be used in the real world if the channels used are secure. Offering a tool that simplifies and speeds up deployment and ensures the confidentiality and integrity of the data being transmitted can speed up response times while also mitigating risks commonly associated with remote deployment solutions. These benefits bring significant value to customers segments where on the field deployment of new configurations is common - like for Search & Rescue related applications.

Remote deployment will be done securely and in a production environment, as in the case of Search & Rescue where the need to quickly reconfigure on the field is a key factor and doing it remotely and automatically is a need.

From our state of the art analysis we can prove that the CPSwarm Secure Remote Deployment is not yet on the market. Moreover, the CPSwarm Toolchain offers the end user several safety and security solutions already configurable from the modelling phase, such as adding contingency behaviours to handle emergency situations, choosing a secure communications library and other target platform hardening guidelines. The CPSwarm Toolchain will make it possible for end users and operators to perform a safe and secure remote shutdown or remote control either on one swarm member or on the whole swarm.

4.1.5 Automotive Platforms

This value proposition is led by TTT and it will allow us to create Innovative platforms for autonomous and connected driving (and farming), supported by modelling and configuration tools for more efficient system development.

The value proposition is an **Innovative Platform for autonomous and connected freight vehicles** like trucks or vans, supported by modelling and configuration tools for more efficient system development. The platform can be used in any autonomous driving vehicle.

TTT will provide the components on a kind of electronic drawbar based on time-triggered technologies and fog computing for wireless connection among vehicles. The information will be reliable and timely predictable (deterministic **real-time**) to meet the safety requirements that the Automotive industry demands.

The **modular design** will make the embedded product development and deployment faster and more efficient for the OEMs and Tier 1 suppliers.

TTTech provides the electronic components but the final system will be built by another provider. TTTech "customers" will be OEMs and Tier 1 suppliers.
CPSwarm workbench architecture will help in the configuration of the platooning part of the work where the vehicles are following each other at a small distance with a leader and this is not yet available on the market. Large scale experiments like the European Truck Platooning (www.eutruckplatooning.com) and European projects like Companion (http://www.companion-project.eu/) have addressed the truck platooning; however, the technologies are not commercialised yet. Moreover, the CPSwarm provides the swarm intelligence unlike the "standard" platooning offered by other projects, where no intelligence is implemented, but only the platoon configuration.

4.1.6 Optimize the inspection/detection times

This value proposition is led by DigiSky and it will allow us to offer a tool to optimize the inspection/detection times compared to standard UAV/rover approach. Currently, in a standard approach in SAR (Search & Rescue) Scenario where drones are used, operators should define one mission for each UAV/rover, subdividing the entire search area into smaller zones assigned to the drone. This approach takes a long time to be defined increasing the risk of errors and omissions.

In the Search & Rescue context one of the major critical points is the efficiency with which the operations are performed. CPSwarm project's goal is to offer a complete set of tools for UAS (Unmanned Autonomous Systems) that can reduce the in-place setup, the inspection/detection cycle time for surveillance and to increase the safety of the personnel involved in the operations. The CPSwarm Search & Rescue scenario is based on a fleet of drones (multicopters) and rovers with same autopilot intelligent system, a single mission planner used to define the area of intervention, setting only the limits and the fleet composition, and self-organizing swarm algorithms. Using this approach, we can estimate to reduce setup time by more than 50% and about 30% of improvement in search efficiency.

This configuration of missions for multiple UAV is not available yet on the market.

4.1.7 Process knowledge for IoT / CPS Swarm solutions

This value proposition is led by FIT and it will allow us to provide process knowledge on how to design, model, deploy and maintain IoT/CPS systems, as well as information on optimization, monitoring, simulation of swarm of CPS.

Cross-Consultancy to other partners, knowledge gained through the CPSwarm project on how to design, deploy and maintain a swarm of CPS brings added value. The CPSwarm consortium could offer cross-consultancy on Management of Swarm of CPS concept as it is not on the market yet.

4.1.8 Central Configuration and Control Toolchain ("FIT-C-Cube" or "FIT-C^3")

This value proposition is led by FIT and will allow us to offer a tool for centrally configuring and controlling the components / third-party tools interplay / orchestration.

This solution is not available yet on the market.

4.1.9 Modelio CPSwarm Modelling Tool

This value proposition is led by Softeam. The CPSwarm workbench is a toolchain that facilitates the entire design process of swarms of CPS including modelling, design, optimization, simulation and deployment. Modelio is a modelling environment developed by Softeam under a dual license, commercial and GPLv3

open-source. Modelio is based on Eclipse Rich Platform (RCP). It is used to create and manage models in various formats and notations. In addition, it provides many software features that compliments its modelling features such as: model transformation, code-to-model reverse engineering, and code generation. The CPSwarm Modelling Tool is built on top of the open source modelling environment (supporting UML2, BPMN2, MARTE, and SysML standards among others).

Through the Modelio UML/SysML modelling tool with the CPSwarm Profile allows to create a generic swarm library that can be customized by developers to design new swarm environments, new swarm members and new swarm goals. This value proposition is led by Softeam and will allow us to offer a tool for centrally modelling Swarm of CPS. The Modelio modelling environment is flexible and configurable simply by adding the desired extension and related functionalities. In particular the CPSwarm Modelling tool is composed of Modelio itself, a dedicated CPS-warm extension to provide the functionalities related to CPS swarm design, and also a set of pre-existing extensions to reuses their relevant functionalities in the CPSwarm context as the SysML extension.

The modelling of a Swarm of CPS is not available yet on the market. [13][14].

4.2 Key Partners

4.2.1 [Softeam] Modelling provider

Softeam will be able to provide

- A set of swarm modelling elements provided in the CPSwarm library (together with description & recommendations, when to use what).
- Consultancy and training on new modelling needs and on the whole CPSwarm solution.

Softeam will be a key partner for each identified the value propositions.

4.2.2 [DigiSky] UAV manufacturers

Digisky is a manufacturer of avionics and UAV products that brings its expertise to realize custom drones (multicopter) and to implement the software stack layer for swarm algorithms coming from other partners and provides its own experience to identify the needs of the Search & Rescue scenario.
Digisky will be key partner for Digisky lead value propositions.

4.2.3 [TTT] Electronics manufacturers (e.g., Infineon, Renesas)

The hardware platform requires specific high-performance electronic devices such as sensors, microcontrollers or integrated circuits with high requirements of safety, reliability and robustness. The electronic manufactures that provide TTTech with devices that meet the demanding requirements are key partners to deliver the innovative automotive platform proposed. Some of these providers are, i.e., Infineon and Renesas.
TTT will be key partner for TTT lead value proposition.

4.2.4 [LAKE, UNIKLU] Customized optimization algorithms that could be needed in the various value propositions

Lake and UNIKLU will be able to provide:

- A set of swarm algorithms provided in the swarm algorithm library (together with description & recommendation, when to use what)
- A set of mini-behaviours provided in the mini-behaviour library, that allows the user to customize its own swarm behaviour
- A set of pre-defined problem descriptions (meet use cases) so that the user is able to optimize the solution accordingly

Lake and UNIKLU will be key partners for each identified the value proposition.

4.2.5 [SLAB] Security evaluation and research laboratory

SLAB brings its expertise in security matters to help implement secure communication channels for remote deployment, as well as to ensure the security of project components in general.

SLAB will be a key partner for each identified value proposition.

4.2.6 [ISMB][FIT] ICT research centres focused on IoT / CPS applications

Collaboration with ICT research centres focused on IoT / CPS applications and user-centred approaches for technology integration and application design.

ISMB and FIT will be key partners for each identified the value proposition.

4.3 Key Activities

4.3.1 [TTT] Research & Development

TTTech was established in 1998 as a spin-off of the Vienna University of Technology (TU Wien) based on research performed under EU projects. This extensive research and development work is the key of the success of TTTech and provides a mature basis for our core technology to build applications in safety-critical areas.
TTTech dedicates most of its personnel costs to R&D for the development of new products in the different business units: Automotive, Aerospace, Industrial, Off-Highway. TTTech offers both off-the-shelf products and customized products. Additionally, TTTech is partnering with dynamic international research institutions to bolster its technology leader position.
The components for the electronic drawbar of the automotive platform proposed under the research work of the CPSwarm project are based on research and development work carried out by expert and specialised workforce of TTTech in collaboration with the project partners.

Key activities for TTT value proposition 4.1.5.

4.3.2 [ISMB] Research and development

ISMB plans research and development on:

- Software frameworks for the abstraction of CPS sensors, actuators and functionalities.
- model-based code generation tools
- framework for simulation and co-simulation

These key activities will be performed by ISMB for every identified value proposition.

4.3.3 [SOFTEAM] Swarm of CPS Modelling, Research and Development

These key activities will be performed by SOFTEAM for every value proposition:

- State-of-the-Art research.
- Improvement and maintenance of Swarm of CPS documentation generation.
- Improvement and maintenance of the swarms of CPSs modelling library including study of potential limitations for individual CPSs.
- Cooperation with institutes where there is the need to model swarms of CPSs.

4.3.4 [LAKE] Research on applicable swarm intelligence algorithms and preparation for the usage in swarms of CPSs

These key activities will be performed by LAKE for the identified value proposition.

- State-of-the-Art research: what has been applied where?
- Processing of swarm intelligence algorithms to make them applicable for swarms of CPSs (requirements, limitations for individual CPSs).
- Cooperation with institutes that where already able to apply swarm algorithms onto swarms of CPSs.

4.3.5 [LAKE] A tailored version of the framework of evolutionary design to satisfy the requirements of the pilot owners.

This key activity will be performed by LAKE for the identified value proposition:

- The current open-source version of FREVO is reduced to the functionalities that are required by the pilot owners. This guarantees a fluent work process omitting unnecessary details.

4.3.6 [LAKE] Research and Development on models to represent swarm intelligence algorithms in the modelling tool

These key activities will be performed by LAKE for every value proposition:

- Support the establishment of the interfaces to external simulators: A set of interfaces to external simulators is offered, including Stage and Gazebo.
- On the basis of D4.1 and D4.4 modelling of swarm algorithms is enhanced.
- Multiple algorithms are implemented as models. This gives us new evidence on the usage of models for swarm algorithms.

4.3.7 [ROB] Research & Development

These key activities will be performed for ROB-led value proposition:

- Research & Development of new robots built with the latest technology: The rapid technological evolution along with our desire to be able to offer the latest technology applied to our robots, derives to the need to be continuously investigating and developing the way to apply new technologies to our robots.
- Research & Development graphic tool for controlling the robots by the end user: The command-line interface of ROS is not fully attractive for end users who are not familiar with Linux systems without graphic interface. Offering a graphic tool with which the end user can manage the ROS interface through a graphic manager would allow to the client to work with our robots without learning ROS.

4.3.8 [FIT] Development of Vision Scenarios and Requirements Engineering

These key activities will be performed FIT for every value proposition:

- Creation of vision scenarios as innovation derivation method
- Iterative and incremental domain and requirements engineering
- Development of CPSwarm workbench architecture and component interfaces, and their integration in the workbench.

4.3.9 [FIT] Deployment Toolchain and Over-the-Air Updates

FIT develops a tool for large-scale over-the-air (OTA) software deployment in IoT systems.
These key activities will be performed FIT to FIT-led value propositions:

4.4 Customer Relationships

4.4.1 [TTT] Direct interactions with potential customer

The main sales strategy of TTTech is the direct interaction with potential customers.

A key element to our success is the close cooperation with customers who are innovation leaders in their fields such as automotive, aerospace, off-highway mobile machines and industrial control. Currently Automotive unit is the biggest business of the company with relevant customers leading the sector worldwide such as Audi and Volvo. Although freight vehicles OEMs are not our key customers today, the direct interactions with other automotive customers would give TTTech access to freight vehicles customers potentially of the same holdings of our current customers.

On the other hand, TTControl is a joint-venture company of TTTech and HYDAC International. TTControl boasts a broad experience regarding commercial production projects in the domain of electronic control systems for off-highway and farming vehicles that rely on their equipment to function under the most difficult conditions. This would be another market segment of the innovative platform developed under the CPSwarm project and TTTech has already relevant customers in this sector.

4.4.2 [Consortium] Knowledge Transfer to Customers

Transfer of knowledge and concepts to the customer's domain.
The consortium plans to customize the existing approach coming out of the research carried out to specific customer needs.

4.5 Customer Segments

The following sections highlight the first customer segment targeted by CPSwarm. The identified segments are resulting from an analysis of the CPSwarm end user partners targeted customers as a first potential target markets for us to address.
The First Use Case of Reference (ROB, DigiSky or TTTech) we used for the identified customer segments is given in the header of each section. We express in each of the following paragraph why we believe the identified one are customer sectors of relevance for the CPSwarm identified value propositions.

4.5.1 [ROB] Companies interested in the automation of their warehouses.

Every day more companies are interested in automating their warehouses with the aim of minimizing time and costs of stock management. In logistics, in 2017 Amazon offered $250000 to a team that comes up with an advanced robot for its warehouse.

4.5.2 [ROB] Courier companies

Logistics operations in courier companies are indispensable to carry out the good organization of their stuff and manage the shipments optimally and quickly. The use of mobile robots for the transport of goods in interior warehouses is becoming more and more established.

4.5.3 [DigiSky] Precision farming

Agricultural drone technology has been improving in the last few years, and the benefits of drones in agriculture are becoming more apparent to farmers. Drone applications in agriculture range from mapping and surveying to crop-dusting and spraying.

Precision agriculture refers to the way that farmers manage crops to ensure efficiency of inputs such as water and fertilizer, and to maximize productivity, quality, and yield. The term also involves minimizing pests, unwanted flooding, and disease.

Drones allow farmers to constantly monitor crop and livestock conditions by air to quickly find problems that would not become apparent in ground-level spot checks. For example, a farmer might find through time-lapse drone photography that part of his or her crop that is not being properly irrigated.

Global Market Insights forecasts that the agricultural drone market size will exceed $1 billion and 200,000 units shipped by 2024. GMI attributes the growth through 2024 to increasing awareness of the pros and cons of drones in agriculture among farmers.

4.5.4 [DigiSky] Search & Rescue

What makes drones attractive to searchers and rescuers is their ability to fly in, move around and get out of disaster zones and hard-to-reach sites without jeopardising real pilots and crew, and at a fraction of the cost of using a helicopter or plane. Strapping a camera on a small quadcopter or other unmanned aerial vehicle, allows getting real-time overhead footage of a disaster area that can be used to assess the damage and to look for survivors.

Humanitarian organizations have started to use UAVs for data collection and information tasks that include real time information and situation monitoring, public information and advocacy, search and rescue, and mapping.

4.5.5 [DigiSky] Fire Fighters

Every year forest fires burn, on average, about 500.000 hectares in Europe. Each fire requires the intervention of fire-fighters, involving the deployment of aerial and ground assets which need to be coordinated in high risk operational areas. Currently, the intervention is solely coordinated by the chain of command, which may expose to high danger the firemen safety. As the fire dynamics is depending on external factors (wind vegetation, artifact), the development of mathematical models is required. The possibility to employ aerial or ground unmanned assets will ensure safer and more efficient intervention.

4.5.6 [DigiSky] Disaster analysis

Drones can be used not only to support relief activities, but also to prevent and reduce disaster risks and to strengthen community resilience. For example, over the past four years, Haiti has endured a terrible earthquake, a cholera epidemic, and Hurricane Sandy. Each disaster not only caused many casualties but also changed the landscape of the country. To get a quick and detailed idea of the country situation, the International Organization for Migration (IOM) has been using several types of UAVs, including some that produce accurate topographical and 3D maps. They have enabled IOM to register lands, assess destroyed houses, take a census of public buildings, shelters, hospitals and schools, assess damage caused by floods and droughts, monitor internally displaced persons (IDPs) and camps, enabling aid workers to know when shelters were empty and camps could be closed.

4.5.7 [TTT] Automotive OEMs

The Original Equipment Manufacturers (OEM) are companies that make a final product for the consumer marketplace. For example, Ford and General Motors are OEM companies that manufacture cars.

Automotive industry is the largest private investor in R&D in Europe. It represents 10% of the EU GDP, offers 5% of total EU employment and exports for €70 billion every year. Various studies reveal the outstanding economic impact for automated driving in the years to come amounting to €71bn in 2030 (automated driving requires high-performance computing). Demand for safety electronic control units in automotive will grow at a CAAGR of 13.5%, against an overall market average of 6.5%. When talking about freight transport OEMs, there are 59 truck assembly plants in Europe where 417,339 trucks were manufactured in the EU in 2016. The performance of road freight transport (measured in billion tonne-kilometres) grew by 14.3% between 2000 and 2014[1].

Road freight transport is the backbone of trade and commerce on the European continent. Trucks carry 71.3% of all freight transported over land.

Freight vehicle platooning holds great potential to make road transport safer, cleaner and more efficient in the future. Platooning results in a lower fuel consumption, as the trucks drive closer together at a constant

[1] Source http://www.acea.be

speed, with less braking and accelerating. Freight vehicle platooning also has the potential to reduce CO2 emissions. Likewise, connected driving can help improve safety, as braking is automatic with virtually zero reaction time compared to human braking. Finally, platooning also optimises transport by using roads more effectively, helping deliver goods faster and reducing traffic jams.

With the automotive industry's increasing focus on autonomous driving, OEMs are set to play a key role in ensuring the safety and robustness of innovative functions. The innovative automotive platform offered by TTTech will enable OEMs to drastically reduce both development efforts and the time needed to bring autonomous driving on the transport road sector. The innovative automotive platform can be used by Tier 1s and OEMs to immediately prototype their functions in embedded automotive control units.

4.5.8 [TTT] Automotive Suppliers (Tier 1)

Tier one companies are direct suppliers to OEMs. For example, Sensata Technologies is a tier one supplier of exhaust gas sensors to automotive OEMs.

In 2020, automakers are expected to produce 85.9 million vehicles equipped with collision avoidance systems, up from 10.8 million last year, according to a forecast by Gartner Research. Companies such as Bosch, Continental and Autoliv — the mega suppliers that dominate the Automotive News list of the Top 100 Global Suppliers2 — are promoting their ability to integrate the necessary array of sensors, computer chips and software.

These are the potential Tier 1 customers of the innovative automotive platform as they can apply the innovative automotive platform across families of control units which are used at different OEMs.

4.5.9 [DigiSky] Security & Police (Surveillance)

The global market for commercial applications was projected to be worth $127.3bn by 2020 - a staggering 6,000% jump in three years - by a PwC report published in May 2016. And security is set to account for $10bn worth of the market, behind only infrastructure, agriculture and transport.

Drones are already more widely used in the security industry even if it is not evident. Based on the IFSEC Global recent survey, 16% of respondents - mostly comprising security professionals, heads of security and other senior executives – claim that they have already deployed the technology. Three in five (60%) either already use drones or can foresee doing so eventually, thus it does not seem hyperbolic to describe the growth trajectory for this market as increasing rapidly.

4.5.10 [ROB] Mines search

Sometimes military teams have been interested in the acquisition of mobile robots with the purpose of performing functions of area exploration or autonomous patrolling in danger zones.

4.5.11 [FIT] Manufacturing Factories, Public Authorities

Factories, public authorities such as those involved in providing civilian safety services.

4.5.12 [ALL] Research Groups

There are many research groups at universities that are interested in acquiring state-of-the-art mobile robots on which to apply their research and perform their field tests

[2] http://www.autonews.com/assets/PDF/CA110870620.PDF

4.6 Key Resources

The following key resources/qualified employees have been identified so far by the consortium to achieve its goals, R&D Innovation Capabilities and value propositions:

- Experience on system integration, wireless sensors networks, IoT standards, service-oriented architectures
- UCD Methods, Software Architecture and Integration Expertise, and CI infrastructure
- UCD methods, software and systems architecture knowledge, software integration experience, infrastructure for CI

4.7 Channels

4.7.1 [ROB] In place deployment

In complex applications or where the client does not know the technology used by the company, the company travels to the client's location to offer a service adapted to the environment and the needs of each application.

Deployment at the customers' location.

4.7.2 [ROB] Cloud deployment

The ability to develop in the cloud allows software updates of robots without the need for displacement. The client can access the latest version of the software by accessing the internet.

Offer of Cloud Deployment, upload to the cloud for the customers that can update their robots.

4.7.3 [TTT] Sales distribution network

The sales strategy of the innovative automotive platform is based on the current sales distribution network of TTTech. The strong relationship with our customers allows us to have a wide and constantly growing distribution network.

TTTech counts with expert sales personnel with very good understanding of the commercial and automotive electronics markets and their respective trends and procurement processes.

Automotive groups like Volvo can give access to other manufacturers in same group.

4.7.4 [SOFTEAM] Direct Sales

A direct channel of distribution describes a situation in which the producer sells a product directly to a consumer without the help of intermediaries. A direct chain of distribution may involve face-to-face sales, computer sales or mail order but does not involve any form of distributor other than the original producer. Chains of distribution that involve non-affiliated retailers or wholesalers cannot be described as direct channels of distribution and are instead classified as indirect chains of distribution.
SOFTEAM plans to use direct sales channel.
Using a direct channel of distribution to connect consumers with our product, especially a Web-based channel, can have several benefits. Most importantly, web-based sales have low overhead and gives our product a potentially global reach. Since no intermediaries share the profits, most direct distribution channels tend to have higher rates of profit than indirect distribution channels. Direct distribution via the Internet is convenient for customers and available 24 hours a day. Lastly, many customers appreciate the opportunity to give profits directly to producers and artists. Softeam will use its own already ready Modeliosoft Web Space[3] to do that.

[3] https://www.modeliosoft.com/fr/

4.7.5 [SOFTEAM] Workshops, fairs, conferences, living lab, scientific publications

Softeam plans to sell through fairs selling directly to customers at events or conferences. Softeam has already experience in this sales channel by attending fairs like Embedded World every year and using channels such as workshops, demonstrations, conferences, press releases, scientific publications, and labs to reach customers and exploit future collaboration.

4.8 Cost Structure

The costs listed herewith have been considered as appearing on each of the value propositions:

- [ROB] Configure the own fleet of robots to Offer the customers the possibility to configure their own fleet of robots for their own purposes or their own use cases.
- [ROB] Offer a tool to optimize to Offer a tool to optimize the logistic oriented to human assistance
- [ROB] Adapt the use case application to their specific warehouse to Offer the customers the flexibility to adapt the use case application to their specific warehouse
- [SLAB] Remote deployment through secure channels
- [TTT] Modular Automotive Platforms

4.8.1 [TTT] Engineering services and other fixed costs such as personal, marketing, material costs.

The development of the innovative automotive platform has direct engineering costs and also implicitly related costs of R&D, marketing, sales, legal and other departments' personnel.

On the other hand, the development of the platform requires multiple material costs like plugs, cables, etc. Additionally, the components need to run with specific runtime environments and software both open and proprietary such as Windows, OMNeT++, Matlab, etc.

Costs that apply only to value proposition 4.1.5.

4.8.2 [TTT] Selling HW Platforms to customers

The electronic drawbar for the automotive platform consists of real-time, robust and reliable hardware components.
Costs that apply only to value proposition 4.1.5.

4.8.3 [DigiSky] Costs to design, simulate, test and build UAV systems from scratch (multicopter, fixed wings, VTOL)

The design, construction and programming of UAV is the major cost of the company. The swarm drones are developed with a specific design to cover the scenario's requirements. Digisky works to make improvements on them is constantly under study.

4.8.4 [ROB] Costs to design, build and test the robots from scratch

The design, construction and programming of robots represent a high percentage of the cost of the company. The design of the robots is very exclusive and customized therefore they are under continuous improvement.
Such costs apply only to value proposition 4.1.1, 4.1.2, 4.1.3.

4.8.5 [ROB] Cost to develop software for the robot applications

The software development team works to develop up-to-date, reliable and flexible software that offers the client the ability to meet all their needs.
Such costs apply only to value proposition 4.1.1, 4.1.2, 4.1.3.

4.8.6 [ROB] Cost of hardware needed to build the robots

Such costs apply only to value proposition 4.1.1, 4.1.2, 4.1.3.

4.8.7 [Consortium] Personnel, Administrative, Infrastructure

Every team member in the consortium plans to incur in some administrative costs to manage the selling channels and the employees dedicated to that.
Costs related to personnel, administration, and infrastructure (e.g., server, licensing, maintenance) for integration and documentation apply to all the value propositions.

4.9 Revenue Streams

The revenue streams listed herewith have been considered as appeared on each of the value propositions:

- [ROB] Configure the own fleet of robots. Offer the customers the possibility to configure their own fleet of robots for their own purposes or their own use cases.
- [ROB] Offer a tool to optimize the logistic oriented to human assistance
- [ROB] Adapt the use case application to their specific warehouse. Offer the customers the flexibility to adapt the use case application to their specific warehouse.
- [SLAB] Offer remote deployment through secure channels.
- [TTT] Offer solution for Automotive Platforms.
-

4.10 [ROB] SaaS: software as a service (pay per use)

Software as a service means offering the software while paying for its use, i.e., monthly payments that allow access to the updated software of the robots.

Revenue Streams that apply only to the ROB-lead value proposition (4.1.1, 4.1.2, 4.1.3).

4.11 [ROB] RaaS: robot as a service (pay per use of robot)

Robot as a service means offering a robot as a service allowing customers to use the products temporarily both for trial periods and for temporary needs that may arise.

Revenue Streams that apply only to the ROB-lead value proposition (4.1.1, 4.1.2, 4.1.3).

4.12 [ROB] Software license fee (perpetual/time limited) plus maintenance/update fee

Software license fees allow the customer to keep their software updated constantly.

Revenue Streams that apply only to the ROB-lead value proposition (4.1.1, 4.1.2, 4.1.3).

4.13 [TTT] Selling HW Platforms to customers

The direct sale of the platforms or of the modular components would be the revenue stream.

Revenue Stream that applies only to value proposition 4.1.5.

4.14 [DigiSky] Software license fee (perpetual/time limited) plus maintenance/update fee

Selling customized hardware platforms based on customer needs, with a direct sales approach. Software license fees allow the customer to keep their software updated constantly. A specific maintenance program allows customers to have a fleet always in the optimal conditions to operate in a safe and timely manner.

Revenue Stream that applies to the Digisky-lead value proposition.

4.15 [DigiSky] Selling custom hardware platforms to customers

Generating revenue selling a custom UAV platform adapted to customer needs. Also, offering a service of research assignments, direct implementation, consultancy on technology and processes from industry.

Revenue Stream that applies only to value proposition led by DigiSky.

4.16 [SLAB] Offer consultancy and training in CPS security

As a security evaluation laboratory, SLAB can take advantage of the lessons learned and solutions developed during the project to offer consultancy and training services to existing and new customers involved in CPS design, manufacturing and operation.

Revenue Streams that apply only to SLAB-lead value proposition.

4.17 [SOFTEAM] Consulting Fee and Services Subscription fees

Softeam revenue stream will come from consulting fee from customisation and training on the whole CPSwarm environment.
Also, Softeam revenue stream will come from Maintenance of Modelling environment, Maintenance of the overall CPSwarm environment.

Revenue Stream that applies to every value propositions.

4.18 [ISMB] Professional training courses

ISMB revenue stream will come from professional training courses on CPSwarm subjects.

Revenue Stream that applies to every value propositions.

4.19 [Consortium] Others

The Consortium considers also the following aspects are advantageous in terms of potential revenue streams:

- Follow-up project between research and industry and
- Contacts to industry to identify (future) industry-driven research challenges.

Also, the consortium aims to generate revenue from research assignments, direct implementation, consultancy on technology and processes from industry and future research consortia.

5 Summary and Conclusions

The main objective of this deliverable was to describe the initial version of the business models derived from the CPSwarm use cases considering the results already described in D2.1 *Initial vision scenarios and use case definition*. When elaborating this deliverable, we have primarily concentrated on our specific use case business models and customer added value and we have derived from them our CPSwarm specific's general business model.

The following tables provide a summary of the value identified for each identified customer segment and the use case that was taken as reference for this work. In Table 1 we list the key partners involved and the Distribution Channels taken into account for each one of them.

In Table 2 we summarize our value propositions and their specific revenue and cost stream as analysed in this first stage of the project. The content of this deliverable as well as of those two tables will be continuously updated and refined through an iterative process that will lead to the production of final business models deliverable at M35.

Table 1: Summary Customer Segments interest

Customer Segment ID	Description	Value Propositions of interest	First Use Case of Reference	Key Partners(s) Involved	Distribution Channels
Companies interested in the automation of their warehouses.	Every day more companies are interested in automating their warehouses with the aim of minimizing time and costs of stock management.	New research and economic	[ROB]	Merchandise warehouse companies	Webpage, phone contact, physical contact
Courier companies			[ROB]		
Precision farming	Reduction of fertilizers costs, analysis of the vegetative state	Research and economic	[DigiSky]	Universities, research centres, farms, fertilizer producers	Webpage, phone contact, physical contact
Search & Rescue	Reduction of intervention and detection times, greater safety for staff	Economic	[DigiSky]	Search & Rescue department	Webpage, phone contact, physical contact
Fire Fighters	Reduction of intervention and analysis time, greater safety for staff	Economic	[DigiSky]	Fire Fighters department	Webpage, phone contact, physical contact
Disaster analysis	Reduction of intervention and analysis time, greater safety for staff	Research and economic	[DigiSky]	Territory & Environment department	Webpage, phone contact, physical contact
Research groups	There are many research groups at universities that are interested in acquiring state-of-the-art mobile robots on which to	Economic	[ROB, ALL]	Research groups, institutes, universities and schools	Webpage, phone contact, physical contact

Customer Segment ID	Description	Value Propositions of interest	First Use Case of Reference	Key Partners(s) Involved	Distribution Channels
	apply their research and perform their field tests				
Automotive OEMs	companies that make a final product for the consumer marketplace	Economic	[TTT]	electronic devices manufacturers	Sales distribution network
Automotive Suppliers (Tier 1)	direct suppliers to OEMs	Economic	[TTT]	electronic devices manufacturers	Sales distribution network
Security & Police	Reduction of intervention and analysis time, greater safety for staff	Economic	[DigiSky]	Local Police, Ministry of The Interior	Webpage, phone contact, physical contact
Mines Search	Requests mobile robots for exploration or patrol operations for mine search	economic	[ROB]	Military agencies	Webpage, phone contact, physical contact

Table 2: Value Proposition Plan

Value Proposition [Leader]	Description	Revenue Stream items	Cost Structure items	Key Activities
Configure the own fleet of robots [ROB]	Offer the customers the possibility to configure their own fleet of robots for their own purposes or their own use cases.	SaaS: software as a service (pay per use) RaaS: robot as a service (pay per use of robot) Software license fee	Software development, research	Research & Development
Offer a tool to optimize [ROB]	Offer a tool to optimize the logistic oriented to human assistance	SaaS: software as a service (pay per use) RaaS: robot as a service (pay per use of robot) Software license fee		Research & Development
adapt the use case application to their specific warehouse [ROB]	Offer the customers the flexibility to adapt the use case application to their specific warehouse		Software development, research	Research & Development
Remote deployment through secure channels [SLAB]	Offer a tool to perform secure deployments over public channels in a secure way	N/A	Software development, research	Research & Development
Automotive Platforms [TTT]	Innovative platforms for autonomous and	Selling HW Platforms and	Fixed Costs such as personal,	Research & Development

Value Proposition [Leader]	Description	Revenue Stream items	Cost Structure items	Key Activities
	connected driving (and farming), supported by modelling and configuration tools for more efficient system development.	related engineering services to customers	marketing, material costs, tools and runtime environments	
Optimize the inspection/detection times [DigiSky]	Offer a tool to optimize the inspection/detection times compared to standard UAV/rover approach	Selling hardware platforms and related engineering services to customers	Software & hardware development, research	Research & Development
Process knowledge for IoT / CPS solutions [FIT]	Providing process knowledge on how to design, model, deploy and maintain IoT/CPS systems	Research, Implementation and Consultancy on Technology	Personnel, Administrative, Infrastructure	Development of Vision Scenarios and Requirements Engineering
Large-scale IoT Deployment Tool [FIT]	Offer a tool for large-scale over-the-air (OTA) software deployment in IoT systems			Deployment Toolchain and Over-the-Air Updates
Central Configuration and Control Toolchain ("FIT-C-Cube" or "FIT-C3") [FIT]	Offering a tool for centrally configuring and controlling the components / third-party tools interplay / orchestration			Workbench Architecture Design
Modelio CPSwarm Modelling Tool [SOFT]	Offering a tool for centrally modelling Swarm of CPRs	Research, Implementation and Consultancy on Technology	Personnel, Administrative, Infrastructure	Workbench Architecture Design

Acronyms

Acronym	Explanation
CPS	Cyber Physical System
UC	Use case
RE	Requirement Engineering
HAL	Hardware Abstraction Layer
UCD	User Centred Design
CI	Continuous Integration

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