Deliverable 4.1

Centre Handbook

DISSEMINATION LEVEL		
PU	Public	**X**
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COVER AND CONTROL PAGE OF DOCUMENT	
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[1] **R**=Report, **DEC**= Websites, patents filling, etc., **O**=Other

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Change Control

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Consortium Information

Institution / Design Centre (incl. address)	Role in CPSELabs
FORTISS GMBH (FOR) BOLTZMANNSTRASSE 3, GARCHING 85748, Germany	The main role of **FOR** is to serve as a design centre in the network of the CPS Engineering Labs with a focus on co-simulation of virtual vehicles and cloud-based flexible production systems. **FOR** is the main coordinator of the CPSELabs.
KUNGLIGA TEKNISKA HOEGSKOLAN (KTH) BRINELLVAGEN 8, STOCKHOLM 100 44, Sweden	The main role of **KTH** is to serve as a design centre in the network of the CPS Engineering Labs with an emphasis on autonomy (platforms and reference architectures) and on marketplaces for CPS platforms, in particular for engineering environments. In CPSELabs **KTH** leads WP4 and provides the Innovation Manager. **KTH** moreover contributes with its experiences in best practices dissemination and in industry/academia collaboration on demonstrators and training.
OFFICE NATIONAL D'ETUDES ET DE RECHERCHES AEROSPATIALES (ONR) Avenue de la Division Leclerc 29, CHATILLON 92322, France	The role of CPSELabs is to ease exchange of technologies developed in different research contexts, to mature and to adapt them for CPS new applications. **ONR** will play this role thanks to the following assets: **ONR** conducts multi-disciplinary researches in aeronautic, space and defence fields. In the CPS Labs, **ONR** gathers in a coherent framework research results and experimental means related to autonomous systems (developed initially for the defence) and to safety critical systems (developed initially for the aeronautic). These results will be adapted to better address CPS needs related to autonomous dependable vehicles (e.g. civil UAV or advanced driving systems for cars) and to ease their access to companies which shall enhance their artificial intelligence and dependability culture to enter new markets. Finally, **ONR** is strongly involved in collaborative researches with European and National academic and industrial partners. At the regional level, it has a privileged link with their regional partner CNRS-LAAS, to perform joint research projects during long periods. It also contributes actively to the scientific animation of the Aerospace Valley cluster. So **ONR** network will be widely used in the project to promote the CPSELabs approach and potentially to identify new contributors.
UNIVERSITY OF NEWCASTLE UPON TYNE (UNEW) KINGS GATE, NEWCASTLE UPON TYNE NE1 7RU, United Kingdom	The main role of **UNEW** is to serve as a design centre in the network of the CPS Engineering Labs with a focus. **UNEW** is also primarily responsible for maintaining and executing the communications plan of the network through WP2 and for administrative issues regarding the management of the open calls (including amendments and third party agreements).
OFFIS EV (OFF) ESCHERWEG 2, OLDENBURG 26121, Germany	The main role of **OFF** is to serve as a design centre in the network of the CPS Engineering Labs with a focus on transfer of CPS innovations from the automotive and avionic domain into the maritime domain.

INDRA SISTEMAS S.A. (IND) Avenida de Bruselas 35, ALCOBENDAS-MADRID 28108, Spain	**IND** offers its experience in previous CPS research, providing a platform of Smart Objects for Intelligent Applications. This platform will be used for the experiments proposed by the Spanish Lab regarding to the Smart City, but it will be also be used by the other labs that need a platform for smart data in a grid context. The experience of **IND** in other competencies will be also available for the Labs. Such as cloud computing, geographic information systems or architectures and platforms. **IND** will also be the coordinator of the open calls, defining and executing the process according with the UE principles and the objectives of the consortium.
STEINBEIS INNOVATION GGMBH (SEZ) WILLI BLEICHER STRASSE 19, STUTTGART 70174, Germany	Due to its experience in managing European projects, **SEZ** will take over the administrative and financial management. Furthermore, **SEZ** has invaluable experience in technology transfer and knowledge management, therefore it will strongly supporting WP2 and WP5 dealing mainly with the communication, dissemination of the project's activities and results, the exploitation of the project's results by its own networks and channels as well as networks to be established on the event management and governmental fields, as well as the IPR management and technology watch of the applications and devices to be developed. • WP1 administrative and financial project management • WP5 support project dissemination and exploitation
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS) Rue Michel-Ange 3, PARIS 75794, France	**CNRS**-LAAS has extensive expertise in Decisional and Planning issues in robotics including learning and adaptation. It will in particular be a supplier of navigation algorithms for mobile robotic platforms. It also has extensive expertise on run-time verification of autonomous systems, whether the monitoring is integrated to the control system or is an independent safety device. **CNRS**-LAAS also has a lead position on testing methods applied to a variety of embedded systems, including both conformance and robustness testing.
UNIVERSIDAD POLITECNICA DE MADRID (UPM) CALLE RAMIRO DE MAEZTU 7 EDIFICIO RECTORADO, MADRID 28040, Spain	The main role of **UPM**, in close cooperation with INDRA, is to serve as a design centre in the network of the CPS Engineering Labs with an emphasis on smart cities. **UPM** provides access to their Integrated Facility4Smart Cities facilities which are in distributed among different geographical locations (Campus Sur and Campus Montegancedo), and its background in platforms are architectures. **UPM** will also contribute with its experience in setting up collaboration between industry and academia, and in promoting the consolidation of experiments/ideas into products/start-ups.

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Executive Summary

The goal of D4.1 – the Centre Handbook – is to be operational, i.e. to directly support further work and the deliverables of WP4. The primary target audience is therefore the project partners. However, in this capacity D4.1 also provides information on the participating design centres and their work towards establishing best practices and professional training.

The handbook focuses on the core topics of WP4 and provides a baseline for further work in terms of clarifying the rationale (why), expected results (what), and how to accomplish these results (guidelines and considerations for further work). The "how to" part, consists of guidance and templates, centering on investigations and knowledge gathering processes that are necessary for further work in WP4.

The overall structure of the deliverable is therefore as follows (the chapters are ordered corresponding to the deliverables of WP4, with Section 2 and 3 corresponding to Deliverable 4.2):

- **Introduction and rationale:** Recaps the goals of WP4, provides the context and defines the scope of the deliverable.
- **Best practices for creating innovation eco-systems**: Outlines our understanding of innovation eco-systems, i.e. their key ingredients and terminology. Describes the initial capture of existing innovation practices and opportunities for innovation. Includes a plan for collaboration and further exchange of practices within CPSELabs.
- **Professional training:** Defines two planned investigations for each design centre, i.e. (1) an inventory of existing professional training, good practices and effects, and (2) an investigation of needs for professional training as perceived by relevant stakeholders.
- **Innovation management:** Defines innovation management activities, including setting innovation goals, and establishing marketplaces for selected CPS technology platforms.
- **Strategic Innovation Agenda (SIA):** Defines the approach, scope, direction and approach for the SIA deliverable.
- **Marketplaces (MP's):** Defines the concept and role of MP's as part of innovation eco-systems, and describes three planned investigations to support the development of pilot MP's and for providing inputs to the SIA. The investigations encompass, (1) CPS areas of relevance for stimulating innovation by means of MP's including an overview of existing MP's, (2) best practices of MP's, and (3) stakeholder needs and considerations for the MP pilots within CPSELabs. Includes considerations and plans for further work.
- **Future work and conclusions:** Finalizes D4.1 with a short statement on the value of this deliverable in future work within CPSELabs.

1 Introduction

The target of the CPSELabs is to increase the conversion rate and to accelerate the transfer of scientific findings, research prototypes, and development tools for the rigorous design of embedded systems and CPS into innovative products and services. In CPSELabs Work Package 4 (WP4) has the goals to accomplish effective interactions and synergies among the CPSELabs centres themselves; promote best practices in CPS engineering and provide professional training; provide appropriate innovation management for CPSELabs including establishing marketplaces for selected CPS technology platforms; develop and evolve a strategic innovation agenda; and provide technical support for experiments. The D4.1 Centre Handbook deliverable is the first deliverable of WP4.

The goal of D4.1 is to be operational, i.e. to directly support further work and the deliverables of WP4. The handbook therefore provides **plans** and **support material** for the five core tasks of WP4:

- To accomplish effective interactions and synergies among the CPSELabs centres (T4.1)
- To promote best practices in CPS engineering and provide professional training (T4.2)
- To provide appropriate innovation management for CPSELabs, including establishing marketplaces for selected CPS technology platforms (T4.3 and T4.4)
- To develop and evolve a strategic innovation agenda (T4.5)

Each of these tasks is related to deliverables as defined by Table 1.a, with one or several of Sections 2 to 6 dealing with each deliverable.

Table 1.a Initial list of deliverables

Deliverable/Milestone	Associated Task	Deliverable Owner	Due Date
D4.1 Centre Handbook	T.4.1	KTH	4
D4.2 Report on best practices and professional training	T.4.1 and T.4.2	KTH	12 (24, 36)
D4.3 Innovation management report	T.4.3	KTH	12 (24, 36)
D4.4 Strategic innovation agenda for CPS	T.4.5	FOR	8 (14)
D4.5 Marketplace report	T.4.4	KTH	36
D4.6 Design centres final report	T.4.6	KTH	36

For the contents of each of these tasks and associated deliverables the D4.1 deliverable will provide a baseline. This baseline will clarify the rationale (why), expected results (what), and how to accomplish the expected results. The “how to” part, consists of guidance and templates, focusing on investigations and knowledge gathering processes that are necessary for further work in WP4.

2 Best practices for creating innovation eco-systems

This section captures parts of several WP4 tasks:

1. To establish a learning network among the design centres to exchange best practices in creating innovation eco-systems (T4.1).
2. To carry out cross-centre opportunity scouting in which the research, industrial and business profiles of centres and their regional eco-systems are examined to identify innovation and other collaboration opportunities (T4.1).
3. To establish regional learning networks (T.4.2) (for exchange of best practices in CPS engineering).
4. To identify business opportunities and improvements in practices for CPS innovation management; including interview studies of firms having central roles in the innovation eco-systems based on cyber-physical systems in order to identify existing best practices for managing networked and open innovation in this field (T4.3).

Two things are therefore important to highlight:

- This section and Section 3 **together** describe the effort towards delivering D4.2 (Section 3 captures the related professional training efforts).
- The efforts described in this section constitute a top-down attempt to describe different eco-systems of relevance. Their output will therefore have implications also for the other parts of WP4, which are more focused and bottom-up; parts of this output will be included in several deliverables (D4.2, D4.3, D4.4 and D4.5). However, only the plan for delivering D4.2 is described in detail in this section. The plans towards the other deliverables are described in Section 4 (D4.3), 5 (D4.4) and 6 (D4.5).

To prepare for these four parts of the WP4 tasks a plan has been defined for the first year of CPSELabs. Some rudimentary guidance and templates for executing this plan have also been compiled.

2.1 The plan

The following actions will be taken during the first 12 months of CPSELabs:

Table 2.a The best practices plan

Description of Action	**Deadline**	**Resp**	**Included in Deliverable**
Finalize best practices plan.	2015.Q2	KTH	D4.1 (Month 4)
Each Design Centre identifies the innovation eco-systems they are most interested in, which are tied to the overall goals of their centre (the focus on autonomous vehicles by KTH may point to e.g. the AUTOSAR eco-system). The rationale for the choice should be made explicit (by elaborating on the relationship to the goal, pointing to a regional innovation strategy, etc.). This can be regional eco-systems, eco-systems in which the centre is already participating or eco-systems that are simply “of interest”.	2015.Q3	KTH (All)	-
Face-to-Face Meeting between Design Centres to: A) Ensure understanding of plan, guides, templates, etc.	2015.Q3	FOR/ KTH	-

B) Identify possibilities for synergies in the investigations. C) To – if necessary – elaborate on the plan, guides, etc. D) Decide the scope and size of the investigations (e.g. the number of eco-systems to be surveyed). E) To – if possible – start the investigations by collective, initial brainstorming.			
Each Design Centre uses the guides and templates to study and describe the eco-systems of interest to them. Each eco-system should be related to the following aspects: A) Best practices in creating innovation eco-systems (BPiCRES). B) Innovation and other collaboration opportunities (IaOCO). C) Existing best practices for managing networked and open innovation (EBPfMNaOI). Each Design Centre should discuss all three aspects at least once (however, eco-systems can be reused for several aspects).	2015.Q3	KTH (All)	D4.2 (Month 12)
One Design Centre interviews all other Design Centres and compiles a pre-analysis/summary of the Design Centre eco-system investigations.	2015.Q4	KTH	D4.2 (Month 12)
Face-to-Face Meeting to discuss and create plan for each: A) BPiCRES – What is of interest to exchange? What is required to facilitate the exchange? B) IaOCO – What is of interest to act on? What are the obstacles and how are these to be overcome? C) EBPfMNaOI – Who are the important stakeholders to interview further? How can these be approached? Set up plan for writing D.4.2.a	2016.Q1	FOR/ KTH	D4.2 (Month 12), D4.3 (Month 12), D4.4 (Month 14), D4.5 (Month 12)
Write the first edition of D4.2 (labelled D4.2.a)	2016.Q1	KTH (All)	D4.2 (Month 12)

D4.2.a will thus include the plans for continuing these efforts during the second year of CPSELabs.

It is the intention that these actions will facilitate the creation of an "innovation team" from the participants of WP4. This team will be the basis for the T4.1 and T4.2 learning networks.

2.2 The guidance

This subsection provides elementary guidance for the actions described in the previous subsection.

2.2.1 Eco-system definition and stakeholder elicitation

The first step to perform when describing an eco-system of interest is to identify the important stakeholders of the eco-system. Figure 1 provides examples of stakeholder types that might be valuable to consider. These are divided among three groups found within CPS eco-systems:

- The *knowledge capital* group, which provides engineering and scientific expertise.
- The *relationship capital* group, which facilitates or enforces networking.

- The *monetary capital* group, which provides monetary resources and expertise.

These are often connected through technology platforms, i.e. a "set of stable components that supports variety and evolvability in a system by constraining the linkages among the other components" (Baldwin & Woodard, 2009). However, the relationships to platforms differ between eco-systems. Depending on the type of the platform the stakeholders can for instance develop it, include it in their products or use it to keep themselves up-to-date.

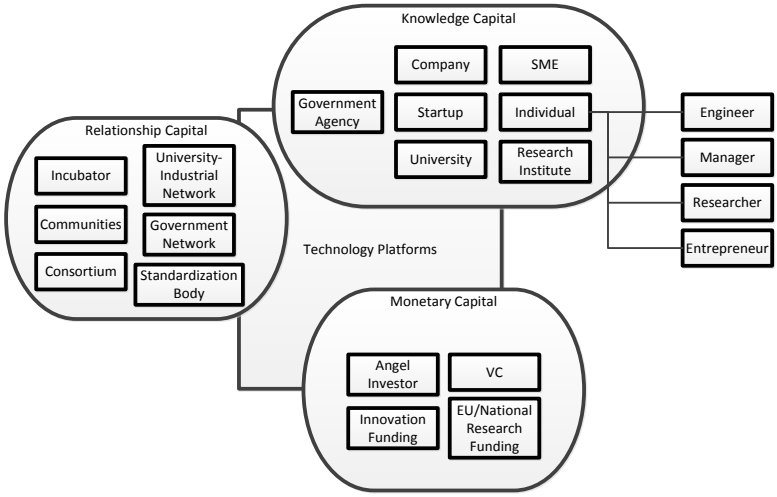

Figure 1 Stakeholder Meta-Model

Figure 2 provides an example of using these stakeholder types to examine the *International Association for Aids to Navigation and Lighthouse Authorities (IALA)* eco-system.

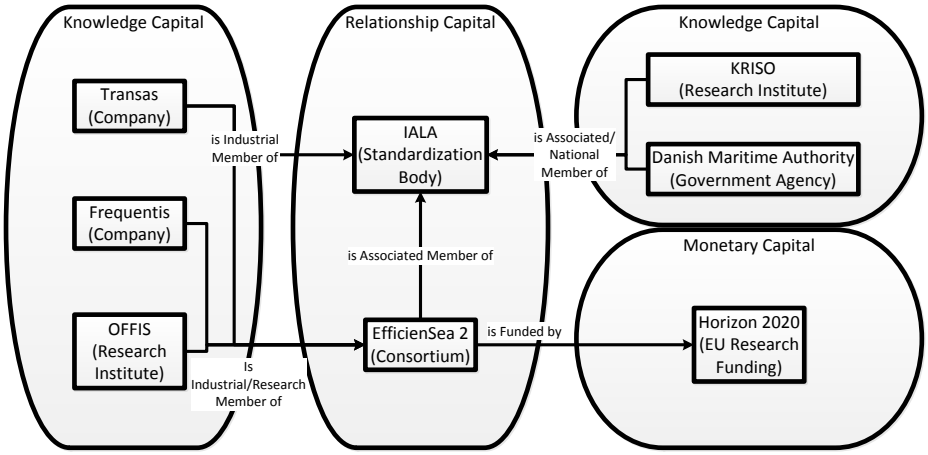

Figure 2 Stakeholder Meta-Model

2.2.2 Eco-system analysis

After the structure of an eco-system is defined, it needs to be analysed to be of use to the tasks outlined in the beginning of this section. Below a number of questions are listed for each task. These are meant to support brainstorming centred on the eco-systems, while simultaneously supporting the creation of coherent input towards reaching the task outcomes.

Task outcome	**Example questions**
Identify best practices in creating innovation eco-systems	Why was the eco-system created? Does the eco-system provide additional benefits than those originally envisioned? Have the benefits transformed over time? Who initiated the creation of the eco-system? Which were the critical factors to establishing the eco-system? How has the eco-system led to

	innovation? What parts of the eco-system can be considered related to innovation? Do the "what, who, which and how" differ for the parts of the eco-system related to innovation? Do the innovation-related parts only influence members, or does the influence extend to external parties?
Identify innovation and other collaboration opportunities	What is to be shared – knowledge, technology and/or resources? How is this to be shared? What is missing before this can be shared? Knowledge - Who holds the knowledge and what are the topics? Technology – What is the maturity and what are the conditions (limitation due to intellectual property, etc.)? Resources – How much can they be utilized and when?
Identify existing best practices for managing networked and open innovation	What are the stakeholder roles? What are the governance and decision structures in the eco-system? What are the incentives / added value for stakeholders to participate in the eco-system?

A template to be used when performing the eco-system analysis has therefore been constructed (note that a picture and description of the analysed eco-system should also be provided):

For Eco-system	Name the eco-system.
Rationale	Describe the rationale for choosing this eco-system.
Aspect Discussed	[ ] Best practices in creating innovation eco-systems. [ ] Innovation and other collaboration opportunities. [ ] Existing best practices for managing networked and open innovation.
Answers to the example question for this aspect	Answers…
Other information of value	Information…
Contact person for follow-up interview at Design Centre	John Doe, Telephone Number, Email Address

With regard to the example sketched in Figure 2 the targeted task outcome was "Identify best practices in creating innovation eco-systems", and led to the answers below (structured using the above template). These were evaluated and the text below also includes the review comments:

For Eco-system	International Association for Aids to Navigation and Lighthouse Authorities (IALA)
Rationale	Good example for these guidelines.
Aspect Discussed	[X] Best practices in creating innovation eco-systems. [ ] Innovation and other collaboration opportunities. [ ] Existing best practices for managing networked and open innovation.
Answers to the example question for this aspect	**Why was the eco-system created?** IALA was founded in 1957 to support technical coordination, information sharing, and coordination of improvements to visual aids to navigation (cf. Wikipedia). *(Comment by Reviewer: No comments. Straight-forward purpose.)*

Does the eco-system provide additional benefits than those originally envisioned?

Today IALA also develops recommendations that are de-facto standards for the maritime areas they designed for.

(Comment by Reviewer: The questions are a support to brainstorm around the stated purpose of this exercise (to establish best practices for the creation of innovation eco-systems). The answers should therefore try to be as exhaustive and explicit as possible, and continue the relevant analysis: Does this additional benefit somehow relate to the creation of innovation eco-systems, or is it just something that is mentioned for the sake of completeness? In case of the former, how and why did this change come about?)

Have the benefits transformed over time?

No.

(Comment by Reviewer: No comments. Straight-forward answer.)

Who initiated the creation of the eco-system?

Not known.

(Comment by Reviewer: With the purpose of this exercise being the creation of innovation eco-systems this information could be very important. Who created the eco-system, in what capacity was this entity working, etc.? If the answer is not known, then a large part of the relevant analysis cannot be performed. Please investigate and answer the question.)

Which were the critical factors to establishing the eco-system?

An organization was needed covering the goals of the Technical Lighthouse Conference held since 1929 (cf. Wikipedia).

(Comment by Reviewer: This is the reason the eco-system was created, not the critical factors that made sure it was founded/created/emerged: Why was technical coordination, information sharing, and coordination of improvements to visual aids to navigation seen as so crucial? Who provided the people needed for establishing the eco-system? Why these people? Who provided the money required? Why could information be shared? Was it "inevitable" that the eco-system would be created, or was there a window of opportunity or an element of chance? The answer must be more exhaustive and explicit, so that an analysis can be made.)

How has the eco-system led to innovation?

Technical innovations are discussed within in IALA committee meetings. From discussion IALA recommendations are built, so that the maritime industry needs to follow them.

(Comment by Reviewer: For which type of innovations are recommendations ultimately built? How are the recommendations enforced (standards, laws, etc.)? Do these things have implications for innovations in the maritime domain that relevant stakeholders have to take into account (do stakeholders champion their innovation in IALA somehow)?)

What parts of the eco-system can be considered related to innovation?

The IALA committees directly focus on new innovations in the maritime domain.

(Comment by Reviewer: How are the technical innovations provided to the

	committees? Is there a value to having one´s innovation discussed by IALA, or can it be negative? How are the innovations discussed, i.e. are all technical innovation of relevance or only certain ones?) **Do the "what, who, which and how" differ for the parts of the eco-system related to innovation?** Not known. *(Comment by Reviewer: With the purpose of this exercise being the creation of innovation eco-systems this information could be very important. Can certain efforts be positive for innovation, but negative for an organization in general (or vice versa)? If the answer is not known, then a large part of the relevant analysis cannot be performed. Please investigate and answer the question.)* **Do the innovation-related parts only influence members, or does the influence extend to external parties?** It influences the whole domain the recommendations are valid for (IALA members and non-members). *(Comment by Reviewer: No comments. As mentioned earlier, it would be good to know more about the limitations (legal, etc.) of this influence.)*
Other information of value	None.
Contact person for follow-up interview at Design Centre	[Name, Telephone Number, Email Address]

3 Professional training

As a Consortium, we are committed to providing the best possible and most relevant training for CPSE stakeholders that we can, within the limits of the project and the needs of external bodies. This training will act as a conduit for best practices in CPS engineering. In order to do this, we set out below:

- An inventory of relevant training currently available.
- A framework against which to assess current training, assess the needs of stakeholders as they interact with the project and help us identify gaps which will require new or even external provision.
- How we will conduct the professional training investigation.
- Some of the factors the investigation will be required to take account of and issues to provide solutions to (if we are to evolve a package integrated across all Centres and provide potential longevity outside the project funding window).

3.1 Existing Training Courses

CPSELabs Centres are generally well versed in the provision of training and education across a broad spectrum of subjects. Many can be tailored to fit the needs of the recipients. The courses and workshops listed below give a flavour of those offered by the CPSE Centres. They are also, for now, stand-alone courses.

3.1.1 Training Courses Currently Available

- 4DIAC
- Adaptable factories consultancy
- Architectural modelling in SysML
- Design space exploration
- Fortiss Future Factory
- Hazard and risk analysis
- Model-driven software development in industrial automation
- Modelling distributed industrial process, management, and control with IEC 61499
- Overture toolset
- Real time analysis
- Requirements engineering
- Safety and security analysis
- SOPHIA technology and paradigm
- SysML
- Timing and resource analysis
- VDM

3.2 Investigation into needs of stakeholders regarding training

In order to begin the process of having an integrated training offering across the consortium, the first step is to carry out a project wide investigation into the training that is or will be required by the various stakeholders. To do this, we must provide a framework against which training, or training needs can be assessed. There are therefore several key questions that must be answered. As these questions are answered with respect to both the training provision available at present, and the needs of all parties who feel their require training in one or more area of our technologies, it should become possible to map one to the other, and identify/fill any gaps which become apparent.

3.2.1 Breadth versus depth?

Are we looking to achieve breadth of coverage by pushing out only the key concepts to a wide group of people in an Organisation, or are we looking to provide a deep understanding of the technology for fewer people, most typically Engineers? This may well depend on whether we are trying to turn the Organisation in question into "early adopters" of the technology (breadth) or we are looking to really embed the it into their work processes (depth).

3.2.2 Level Required?

Undoubtedly this is linked to the discussion above. Is the provision suitable for accreditation, is there the need for this lengthy process to be carried out, or has it been done already? Does the level of provision unduly influence its take up among target groups? Would having credits on offer for formal exams, act as encouragement or deterrent for the target group?

3.2.3 Theoretical versus practical

This is related to the depth of understanding. Are we looking to impart the theory and create experts in the field who have the tools to make their own advances in the science, or are we looking to give a broader understanding and create users of the technology only? Does the training look to provide information based only on experiences in the laboratory, or is there an opportunity to show practical application via real case studies?

3.2.4 Is delivery by course of programme?

Given the material available, is it best delivered in short course format (seminar, workshop, etc.) or is there material of sufficient quantity and depth to provide a longer programme? What is achievable in terms of time commitment from targeted stakeholders? Answers here will be linked to how much information there is to impart, and how intensively that can be done.

3.2.5 Are we building or exploiting knowledge?

Is the primary purpose of the training to disseminate knowledge for its own sake, or is it designed to enable the Organisation receiving information to use it to push their commercial frontiers? If so, is it readily translated into business processes or machinery or is there a conversion cost?

3.2.6 Financial Models for training provision.

Whilst for now, it may well be perfectly possible to provide training that is free to the customer, due to the funding we receive as part of the project, it is important to look at potential financial models, if we are to begin to create a sustainable eco-system for the end of the project. It may be that we can simply ask the customer to pay, but if that level of demand is not immediately apparent, then it will be necessary to think more innovatively, possibly by creating an Interest group with membership by subscription, or by charging for artifacts such as books. Centres should identify any financial models they currently use, outside of a standard fee.

3.3 Further Work

The questions above will do no more than allow us a consistent way to assess training provision and requirements, but they will form the basis of our assessment of training needs and provision. In order to reach the point where we can provide a coherent and comprehensive investigation into training in CPSELabs, there are several steps required. This assessment can be carried out from the point of view of existing courses, or indeed when assessing the usefulness of proposed new offerings

In M8 UNEW will ask all Design Centres to carry out a broad survey of their current offerings with respect to the framework and understand where they stand on each question. In addition, each Centre will be asked to take some notice of the "state of the art" in training in their specialist area(s) to see whether there are complimentary courses available outside the Consortium. Obviously it will be impossible to survey the whole training landscape, but it is important that we are aware of whether there are readily available courses that can be tapped into readily and at what cost, both financial and non-financial. Centres will also be responsible for ensuring appropriate delivery methods are available, for example, we might wish to look at how we can interact with the new internet infrastructures such as Coursera. As a group we should look also at innovative ways of training and of funding training in order to aid sustainability after the end of the project. The proposal is that a small working group will be set up from among the WP4 list, to look at these project-wide issues. UNEW is prepared to take the lead on this working group and will ask for inputs from other interested parties. The working group will begin from M8, and will first look at the survey data.

As stakeholder groups define themselves and begin to work with the project both formally and informally, Centres will take responsibility for scoping training needs with them and for looking at them in relation to our framework. By taking these steps, our project wide training package should evolve into something that is coherent across Centres, and is relevant to the needs of those who seek to interact with us. Whilst the identification of training topics must originally come from external stakeholders, often in conversation with the various Centres, the framework supplied above can be used to assess what the course will look like, in terms of coverage and delivery. As our provision grows and is mapped against needs, we can expect to provide more concrete answers with respect to a coherent training strategy. The relevant steps are summarized below.

Table 3.a The professional training plan

Description of Action	**Deadline**	**Resp**	**Included in Deliverable**
Investigate review of Partner training courses currently available against the above framework, to provide information on suitability for stakeholders needs.	2015.Q3 (M8)	UNEW	-
Begin review of external training offerings, with all partners.	2015.Q3 (M8)	UNEW	-
Interim report on currently available training	2015.Q4 (M9)	UNEW	D4.2 (Month 12)
Set up small working group to look at innovative funding and delivery methods	2015.Q4 (M9)	UNEW	-
Identification of gaps in training – all partners in discussion with experiment partners and other CPSELabs contacts	2015.Q4 (M10)	UNEW	-
Initiate process to fill gaps in available training both by internal and external provision	2015.Q4 (M11)	UNEW	-

Prepare training investigation report detailing a comprehensive and coherent training provision	2016.Q1 (M12)	UNEW	D4.2 (Month 12)

4 Innovation management

Innovation management aims to support the CPSELabs to increase the conversion rate and accelerate the transfer of scientific findings, research prototypes, and development tools for the rigorous design of embedded systems and CPS into innovative products and services. Innovation management complements engineering research performed at CPSELabs by creating clear goals, objectives, and KPIs for innovation, as well as putting in place suitable mechanisms and systems that can facilitate and support innovation activities.

Using the definitions in the Technical Specification CEN/TS 16555-1, innovation is defined as the implementation of a new or significantly improved product (good or service), or process, new marketing method, or new organizational method in business practices, workplace organization or external relations. Innovation management systems refer to sets of interrelated or interacting elements of an organization to establish innovation policies and objectives as well as processes to achieve those objectives. Given the distributed and multi-faceted nature of many CPS innovations, as these are developed in collaborations between multiple stakeholders, particular emphasis is put on policies, objectives, and processes that facilitate and support innovation eco-systems.

In order to direct and guide CPSELabs activities in their striving to generate innovations, a list of KPIs have been developed, clarifying the demand-side and priorities of their innovation activities. Innovation-related performance objectives, KPI definitions and underlying rationale of the KPIs, as well as their inter-relationships are presented below.

4.1 Performance Objectives

1. Reduction of development time for CPS by 30% as compared to the state-of-the-art in 2013 and significant reduction in maintenance costs.
   KPI-C, KPI-D, KPI-G, and KPI-I
2. Stronger pan-European collaboration across value chains and technology levels from the components and hardware to higher systems level creating open innovation eco-systems and stimulating consensus building on open tools, platforms and standards.
   KPI-H, KPI-K, KPI-M, KPI-P, and KPI-Q
3. Development in Europe of a competitive offer for next generation core ICT platforms spanning from operating systems and middleware to application development and deployment tools with built-in security. This should translate into a significant increase of Europe's market share in this area and in higher added value generated from embedded ICT.
   KPI-E, KPI-F, KPI-J, KPI-N, and KPI-O
4. Uplifting Europe's innovation capacity and competitiveness across all economic sectors with the wider adoption of networked embedded ICT, notably in SMEs.
   KPI-A, KPI-B, KPI-L, KPI-R, KPI-S, and KPI-T

4.2 Key Performance Indicators (KPIs) to assess impact

ID	Measure to maximize impact	Target	Rationale
A	# organizations involved in the regional learning networks	> 100	Increase overall learning and impact.
B	# SMEs and mid-caps participating as third party experiment partners through	20	Promote inclusion of active SME partners.

	cascading funding		
C	# companies contributing to experiments or using results	> 40	Increased knowledge utilization and impact.
D	# user-supplier experiments conducted by the consortia	18-20	Increase overall potential for generating new products services and solutions.
E	# unique assets contributed to marketplace	> 20	Increase economic and societal value.
F	# validated business opportunities developed through experiments	10	Increase economic and societal value.
G	# ratio of experiments successfully meeting the proposed innovation targets	> 80%, 0% complete failure	Efficient use of provided funding.
H	# technology platforms from large-scale projects in experiments	5-7	Enable future innovation eco-systems.
I	# high-quality proposals received and evaluated in open call process	50	Visibility of calls and quality of received proposals.
J	# assets in marketplace	20	Quality and impact of marketplace(s)
K	# stakeholders in database	500	Effective communication and utilization of results.
L	# evaluation and exploitation of large-scale EU and national projects for transferable CPS technology	30	Increase quality of CPSELabs deliverables through wide scouting in preparation for strategic innovation agenda.
M	# contributions to standardization	5	Enable future innovation eco-systems.
N	# creation of new as well as improved products and services	8	Economic and societal value.
O	# incubation of business ideas as well as creation of start-up and spin-off companies	5	Economic and societal value, and job creation.
P	# scientific or market-oriented publications	Mean 1 per experiment	Visibility, quality and diffusion of results.
Q	# visits on the CPSELabs website	15000 over a period of 6 months	Visibility and diffusion of results.

R	# performed CPSE training sessions (Perf Obj 1)	1 per design centre	Knowledge diffusion and competence development.
S	Mean # individuals participating in CPSE training sessions (Perf Obj 1)	5	Knowledge diffusion and competence development. Training efficiency.
T	Technology acceptance model	Perceived usefulness of developed technology, in terms of quality, relevance, and demonstrability. Perceived ease-of-use of developed technology.	Visibility, quality and diffusion of results

In order to be meaningful, several of the measurements above need to be related to a baseline measurement capturing the state-of-the-art and performance at the outset of the project. The baseline measurement includes a supported self-assessment of each centre, complemented by interviews with key project members at each of the centres and with selected representatives of their innovation eco-system stakeholders.

KTH researchers provide guidelines and information collection needs for the self-assessment, and also perform the interviews in collaboration with researchers at the different centres. Apart from establishing a baseline for subsequent performance evaluations, the initial measurement also aims at identifying strengths and weaknesses of the investigated innovation management systems, together with innovation opportunities and potential improvements of existing innovation processes, support structures, and practices.

Insights gained from the initial baseline measurement and subsequent performance evaluation will inform the development and prioritization of innovation management mechanisms to be used in experiments and innovation marketplaces. If deemed necessary, further KPIs relating more closely to experiments may be developed during the course of the project, drawing upon established innovation management frameworks as well as proven good practices at the centres.

4.3 The plan

Table 4.a The innovation management plan

Description of Action	**Deadline**	**Resp**	**Included in Deliverable**
Collection of baseline measurement for KPIs of each centre	2015.Q3	KTH (All)	D4.3 (Month 12)
Interviews with key project members at each of the centres and with selected representatives of their innovation eco-system stakeholders. Also included to identify strengths and weaknesses of the investigated innovation management systems, together with innovation opportunities and potential improvements of existing innovation processes, support structures, and practices.	2015.Q4	KTH	D4.3 (Month 12)
Write the first edition of D4.3 (labelled D4.3.a)	2016.Q1	KTH (All)	D4.3 (Month 12)

5 Strategic Innovation Agenda

As one of the tasks within the Innovation Management, CPSELabs will develop and maintain a Strategic Innovation Agenda (SIA). The SIA will serve as an important instrument to maximize the impact of CPSELabs by providing a strategic guidance for the work to be performed by the design centres within WP4 after the first project year, and forming the basis for evolving the portfolio of experiments that has been developed during the first round of open calls.

The SIA will be based on an analysis of state-of-the art in CPS engineering with a focus on the competencies of each of the CPSELabs design centres. It will take into account perceived industrial needs and potential barriers to innovation in the engineering of trustworthy cyber-physical systems to identify corresponding innovation opportunities and to develop a roadmap of concrete actions addressing these opportunities.

The main purposes of the SIA are:

- to provide a foundation for the planning of the upcoming rounds of open calls, including the identification and prioritization of call topics;
- to guide the process of selecting experiments proposed by third parties in response to the open calls;
- to support the alignment of the plans of the individual design centres in order to identify needs and opportunities for collaboration across centres and to define corresponding cross-centre experiments.

Besides impacting the definition of the portfolio of centre experiments, the SIA will also influence further CPSELabs activities such as innovation eco-system development, e.g. by identifying potential gaps in value chains and important stakeholders relevant to achieve the innovation objectives of experiments.

There will be two iterations of the Strategic Innovation Agenda, aligned with the second and third round of open calls. The development of the first iteration will be concluded in September 2015 (project month 8), in time for the definition of the second round of open calls in month 9. It will be reported in deliverable D4.4. Before the third round of open calls, a second iteration will be produced in month 14. The initial SIA will be reviewed, and possibly updated, in order to account for the findings of experiments and innovation management activities performed so far. We envisage that the first iteration of the SIA will mainly focus on providing guidance for the definition of the open call topics, while the second iteration may include strategies and prioritization relevant to other tasks in WP4. Particularly, initial findings from marketplaces and professional training investigations (first iterations of D4.2. and D4.5) can provide relevant input. Further updates of the SIA may be produced if needed.

The planned approach to develop the SIA will rely on the collection of input from each of the design centres. To facilitate the consolidation of the various contributions from the centres a template will be produced in order to structure the input. Potential elements of such a template are:

- Description of the competencies of a design centre in CPS engineering.
- Description of the technology platforms provided by the centre.
- Analysis of industrial needs, and corresponding opportunities addressed by the platforms.
- List of concrete actions necessary to address needs and opportunities; actions may cover both innovation objectives to be addressed by potential experiments and efforts w.r.t. professional training and marketplaces.

- Analysis of potential market impact of planned developments.
- Analysis of relevant stakeholders and value chains.

The tentative timeline for the production of the first version of the SIA is found in the table below.

Table 5.a The strategic innovation agenda plan

Description of Action	**Deadline**	**Resp**	**Included in Deliverable**
Definition of, and agreement on, the template to collect structured input from each design centre	2015.Q2 (M5)	FOR	-
Each design centre provides inputs according to the template	2015.Q3 (M7)	FOR	-
Consolidation of centre inputs, potentially during a face-to-face meeting of the centre board representatives; finalization of first iteration of D4.4	2015.Q3 (M8)	FOR	D4.4 (M8)
Review of SIA; collection of additional input from centres with emphasis on: potential for cross-centre experiments, efforts in professional training and marketplaces	2016.Q1 (M13)	FOR	-
Update of SIA to produce second iteration of D4.4.	2016.Q1 (M14)	FOR	D4.4 (M14)

6 Marketplaces

This section concerns the "Marketplace" efforts as part of WP4, thus relating to the corresponding task, T4.4 (Creating marketplaces for CPS technology platforms) and its Deliverable D4.5 (D4.5 Marketplace Report). The intention with the marketplace efforts for CPSELabs, as a whole, is to support innovation eco-system building (recall Section 2) by the use of Marketplaces (MP's) in the context of the design centres and key CPS technologies. It is also the hope that the established marketplaces will contribute to the promotion of results from experiments beyond the lifetime of the project.

MP's receive attention in CPSELabs due to the nature of Cyber-Physical Systems, with vast opportunities for innovation and where the merging of previously disparate competences also provides new opportunities for collaboration and business. CPS's are evolving, and so are the technology, platforms and services that are part of CPS and their engineering environments. The marketplace effort draws upon the realization that multiple and overlapping efforts are spent on creating CPS related assets, and that collaboration, synergies, and business opportunities are within reach.

Marketplace as a term can refer to different things (see e.g. [1]). We are in particular interested in MP's that stimulate collaboration, business, and active involvement across (parts of) a defined value chain, where the marketplace is characterized by

- The provisioning of engineering assets and/or services within one or more specific areas of CPS (such as co-simulation, data integration, and middleware platforms), that facilitate integration, refinements and creation of added value services and tools.
- Commercial, non-commercial and mixed modes of operation, as well involving open as well as closed source assets. A marketplace may for example have a strong component of community building and best practice exchange.

Clearly, a marketplace can concern different technologies relevant to CPSELabs, the scope could be narrower or larger, and the amount of involved business could also be smaller or larger; note that in this sense, we do not mandate a marketplace to include business transactions. At one end of the spectrum there are open source forums which promote collaboration, but may only indirectly involve business. At the other end of the spectrum, a marketplace may primarily be related to business (compare with an App store) according to a specific business model.

The concrete goals for the Marketplace effort in T4.4 are to: (1) establish best practices applicable for CPS marketplaces, and (2) to launch at least 2 pilot marketplaces.

These goals imply that answers to the following questions are of relevance for CPSELabs in order to support the development of pilot MP's and also for providing inputs to the SIA:

- Which technological areas are of relevance for MP's?
- Which MP's already exist in areas of relevance for CPSELabs?
- What are best practices for MP's, drawing upon experiences from research and practices?
- What are considerations of specific importance for the targeted marketplace pilots?

For these purposes, three investigations – introduced in Section 6.1 – have been defined, where the first one targets the first two questions, and the following address one question each.

The remainder of this section elaborates guidance and considerations for the planned investigations (section 6.1) - forming a baseline for developing pilots and for later realizations of other marketplaces, and provides plans for further work concerning MP's (section 6.2).

6.1 Guidance and considerations for investigations

Three investigations that will be launched are described in the following (note that Section 6.2 describes the plan for implementing the investigations and who will be involved):

1. **Marketplace CPSE areas**[3]: What CPSE marketplaces are out there? What are relevant technological CPSE areas, from the perspective of CPS engineering, where creation or (further) stimulation of MP's would be worthwhile?

   This investigation should result in an overview of MP's and areas, providing a useful overview for CPSELabs, and also pinpoint areas of specific interest to support, see further section 6.1.1.

2. **Marketplace best practices**: What are best practices of existing MP's in terms of how to set-up and manage them (in particular, what are key success factors for their sustainability and impact)?

   This investigation should result in a collection of best practices in terms of characteristics, success factors, and other considerations, documented in a suitable form to support further work in CPSELabs, see further section 6.1.2.

3. **Stakeholder needs for marketplace pilots**: Relevant stakeholders will be elicited and their expectations and reasons to engage in the marketplace pilots planned within CPSELabs will be investigated; see further section 6.1.3.

   This investigation should result in an inventory of stakeholders and needs for the specific MP's targeted within CPSELabs. With this specific focus, investigation no. 3 complements investigation number 2 which can be seen as a broader and more general best practices study.

6.1.1 CPSE areas for marketplaces

CPS is a broad area. The focus here will have an emphasis on areas covered by the design centres but will consider other areas when promising areas are not covered otherwise. Our general understanding is that there is large amount of forums and various types of marketplaces out there, related to CPS – but that there is a lack of overview of such forums and marketplaces. It is also of interest for CPSELabs to develop an understanding of the potential of existing, as well as potentially new, marketplaces, feeding relevant information into the SIA.

A typical category of marketplaces are those driven by championing companies (note: a large company driving a marketplace is in the literature often referred to as a keystone company). Other typical categories include those which are open source and/or non-profit. Marketplaces are relevant for various stages of the lifecycle of CPS products and services, for example referring to CPS development, CPS platforms and CPS components. Marketplaces also typically refer to a specific technology or platform. Examples of marketplaces include ones centered on Eclipse[4] (with multiple projects and communities), Android[5] or Modelica[6].

Source for information about CPSE areas and marketplaces can be obtained through

- Interviews with the design centres of CPSELabs and other relevant stakeholders.

[3] "Marketplace areas" as a topic has a potential relation with the Strategic Innovation Agenda (SIA). A suggested approach is to divide the effort into two parts, where the marketplace effort will elicit marketplaces and provide an overview, whereas the SIA addresses strategies and prioritization.

[4] https://marketplace.eclipse.org/

[5] See e.g. https://play.google.com/store

[6] https://openmodelica.org

- Studying relevant literature including CPS roadmaps and agendas, and web search.

6.1.2 Marketplace best practices

The corresponding investigation is envisaged to study literature in the area and learning from experiences with marketplaces. Note that such experiences will come from both specific fields of interests but may also be taken from completely different fields where interesting concepts and (business) models have been developed. The guidance in the following provides hints on some interesting marketplaces and what aspects of marketplaces should be investigated.

Well known cited software ecosystems include Eclipse, Android and the Apple App store, (see example footnotes in the previous subsection and [3]), where existing practices can be studied. Research studies of success factors and frameworks for marketplaces form a relevant background. For example, in [2], critical success factors for electronic marketplaces are described, including, (i) the ability of the marketplace to attract a sufficiently large number of participants (buyers and sellers), (ii) the balancing of interests and objectives between the market actors (a marketplace could be buyer or seller biased, i.e. favouring one market actor, or neutral), (iii) technical organization of the marketplace to support the intended number of users and transactions, (iv) ability to integrate and manage catalogue content.

Guidance for gathering best practices is as follows:

- Study the literature on best practices, including requirements for establishing a marketplace, strategic implications of marketplaces, business models, management, and metrics.
- Investigate a selected set of existing marketplaces, including studying material but also in relevant cases interviewing persons involved with a marketplace.

For the latter part, for each Marketplace, it may be relevant to gather the following information:

- What is perceived as key success factors for the marketplace?
- What is the mission and focus of the marketplace?
    - What is the value proposition and USPs of the marketplace offerings?
    - What is/are the underlying technical platform and standards?
    - What are the considered application/system domains?
- What is the size and dynamics of the corresponding eco-system and how does business actually take place?
- What kind of business model is adopted and what business benefits exist for the involved stakeholders?
    - Technical and marketing support?
    - Legal issues (IP, licenses, liability)?
    - Standardization and network externalities?
- What is the organizational structure and how is the marketplace managed?

6.1.3 Stakeholder needs for specific CPSELabs pilots

There is a need for CPSELabs to decide on exactly which areas that will be targeted as pilots. An initial marketplace pilot has been decided to focus on data integration in the context of CPS development, with a technical basis in OSLC (Open Services for Lifecycle Collaboration, http://open-services.net). This pilot is characteristic in that many stakeholders and domains share the problem of data and tool integration in the context of the engineering of CPS, struggling with the lack of an overall

methodology and tool-lock-in. Moreover, while a lot of software assets for data integration are being developed e.g. through European projects, there is a lack of an arena to publically share ideas, scenarios and software assets, to ensure tangible results are disseminated beyond the life-time of the project and to a broader community. In this case, the marketplace concerns engineering assets and services that facilitate integration, refinements and creation of added value services and tools.

So far two other tentative areas for marketplaces have been identified within CPSELabs, namely co-simulation and CPS middleware. These areas will be investigated as part of future work (see plan in 6.2)

The final investigation concerns expectations and reasons for stakeholders to engage in the marketplace pilots planned within CPSELabs. First relevant stakeholders need to be elicited, followed by interviews and discussions with them. Together with the best practices (investigation 2), the area overview (investigation 1), this provides a useful basis for actual marketplace piloting.

Guidance for this investigation includes considerations for selecting stakeholders and for defining questions and topics for discussions with them.

Stakeholder analysis

Given a particular marketplace focus, there will be a number of stakeholders of relevance to engage with. Examples of categories of such stakeholders include the following:

- Engineering companies, which in turn may refer to product developing companies and tier 1, tier 2, … (system/subsystem and component providers).
    - Within such organizations, engineers, managers and purchasing stakeholders may be of relevance to engage with.
    - Engineering companies may involve one or more domains depending on the given focus (e.g. co-simulation may be of relevance in multiple domains, while Autosar is more naturally focused on the automotive domain).
- End-users and operators of products and services.
- Engineering and IT tool providers, for example referring to ALM, PLM, embedded systems, and networking.
- Service providers, including consultants
- Standardization organizations

Which questions, topics and concerns to raise with the stakeholders?

A number of topics have already been mentioned previously. We here mention a couple of prompts that can be used as a checklist in developing questions, e.g. for semi-structured interviews. We note that the actual questions used may depend on, and be tailored to, the type of stakeholder that is addressed:

- In which areas, technologies, standards, do they see a potential need for a marketplace?
- Is there a need for new marketplaces or improvements of existing ones?
    - In the latter case, which marketplaces and what improvements?
- What would be useful ingredients of a marketplace and what would make you engage?
- What role they would take: contribute/consume: integrator, consultancy, product builders?
- Key success factor for a marketplace to work?
    - Benefits/obstacles/threats?

- Main obstacles commercially?
- Any issues with IP, liability, accountability, licenses?

- Financial benefits? Non-profit? Openness?
  - Relation to competitors
- Attitude towards open source and standards (open standards vs proprietary solutions)?
- Constraints (other) if any from the stakeholders' perspective?

Specific questions referring to the topic of the marketplace should be added.

6.2 The plan

In the following we describe the plan for the activities that will be conducted during the first 12 months of CPSELabs. We note that some of the activities have relations to other tasks in WP4, most notably to Best practices for creating Innovation eco-systems (section 2 of this deliverable) and the Strategic Innovation Agenda (section 5); the interrelations are described in the table.

Table 6.a Plan for marketplaces

Description of Action	**Deadline**	**Resp**	**Included in Deliverable**
Finalize marketplace investigation plan	2015.Q2	KTH	D4.1 (month 4)
Finalize partner involvement in the investigations resource allocation. While resource allocations have been decided per tasks per partner, a more detailed allocation will be defined for the 2nd and 3rd investigations (for the 1st, all partners will be participating).	2015.Q3	KTH	-
Setting up meeting schedule including planning meeting (June or after summer) for the three investigations, and physical meeting in the autumn.	2015.Q2/ Q3	KTH	-
CPS areas for marketplaces – elicitation, study, and analysis (first iteration by Q4 2014), followed later by overview publication on the web. ***Relation to other parts of WP4:*** The work will feed into the Innovation agenda and will be synchronized with the Innovation eco-systems investigations (section 2). The work includes I. Design centre interviews. II. Information and literature study. III. Analysis and decision on which marketplace efforts to be piloted within CPSELabs. Apart from data integration, tentatively co-simulation by FOR, and Sophia2 (http://sofia2.com) by IND and UPM.	2015.Q4	UNEW (with involvement of all centres)	Web + D4.5 (month 12) – we plan for informal drops of D4.5 month 12 and 24.
Marketplace best practices. ***Relation to other parts of WP4:*** The work will be synchronized with the Innovation eco-systems investigations (section 2).	2015.Q4	KTH	D4.5 (Month 12)

The work includes I. Literature study. II. Investigate a selected set of existing marketplaces, including studying material but also in relevant cases interviewing persons involved with a marketplace.			
Stakeholder needs for specific CPSELabs pilots. The work includes elicitation of stakeholders and their needs in the specific context of data integration.	2015.Q3	KTH	D4.5 (Month 12)
Plans for marketplace pilots A) Plan for first pilot B) Longer term plan for other pilot(s)	2015.Q4	KTH /FOR/ IND/ UPM	D4.5 (Month 12)
Set up plan for writing D.4.5	2015.Q3	KTH	

7 Further work and conclusions

As stated in the introduction, the goal of this deliverable is to be operational: further work is now supported through plans that detail the intended efforts of the project partners with regard to each task in WP4; the responsibility to initiate each effort in these plans is allocated to different project partners; clear deadlines have been set; and how the planned efforts will contribute to the different deliverables have been clarified. For some of the planned efforts parts of this deliverable will form the basis for the associated future deliverable.

However, how the different efforts interrelate is not yet well defined. Many of them show a clear potential for synergy, e.g. in the cases when different design centres are poised to be interviewed or prompted for information by several efforts at roughly the same time. We believe that it is important that the planned working groups and face-to-face meetings focus not only on their separate issues, but also seek to coordinate with other efforts.

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