H2020—ICT—732410

RobMoSys

Composable Models and Software for Robotics Systems

Deliverable D7.6
Sustainability Plan - M30

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Executive Summary

This document represents the second deliverable of Sustainability Plan (Deliverable D7.6) for RobMoSys, as part of work package "Exploitation" (WP7). This deliverable describes exploitation and community building activities to ensure sustainability beyond the end of the RobMoSys project.

The main topics of this document are:

1. Focused and specific strategy for sustainability.
2. Community building and RobMoSys hosting organizations.

This document extends the scope of Deliverable D7.3 (Sustainability Plan – month M12) by adding the **feedback from Tier-1 experts** coming from the community management world and by taking into account the **return of experience** of the last 18 months from RobMoSys Integrated Technical Projects (ITPs) and community building activities.

Content

1 Introduction

RobMoSys is about managing the interfaces between different roles (robotics expert, domain expert, component supplier, system builder, installation, deployment and operation) and separating concerns in an efficient and systematic way by making the step change to a set of fully model-driven methods and tools for composition-oriented engineering of robotics systems.

RobMoSys's vision is that of an agile, multi-domain, model-driven European robotics software ecosystem. It will consist of specialised set of players with both vertical and horizontal integration levels, providing both widely applicable software products and software-related services. This ecosystem will be able to rapidly address new functions and domains at a fraction of today's development costs.

The creation of a **sustainable ecosystem** is a major objective of the project, but obviously, this is not something that can be done in a guaranteed or strictly controlled way. However, the more clever, more open and more reactive the strategy is, the better this goal is to reach. Anyway, the project partners though will very actively stimulate active involvement of, and controversial discussions with, a selected variety of different stakeholder groups outside of the consortium of the project representing both technology-pull (application domains) as well as technology push (technical capabilities).

Sustainability is directly related to the business opportunities (see Deliverable D7.5 for full details) to produce RobMoSys artefacts (models, software components and tools). The effects of the commoditization strategy pursued in RobMoSys must be carefully analysed during the project-lifetime. Typically, commoditized software is a software nobody pays for (or is not aware to pay for, as in the case of operating systems). The sustainability of commoditized software directly relies then on open-source communities, and in more structured way through industrial foundations/group of interests. Sustainability through the creation of a foundation or group of interest in existing foundations is being investigated during the project life-time with the final objective of keep sustaining the community.

This document addresses sustainability issues of the RobMoSys ecosystem, particularly focused on an open source and open assets strategy. The proposed sustainability strategy and framework will be incrementally specified and continuously aligned to the exploitation and business strategies. This deliverable represents the second iteration of **Sustainability Plan – Month m30 (Deliverable D7.6)**, as part of work package **"Exploitation" (WP7)**. It aims at organising and planning the RobMoSys related activities to ensure sustainability beyond the end of the project.

1.1 Scope: What's New?

This first version of the Sustainability Plan (Deliverable D7.3) focused on establishing the basics and on specifying a **framework for community management and provision of activities** for ensuring a strong sustainability of the RobMoSys results.

The current document (Deliverable D7.6) extends the scope by adding the **feedback from Tier-1 experts** coming from the community management world and by taking into account the **return of experience** of the last 18 months from RobMoSys Integrated Technical Projects (ITPs) and community building activities.

The following aspects are new in this document (regarding Deliverable D7.3):

- Section 2.2 provides a description of the benefits and governance aspects of the Eclipse Foundation and Working Group, since it is proposed as a one pillar for the tooling platform maintenance and governance.

- Section 3.4 describes the stakeholders targeted for the community building strategy.
- Section 4.1 describes the actions planned for community building.
- Section 4.2 provides a set of messages for community building outreach.
- Section 4.3 describes the proposal for community hosting organizations and our progress into this direction.

1.2 Document Structure

The remaining of this document is organised as follows:

- Section 2 provides a background sustainability concepts, as well as on other community management aspects.
- Section 3 presents our strategy for sustainability focused on the RobMoSys open source community, including a strategy for a sustainable business, quality management, maturity and long-term longevity of RobMoSys tools and assets.
- Section 4 addresses a plan of action for community building and the governance of the RobMoSys community.
- Section 5 summarises next steps and conclusions.

2 Background

2.1 Basics of Sustainability

Sustainability is the ability to develop and implement technologies/methodologies, which are self-sustaining without jeopardising the potential for future generation to meet their needs [Commission 1987]. An open source approach is good for sustainability of a project as it is an enabler to attract a larger community of developers and adopters, as well as a guarantee that if the existing developers of a project decide to leave, the code will still be available for the community to take over the project.

Governance relates to consistent management, cohesive policies, guidance, processes and decision-rights for a given area of responsibility. The management or governance of an open source community is directly related to the type of this community and what kind of product or result it offers to users. It is therefore a critical aspect to be taken into account when creating an open source community. How the community is managed and the type of licence hold is the key aspect when talking about open source communities.

An **Open Source community** is the keystone for the sustainability of a project. If the project development team is not able to attract and convince people that the code is worth spending time and resources on testing it, providing feedback, providing patches, and contributing in general, then a large part of the intrinsic value of Open Source is lost.

In other words, without **Maturity, Quality, Cost of Acquisition and Contro**l, the sustainability of the code is nearly impossible. And vice-versa, a community of adopters, testers, users, extenders of a technology is a great indicator demonstrating the Maturity, the Quality and the Control of the code.

Metrics: A good way to know if an Open Source project is sustainable and viable, is to check the activity of its community: number of committers, number of commits, regularity of the releases, and the quality and quantity of assets built around the project are a great indicator. In other words, the community is an excellent evaluation metric for a project.

Open source platforms as collaboration catalysts for industry: Publishing software assets in open repositories (e.g. GitHub, Gitlab or BitBucket) is not sufficient to ensure sustainability. We need full open source platforms (including governance and vendor-neutral collaboration infrastructure) to combine the best practices of open source development with a set of services required for open innovation, enabling organizations to foster industry collaborations. Then, it is possible to design added-value products or services to do business on top of the platform. Such platforms can help improve the supply chain of software development tools in a particular industry, create a new technology platform that increases interoperability among organizations and technologies, as well as allow organizations to increase their use of open source technology.

2.2 Eclipse Foundation Model for Community Governance

From the early stages of RobMoSys, a strong candidate for the open-source community, and in particular for hosting the tool and software assets, has been the Eclipse ecosystem.

When doing open source and trying to be sustainable at the same time is when open source foundations, like the Eclipse Foundation, come in to enable vendor-neutral open collaboration. These provide a safe space where companies can share code while collaborating with competitors to develop together common platforms. Then, it is possible to design added-value products or services to do business on top of the platform.

The Eclipse Foundation offers an open, vendor-neutral collaboration platform, following the three open source best practices: transparency, openness and meritocracy. All of this is achieved through main four services:

1. *IP Management and Licensing*, focused on enabling the use of open source technology in commercial software products and services, made possible by the fact that all Eclipse projects are licensed under the Eclipse Public License (EPL), a commercial friendly OSI approved license.
2. *Community and Ecosystem Development*, including marketing and promotion of Eclipse projects to the wider healthy and vibrant Eclipse ecosystem, extended beyond the Eclipse open source community.
3. *Governance & Development Process*, ensuring no single entity is able to control the strategy, policies or operations of the Eclipse community and assisting new project start-up while ensuring they are run in an open, transparent and meritocratic manner.
4. *IT Infrastructure*. including Git code repositories and code review tools, bug trackers, continuous integration build farms, development-oriented mailing lists and forums, download site and website.

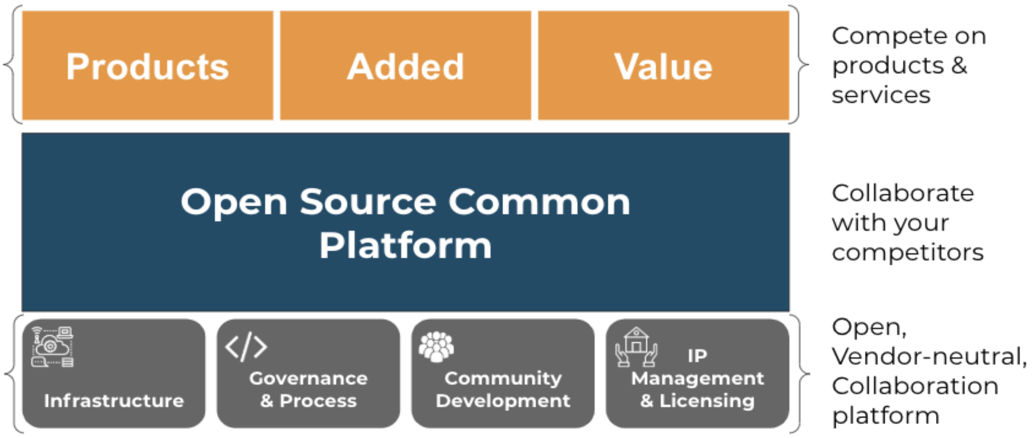

Figure 1: Collaborate on platforms / Compete on Products

2.2.1 Eclipse Working Groups

Eclipse Working Groups provide a vendor-neutral governance structure that allows organizations to freely collaborate on new technology development. Based on the experience within the Eclipse community, collaboration among organizations can:

- help improve the supply chain of software development tools in a particular industry
- create a new technology platform that increases interoperability among organizations and technologies
- allow organizations to increase their use of open source technology.

Eclipse Working Groups make it easy to reuse the Eclipse services provided by the Eclipse Foundation rather than creating them from scratch.

2.2.2 The Eclipse Specification Pprocess

The Eclipse Foundation Specification Process (EFSP) provides a framework and governance model for developers engaged in the process of developing specifications. The EFSP defines a specification as a "collection of Application Programming Interface (API) definitions, descriptions of semantic behaviour, data formats, protocols, and/or other referenced specifications, along with its TCK, intended to enable the development and testing of independent Compatible

Implementations." A specification project is, then, an Eclipse open source project concerned with the creation and maintenance of one or more specifications.

With the Eclipse Foundation Specification Process (EFSP) a single open source specification project has a dedicated project team of committers to create and maintain one or more specifications. The cycle of creation and maintenance extends across multiple versions of the specification, and so while individual members may come and go, the team remains and it is responsible for every version of that specification that is created.

The EFSP leverages and augments the Eclipse Development Process (EDP). The EDP defines important concepts, including the Open Source Rules of Engagement, the organizational framework for open source projects and teams, releases, reviews, and more.

2.2.3 Successful Collaboration around Open Source

Since 2013, the Eclipse Foundation has continuously increased its collaboration with academics, researchers, and industries at EU level by participating in several European projects. The Foundation's main objective in these projects is to help the project consortiums build an open source platform and community around their respective project results, but as positive side effect the Eclipse Foundation's recognition as an expert in building open source communities at European level has consolidated over this period. Also, this has given the Foundation the opportunity to bring new academic and industrial members increasing the EU presence in it.

For these reasons, we believe that the Eclipse Foundation is the right place to host a working group focused on Industrial Robotics, that could become the reference in Europe. Leveraging the well-established Eclipse specification process to create open standards and the business friendly license EPL v2.0 (Eclipse Public License), this working group could play a key role in the growth of the EU Digital Industrial Platform for Robotics.

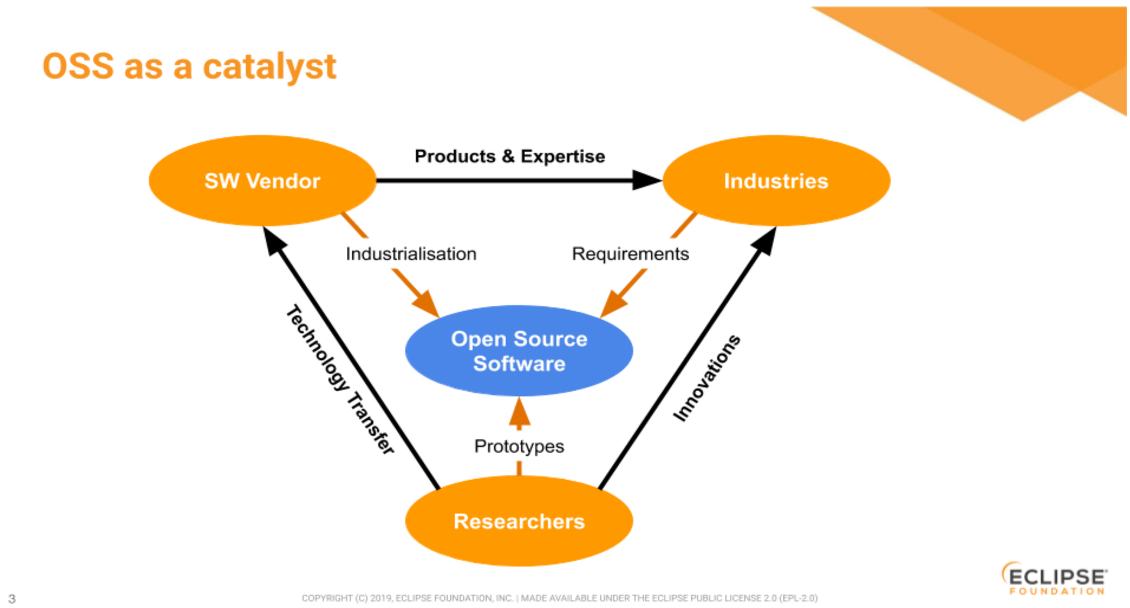

Figure 2: Open Source as a Catalyst for Successful R&D Collaboration

2.3 Existing Robotic Software Platform Communities

The software industry is constantly evolving and is undergoing rapid changes. This is not only because of the evolution of technologies, but also because these technologies drive a fundamental shift in how suppliers and buyers are interrelated. It is the transition from traditional supply chains to a software ecosystem. It is not a simple linear chain anymore, but a complex network of multilateral relationships. A software ecosystem brings co-innovation as a result of different businesses interacting within a shared market for software and services, together with relationships among them. These relationships are frequently underpinned by a common technological platform and operate through the exchange of information, resources and artefacts.

Well-known examples of communities that are seen as software ecosystems are the Apple iPhone with its app store and development tools, the Google Android world, the Eclipse IDEs and, of course, the Web 2.0 technologies which turned the Internet into a platform.

The transition to a software ecosystem also comes with a shift from integration-centric approaches to a composition-oriented approach. In an integration-centric approach, the focus of an organization has been on control of the integration process. Due to the high complexity of nowadays systems, this consequently leads to unacceptable coordination costs - not to speak of the challenges of cross-department or cross-company coordination. In contrast, the composition-oriented approach does away with most of the central mechanisms and relies on a number of principles such as e.g. (i) customers compose their products by selecting from the available functionality and (ii) components satisfy the independent deployment principles.

Most popular robotic communities include ROS, OROCOS and a domain-specific community for neuro robotics is HBP, which are discussed here.

ROS

ROS (Robot Operating System) is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behaviour across a wide variety of robotic platforms. ROS gained tremendous acceptance within the robotics community over the past years, and it has been the first time in robotics software that so many adopted a particular framework.

ROS provides hardware abstraction and device drivers, services such as message-passing between processes (nodes) and tools such as package management and data visualizers. It comes with libraries that implement commonly-used functionality in sensing, planning and control. ROS does not provide anything comparable to an IDE which could support the design, implementation and integration of ROS nodes. Instead, any preferred general purpose IDE (e.g. QtCreator) can be used. Design and implementation agreements are solely the responsibility of the user and are not tool-supported. Some user-driven initiatives tried to address this, e.g. RIDE and rxDeveloper. RIDE aims to "make the creation of ROS controllers from reusable components as easy as possible". Yet, the only provided functionality is to launch and to connect ROS nodes. Similar, rxDeveloper provides a GUI for modifying launch-file parameters of running ROS nodes. This helps in executing the nodes, but neither in their design nor implementation.

ROS is an example for *freedom of choice*. What the ROS founders mean by "we do not wrap your main" is that, among others, they do not want to enforce any architectural design decisions for developers using ROS. In consequence, each developer uses his own personally preferred architecture which is then very likely in conflict with those defined by others. This can lead to confusion as everyone first needs to understand the architectural decisions of each individual component before being able to reuse them in an own system. A proposed solution is just to extensively document each ROS component on the ROS portal. However, this does not circumvent the need to extensively analyse and understand the source code in order to adjust it or to implement workarounds in order to somehow make components compatible and reusable.

ROS, in line with its overall design philosophy, does not yet give enough structure in an appropriate format in order to better support separation of roles and separation of concerns. The minimally required structures are a sound software component model which has to be formalized for use in model-driven tools in order to support separation of concerns (e.g. to maintain semantics independently of the OS/middleware mapping), to assist the different roles in conforming to structures like component life-cycles and to reduce exposed complexity by systematic and computer-assisted management of variation points.

OROCOS

Orocos-RTT is specifically oriented towards programming and executing component-based applications on top of Real-Time Operating Systems (RTOS) and relies on lock-free communication to guarantee a deterministic execution time for all in-process inter-component data exchange. OROCOS offers a collection of commonly used components in robotic applications through a library called OCL (Orocos Component Library). For instance, we can find dedicated components to devices, hardware platforms, motion control and deployment. OROCOS allows also the integration of user-defined types through what is called typekits to ensure data transfer between processes or over a network connection. In OROCOS, there is no guidance about the control architecture to choose. The user is responsible to make his own right choices. Like ROS, OROCOS has no dedicated IDE but many initiatives like BRIDE4, RobotML5 and oroGen6 provide code generators from their models to OROCOS. They allow automatic code generation of component structures, their properties and the communication between them while having a graphical visualization about the system architecture.

Neuro Robotics Platform (HBP)

HBP is developing a novel strategy for advancing multi-level understanding of the brain, by studying brain models in the context of realistic sensory inputs and producing realistic (motor) output that can be compared to experimental data. This is achieved by connecting the brain models to realistic virtual (or physical) bodies that are immersed in realistic dynamic environments.

In brain modelling to date, there are two complementary approaches. The first develops top-down or hypothesis driven models that focus on the functional properties of nervous systems. They define control architectures and neural network models, possibly trained by deep learning algorithms, with the aim of solving a particular set of tasks. Examples are the Spaun model (*Eliasmith et al 2012*) and control architectures commonly found in cognitive robotics. The second approach is pioneered by the HBP and consists of digitally reconstructing and simulating neural circuits or even entire brains of mice, rats and ultimately humans, based on experimental data. These bottom-up digital reconstructions focus foremost on the structural and dynamical details of the reconstructed system and regard brain function as an emergent phenomenon.

While many researchers argue in favour of one or the other position, SP10 proposes that the most productive route is to combine the two approaches: For example, many theories exist for higher-level brain functions like visual perception, but not all of these theories can be true at the same time. Some may be appropriate for humans, whereas others may be applicable to cats or rodents. The only way to separate suitable theories from less suitable ones is to give researchers a tool that allows them to confront a given theory of brain function with the anatomical and physiological realities of a particular brain embedded in a concrete body, be it mouse, cat, or human. The Neurorobotics Platform (NRP) aims to be such a tool, following the time-tested approach of analysis by synthesis.

The NRP is a powerful integration of models, simulation tools, visualisation environments and hardware-/software-in-the-loop facilities that allows neuroscientists and roboticists to connect brain models of different complexity to biological or technical robot bodies, real or virtual, that operate in complex virtual dynamic environments. The NRP is the only platform worldwide, which aims at building, operating and monitoring virtual robots of arbitrary complexity and making these models easily accessible both to neuroscientists and roboticists. It will also enable them to find “common ground” over using those robots together in simulated (or partly or fully real) environments, i.e., a basis for the exchange of ideas and concepts. To this date, such common ground hardly exists.

Since the start of the HBP in 2013, a number of commercial and open competitors have emerged. This confirms the validity and the importance of our approach. OpenAI Gym is an online platform to train top-down models in (very simple) virtual environments. A start-up in Barcelona developed a platform similar to the NRP with regard to our robot programming features, called *ROS Development Studio* (http://www.theconstructsim.com/rds-ros-development-studio/) to teach ROS. NVIDIA is offering a commercial robot simulation platform, called Isaac (https://www.nvidia.com/en-us/deep-learning-ai/industries/robotics/), which is heavily slanted towards Deep Learning. Another project that shares NRP’s vision to connect brain (or AI) models to agents in dynamic environments was also launched by Google Deep Mind (https://deepmind.com/blog/deepmind-and-blizzard-open-starcraft-ii-ai-research-environment/). However, it uses computer games rather than realistic robot and environment models.

In its scope and ambition, the HBP Neurorobotics Platform is still ahead of its competitors in scope and ambition. No other platform offers such a unique combination of realistic physics based robot simulations and multi-scale neural network modelling. Only the NRP is collaborative, open access and open source. The integration of the NRP into the HBP Collaboratory gives all users access to an unprecedented amount of data and models that can be used in neurorobotics experiments as well as access to supercomputing resources in Europe.

3 Sustainability Strategy

3.1 Principles

RobMoSys aims at building an open sustainable ecosystem around public, royalty-free and implementation-driven software platform standards that will ease the development of new robotic applications in multiple domains. The innovation required to advance RobMoSys methodology and tools needs to be driven by the key industrial companies. This is why RobMoSys partners believe that it needs to join an existing industrial platform that guarantees a suitable environment for open innovation and industrial feedback.

More concretely, there is a set of specific goals to be met by the targeted community:

- **Open Innovation**: Ensuring the highest levels of productivity, reliability, service, and performance implies a continuous effort of research and development in robotics software tools. To cover the largest possible spectrum of stakeholder groups, we envisage to keep a high degree of openness. Methodological specifications will be open, not just in the sense of a dissemination with non-proprietary intellectual property rights, but also in the sense of the human development process required to reach such specifications.
- **Industry-friendly Business**. As for implementations, we envisage co-existence of both open-source and proprietary solutions. Obviously, a project with public funding and with an industrial focus, will push development of industry-grade open-source results. Special attention to open-source (with so-called "industry-friendly" licenses) is needed to make the approach accessible and to spread it easily in the community and in the market.
- **Rich Tool Ecosystem**: The numerous and complex operations required to develop and maintain robotics systems imply a high level of automation based on mature software tools. RobMoSys must be connected with a solid ecosystem of software tools providing support beyond RobMoSys features. This is why, RobMoSys target "**harmonisation**" of critical aspects of the various established digital platforms (such as OPC/UA, ROS, etc.), in particular the interactions between sub-systems, as an essential enabler.
- **Long Term Support**: The tool chain needs to remain operational for the life cycle of the robotics products; many domains need more than 10 years, and some need up to 30 years. Firstly, we will enable "**growth**" into a bigger ecosystem by helping existing players to expand through our dissemination and networking activities, and by lowering entry barriers for new players through productising core functionality, thus growing the overall market. Secondly, "**scalability**" means solving bigger problems with equal or reduced costs, which we achieve, on the one hand, through improved tool-chains, and on the other hand through model-driven predictable integration. This latter aspect is squarely aimed at the complexity-from-diversity problem mentioned in the motivation.
- **Conformance**: The project has started to set up a process for expressing the conformance of assets with respect to RobMoSys: Conformance assesses and describes the degree to which a specific asset follows the RobMoSys methodology and approach. An asset can be tools, models, components or methodologies. An asset that is conformant to RobMoSys can use a **conformance label** to make its conformance visible. This is an important contribution from the technical side to the RobMoSys sustainability: The purpose of conformance to relate different assets in the RobMoSys ecosystem to the RobMoSys approach in order to create a "map" of the ecosystem. Conformance thus serves as a guide for users to choose the right assets for their task, role, or intended purpose of use. It will help users to find along in the RobMoSys ecosystem.

RobMoSys partners expect that the project solutions will evolve in pace with the more challenging requirements of modern robotics engineering teams. RobMoSys solutions needs flexible extensibility and customization that makes it easier to adopt its tools, methods and processes by robotics engineering teams.

3.2 Role of the Community Platform

The goals of the potential community platform must be:

- Providing means of collaboration between end user companies.
- Organizing sustainable commercial services and ecosystems around open source models, software components and tools.
- Fostering exchanges between academics and industry partners.
- Managing the quality and maturity of tools and components from early research prototypes through to obsolescence.
- Providing the documents and qualification kits required for certification.
- Recognizing project maturity and company know-how and commitment through a branding process.
- Ensure long-term longevity of models, software components, and tools since they must last for a long time.

The idea of joining an existing community is to avoid re-developing community management aspects but also to connect with other software communities. A lot of very good solutions answering some industrial needs already exist in open source. But most of the time, specific issues like durability or certification are not taken into account. In this case, the community platform must play its part by providing tool components assets, setting up specific support, and coordinating development and support.

3.3 Role of RobMoSys Contributors

The role of RobMoSys contributors in such a community would be:

- Preparing RobMoSys models, software components and tools to be released/hosted in open source.
- Operating dedicated code repositories, build chains, test facilities, etc.
- Fostering exchanges between RobMoSys partners and industry partners.
- Proposing RobMoSys tool enhancements (industry-friendly functionalities, new features, reliability features, tool connectors with other external tools, among others).
- Managing the quality and maturity of RobMoSys tools
- Ensuring open innovation through the sharing of the research, development, and maintenance efforts as far as possible
- Fostering sustainable commercial services and ecosystems around the RobMoSys tools.

The main goal is to use RobMoSys partner’s technical expertise in the models, software components and tool platform and comprehensive understanding of the ecosystem challenges, in an effective way by offering continuous support for industrial players wishing to use these technologies in a cost-effective way for long-term projects.

3.4 Stakeholders

The know-how acquired in RobMoSys is expected to be strategic for European organisations. The RobMoSys stakeholders are shown in Table 1, and concern those actors who will be directly, or indirectly, positively affected by the RobMoSys ecosystem, its activities, and/or its results.

Table 1. Stakeholders identification

Target Group	Examples of stakeholders	Concrete examples
Industry: ▪ transport and logistics, ▪ manufacturing, ▪ healthcare, ▪ agriculture, ▪ other possible domains that RobMoSys could have an impact on.	OEMs, component suppliers, integrators of robotics systems, tool vendors, consulting and service providers, certification organizations, standardization groups and industrial forums. SMEs represent a special interest group for RobMoSys, as they generally have very limited access to basic or applied research to develop new products.	Magazino, Bosch Intralogistics, Bluebotics, Pick-It / Intermodalics, Robotnik, MIR, Swisslog, Omron Adept, Oceaneering AGV Systems, Elettric80, IEMA s.r.l., Cloos, Rio Tinto, Strauss Verpackungsmaschinen, INGRO Maquineria Hocoma, BA Healthcare, Focal Meditech, Endocontrol, F&P Robotics, Marsi-bionics, Instead Technologies AGCO/Fendt, Vitirover, Agrobot, DeLaval, Lely, Naio Technologies, Fullwood, GEA Farm Technologies qbrobotics, Robotnik, BA Systemes, Force Dimension, InMach, MT Robot, Nilfisk, Intellibots, Adlatus Robotics Metralabs, RB3D, Schunk Pilz STENA recycling REFIND Technologies
Policy makers	Consultancy providers, assessor companies, standardization and certification bodies.	TÜV, Occupational insurance association (e.g. BGHM), ISO, European Mirror Committees (Theo Jacobs, Gurvinder Virk)
Scientific and Research communities	Universities, research institutes and other practitioners.	Dr. Jan Kerschgens, Managing Director & Knowledge and Technology Transfer Officer, NCCR Blue Ocean Robotics DFKI Bristol Robotics Lab CHRU

		Scuola Superiore Sant'Anna Biorobotics Institute (agriculture) Leibniz-Institut für Agrartechnik und Bioökonomie Potsdam-Bornim e.V. (ATB) Wageningen University & Research (agriculture) IK4Tekniker Research Alliance (E) IRT Jules Verne (F)
Open-source communities	Stakeholders (development, quality assurance) of open-source ecosystems for Robotics.	Rock (Sylvain Joyeux, sylvain.joyeux@m4x.org), OSGi (Kai Hackbarth) MORSE (Simulation Engine)
Users of Robotics Systems	People that will ultimately use robotics systems or their services.	BMW, Audi, Bosch

Figure 3 shows stakeholders organized according to the level of contributions to the ecosystem.

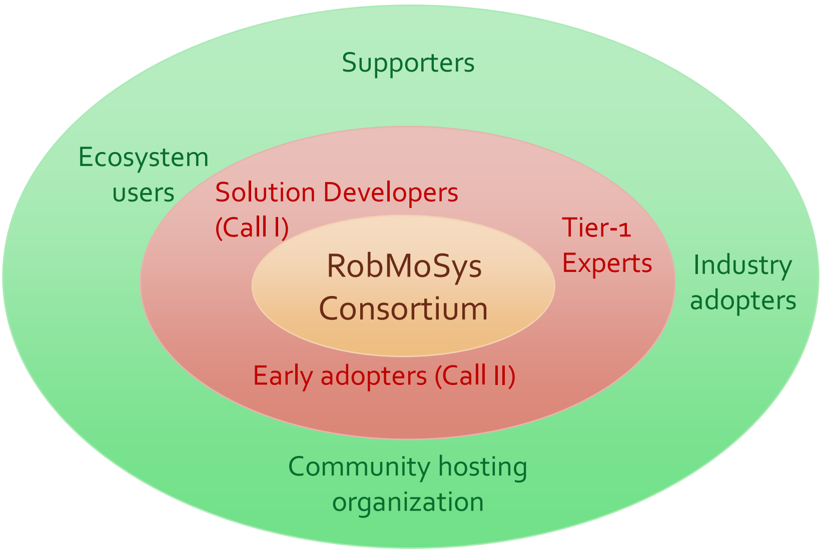

Figure 3: Core Stakeholders

RobMoSys consortium is at the core of this stakeholder view. The second-level contributors are Tier-1 experts and third-party organizations from Open Calls.

Tier-1 Experts will allow to systematically gather requirements and recommendations helping project team members to (i) define the specifications of the Open Call, (ii) to monitor and assess the results of the Open Calls and (iii) to promote strategies for dissemination and exploitation.

Hopefully, they will also lead to some co-development of software.

Third-Party Funding (Solution Developers and Early Adopters) allows the "influx of knowledge and brains" from a broad set of stakeholders, so that the project will be able to tap the tremendous potential of the community in a systematic way.

Then in the third level, stakeholders include:

Supporters which are selected individually: industrial (non-funded) third parties, who help the community to adopt the RobMoSys approach and models and code in the context of their company and the community. The motivations behind this means are (i) less risk for the adopting company, (ii) faster and more effective dissemination with more direct results, and (iii) more intense feedback for the RobMoSys partner from industrial reality.

Ecosystem users and industrial adopters. The change of industrial practices is a complex and long process. A single research project, like RobMoSys, cannot realistically expect to cause a revolution in industrial robotics processes in a short-term. However, the project is demonstrating a feasibility of the advocated approach and industrial RobMoSys partners, Tier-1 experts and third-party partners will be committed to internal dissemination of the outcomes and gradual adoption of both individual concepts and the entire framework developed by the project. It should be noted that one of the secondary, but very important, by-products of the project is establishing networks between industrial and research, training and consultancy stakeholders. Combined with exposure of industrial partners to cutting edge concepts and principles this will naturally facilitate future smaller-scale collaboration that will, in turn, facilitate adoption of RobMoSys concepts in industrial practices.

Community Hosting Organization, as described in Section 4.3.

4 RobMoSys Plans

From the early stages of RobMoSys, a strong candidate for the project's open-source community was the **Eclipse ecosystem**. In this section, we describe our progress in defining the RobMoSys community hosting organizations, as a preliminary baseline to decide if RobMoSys fits well in this community and to find synergies with other related projects and initiatives.

4.1 Phases and Schedule

As a part of the Community Building strategy definition (joint work between WP6 and WP7), we defined three phases for community building (Figure 4): Preparation, Creation and Consolidation.

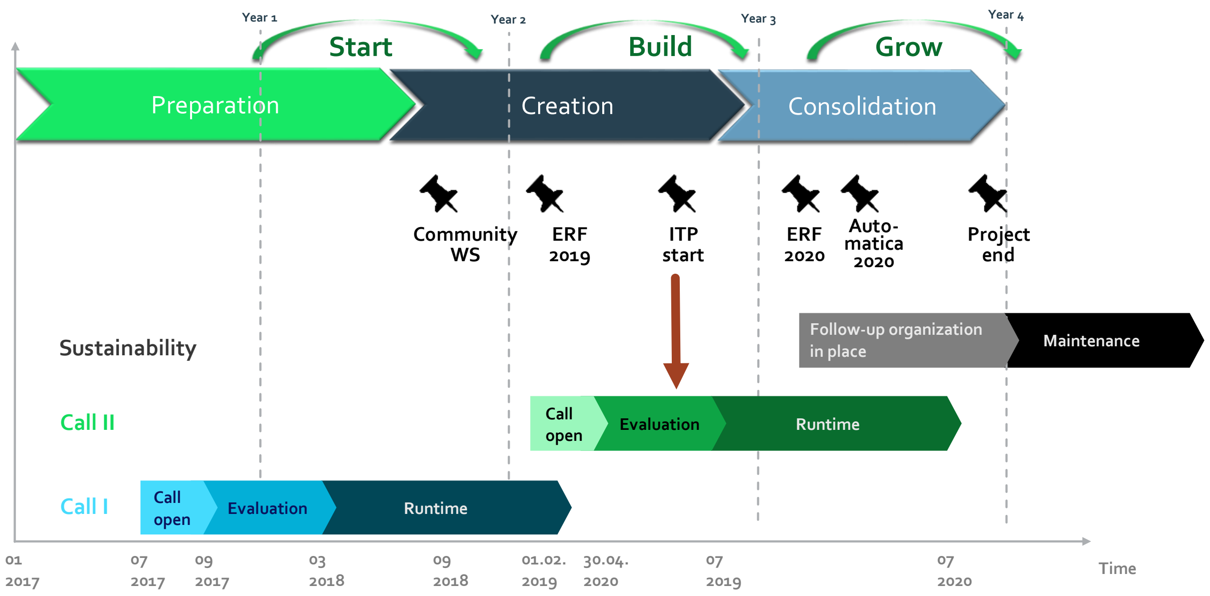

Figure 4: Roadmap phases

During the **Preparation phase**, we focused on identifying stakeholders, principles, and potential sustainability models. At the same time, we created the SmartMDSD and Papyrus4Robotics tooling projects as part of the Eclipse Ecosystem.

During the **Creation phase**, the focus is on setting the community infrastructure (Discourse forum, code repositories for RobMosys tooling baselines and ITPs, RobMoSys methodology wiki), as well as on defining maintenance and governance objectives and getting the support from hosting organizations (euRobotics and Eclipse Foundation).

During the **Consolidation phase**, the goal is to get the community engagement, make the RobMoSys ecosystem public and well known, and consolidating the hosting organizations and the governance charter in those organizations.

We defined a set of actions to execute the Creation and Consolidation phases (concerned in the current period of M13 to M30). See tables below. This is being refined in the upcoming phases.

Table 2. Action Plan: Dissemination and Training

Activity	Date	Resp.	Target Content	Audience	Promotion Mean
Twitter Communication plan	Targets due 13/07/18; ongoing effort	Anna, Susanne, Huascar	Updates on RobMoSys, modelling approach, EC news, ITPs	community	Min. 2-3 tweets a week (incl. Retweets)
Gathering of external stakeholders	Ongoing, every 2 weeks	Technical core consortium, ITPs (Anna & Susanne to coordinate)	Short technical articles - how does RobMoSys contribute to solving user needs (e.g. composability, quality of service)	Industrial community	LinkedIn, technical articles (to be cross-posted in Discourse, etc.) One article every two weeks
Stronger involvement of technical community	ongoing	WP6 + Technical team input	major technical development, crucial issues that require understanding and agreement by community	Technical community (software engineers) / MDE community	Discourse Forum
Actively gather "supporters"	Q3-Q4/18	Susanne	Statements of Stakeholders	General	Website
Tier 1 Workshop	11/09/18	Anna, Huascar	Preparation of Call II	Tier 1 experts	presentations, discussion
Open Community Workshop	12/09/18	Anna, Susanne, Huascar	Summary of Tier 1 workshop, how to use what is already available, general progress, pilots, outlook on call 2	community	talks, presentations, discussions, maybe life demonstrations
ITP Workshop	13/09/18	Anna, Susanne	what has been achieved to far, exploitation of results	ITPs	discussion, presentations, demonstrations
Tutorial (first version, online)	01/10/18	Gaël	RobMoSys modelling approach, Toolchains (early)	MDE community (tool developers)	Talks, Videos, Presentations
"Models" Tutorial	16/10/18	Herman, Christian	RobMoSys modelling approach, tool support	MDE community (tool developers)	Talk, hand-on training, video (steaming ?)
Technical video	02/19	Anna (input from HSU, KUL, CEA)	RobMoSys modelling approach, tool support	MDE community, early adopters	video
Brokerage Day (+ online streaming or VOD?)	12/02/19	Anna, Susanne	Open call explain what is already available	early adopters, pilot users	presentations, discussion, networking
Short WS / talk at Schunk Expert Days	27-28/02/19	Susanne	Open call, RobMoSys modelling approach, available tools	SR community	presentations, discussion, networking
ERF 2019	20-22/03/19	Anna, Susanne	Explain progress, explain open call, allow for pitch presentations of possible applications	MDE, robotics community	Workshop, booth
Online Tutorial (second iteration)	05/19	Gaël	RobMoSys modelling approach, Toolchains	MDE community, Tier 1, early adopters	Talks, Videos, Presentations
Official Training Video	01/20	Anna, technical team	how does RobMoSys work - what can be used and how?	industry, MDE community	video
Online Training	03/20	Anna, technical team	how does RobMoSys work - what can be used and how?	industry, MDE community	webinar
ERF 2020	03/20	Anna, Susanne	introduction of sustainable structure / organisation after RobMoSys, exploitable results	general	Workshop
Summer School	06/20	KUL, HSU	train students and MDE community how to use RobMoSys	R&D	Presentation, talks, videos, hand-on training, life demonstrations
Pilots demonstrators (+promotion material) - Videos	06/20	WP4	showcasing RobMoSys results, pilots, demonstrators, user benefits	pilot users, early adopters, supporters	Videos
One video of every Call II ITPs	06/20	ITPs	showcasing RobMoSys results, pilots, demonstrators, user benefits	pilot users, early adopters, supporters	videos - should be required as mandatory from every ITP
automatica 2020	16-19/06/20	Anna, Susanne	showcasing RobMoSys results, pilots, demonstrators, user benefits	general	booth and forum talk
Composition Festival (Plug Fest)	09/20	Technical core consortium, ITPs (Anna & Susanne to coordinate)	proof of concept for RobMoSys approach, training	pilot users, early adopters, supporters	hand-on training and "experiments"

Table 3. Action Plan: Exploitation and Sustainability

Activity	Date	Resp.	Target Content	Audience	Promotion Mean
Define and setup community infrastructure, Phase "Creation"	15/10/2018	Anna, Eloy	Means for community interaction, RobMoSys "showcase" to the world: separate Web (entry)?, Discourse	community	Website
Share business models, sustainability plan with Tier-1 experts to get feedback	11/09/2018	Huascar	Community strategy, business models, maintenance and governance (deliverables D7.2 & D7.3), incl. discussions on Hosting organization	Tier-1 experts	Presentations, Discussion
Enrich communication plan with feedback from Tier-1 experts	15/10/2018	Huascar, Anna	Communication action plan	community	Action plan
Define and publish core RobMoSys community	01/11/2018	Anna, Susanne, Huascar	Supporters, RobMoSys basic "Library" (Tutorial, Getting Started, etc.), Forum	community	Website, Discourse
Creation of exploitation clusters (RobMoSys + ITPs)	01/04/2017	Daniel, Huascar	Deliverable D7.1: Exploitation case	RobMoSys, ITPs	Deliverable
Selection of RobMoSys business models and their implementation measures	01/05/2017	Huascar	Deliverable D7.2: Business models	RobMoSys partners and community	Deliverable
Refine Sustainability plan	01/06/2017	Huascar	Deliverable D7.3: Business models	RobMoSys partners and community	Deliverable

4.2 Industrial Outreach

The creation of a sustainable ecosystem is a major objective of the project, but obviously, this is not something that can be done in a guaranteed or strictly controlled way. However, the more clever, more open and more reactive the strategy is, the better this goal is to reach. Anyway, the project partners though will very actively stimulate active involvement of, and controversial discussions with, a selected variety of different stakeholder groups outside of the consortium of the project representing both technology-pull (application domains) as well as technology push (technical capabilities).

This involvement (and thus commitment) of relevant stakeholder groups is “secured” by both, Tier-1 Experts Workshops and by Third-Party Funding.

Tier-1 Experts Workshops during the preparation and monitoring phase of Open Calls will reinforce our strategy with concrete recommendations.

Third-Party Funding will be able to successfully “address the open development of integrated sets of tool chains and building block applications that will support the construction of complex robotics systems”. The Open Call mechanism allows to identify the best tools already available, the best modelers and developers to adjust them and the best application areas to validate the results and establish benchmarks. Cascade funding will also solve another burning issue: the access to integrated sets of common tool chains and real-world test installations to support the development of complex robotics systems.

"One-on-One dissemination", in which some core partners of the project engage in a co-development effort with selected individual industrial (non-funded) third parties, to help the company's engineers to adopt the RobMoSys approach and models and code in the context of that company. The motivations behind this means are (i) less risk for the adopting company, (ii) faster and more effective dissemination with more direct results, and (iii) more intense feedback for the RobMoSys partner from industrial reality.

Beyond the project duration. The change of industrial practices is a complex and long process. A single research project, like RobMoSys, cannot realistically expect to cause a revolution in industrial robotics processes in a short-term. However, the project is demonstrating a feasibility of the advocated approach and industrial RobMoSys partners, Tier-1 experts and third-party partners will be committed to internal dissemination of the outcomes and gradual adoption of both individual concepts and the entire framework developed by the project.

It should be noted that one of the secondary, but very important, by-products of the project is establishing of networks between industrial and research, training and consultancy stakeholders. Combined with exposure of industrial partners to cutting edge concepts and principles this will naturally facilitate future smaller-scale collaboration that will, in turn, facilitate adoption of RobMoSys concepts in industrial practices.

The long-term impact of RobMoSys in terms of influencing industrial practices can be facilitated by a follow-up adoption program.

The key to reaching a broad audience is defining clear messages for the different phases. Our message should not only convey what we do and give updates on the project’s status but it should also address the stakeholders by outlining the benefits to them “what is in for you?”

At the **beginning of the Creation phase**, the project have developed a baseline proposal with respect to a governance structure, a hosting organization, the infrastructure needed to support the long-term sustainability of the approach and the methodology and tools developed within the project runtime. At this stage, this baseline proposal is to be discussed with the community.

The related messages were:

- "We take the concern regarding long-term sustainability of the RobMoSys concept very seriously. It is one core aspect in the work of RobMoSys to not only develop methodologies, tools, and software during the EU-funded phase, but to establish an enduring ecosystem that will continue to grow and flourish in the future."
- "We internally have developed a proposal for a hosting organisation for tooling (Eclipse Foundation) to maintain and continue the work started within the official project runtime, and this would be: "XXX". The envisaged governance structure is as follows "YYY". Regarding the infrastructure needed to host tooling and software developed, this could be achieved via "ZZZ". We would now like to discuss this proposal with the community, seeking approval.

At the **end of the Creation phase**, The related messages are:

- Following intense discussions with the community, we selected "XXX" as hosting organization. In the coming month, we will complete the preparatory steps necessary for the on boarding. We will inform you once these steps are completed, and you are able to join and actively support us.
- The following organizations and individuals already committed themselves as supporters of RobMoSys and our follow-up concept: "…"

At the **start of the Consolidation phase,** of the project messages regarding the sustainability of the approach should focus on how RobMoSys fits together and interlinks with other industry-related approaches, e.g. ROS, OPC UA and its companion specifications. The messages should be rather open regarding a collaboration, but also carefully describe limitations.

Detailed messages in this context require more insights in the different approaches and will be provided at a later stage.

At the **end phase of the project**, the messages should get people on board of the hosting organisation and communicate how to get involved in the RobMoSys community and the benefits one will get.

Messages would be as follows (further refinement in the course of the project needed):

- Our hosting organisation "XXX" is open to accept support of RobMoSys new members and invites them to actively contribute to its governance structure.
- The technical infrastructure "ZZZ" that contains tools and software developed in the context of the RobMoSys ecosystem is available through "…"
- Means to actively contribute to the growth of the methodology and the acceptance of model-driven software engineering in robotics are "…".
- At the current stage, the following benefits are already fulfilled by the approach: "…", while "…" are still under development.

4.3 Towards an EU Digital Industrial Platform for Robotics

In lots of innovative domains, like artificial intelligence or big data, innovation is primarily supported by open source platforms, available under a business friendly license, that provide developers with an ever-growing offer of off-the-shelf possibilities that they can use for assembling their products faster and more efficiently. We think the same is true for Robotics.

RobMoSys is part of activities towards an "EU Digital Industrial Platform for Robotics" as a shared joint vision for the benefit of Europe in robotics. Below is a slide from the European Robotics Forum, Bucharest (22.03.2019) presented in the context of the Topic Group "Software Systems Engineering". It describes a proposal of how to organize bodies and projects in three tiers to advance the European ecosystem towards an EU Digital Industrial Platform for Robotics. This proposal is shared by RobMoSys.

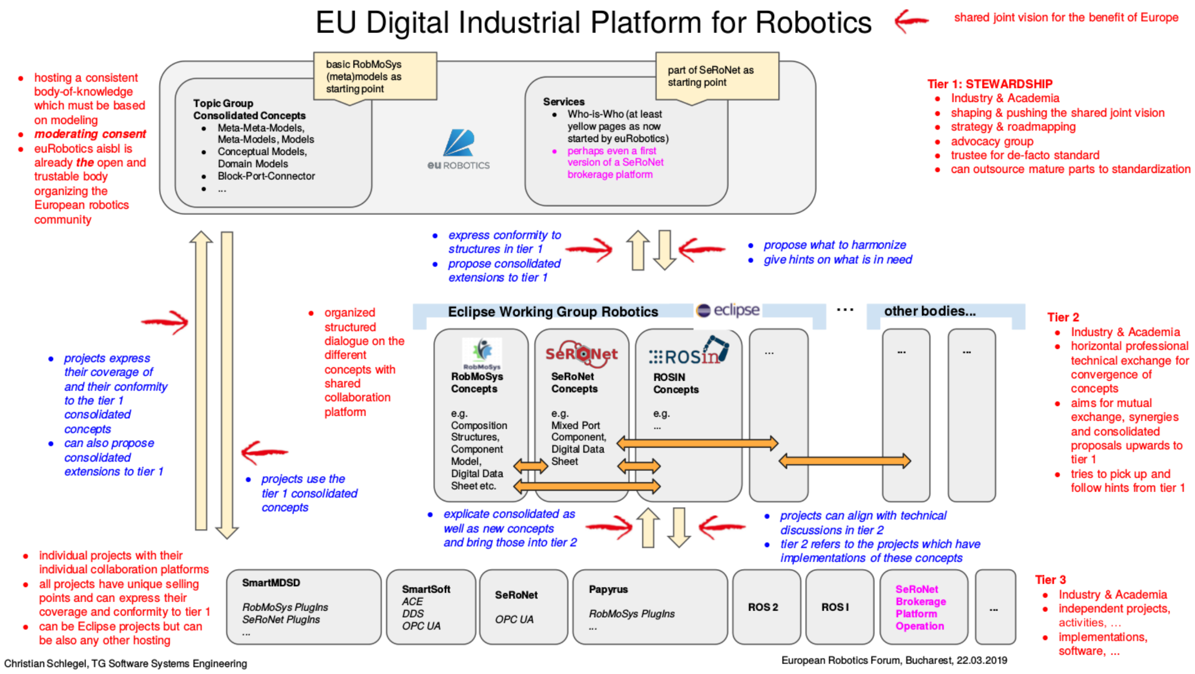

Figure 5: Roadmap phases

The RobMoSys vision for Stewardship (Tier 1) is to let euRobotics be the hosting organization to create a body of knowledge for system and software engineering in Robotics, as well as some standards for the European robotics ecosystem. To this purpose, RobMoSys provides a conceptual structure and mechanisms to deal with different coexisting levels of maturity, acceptance, and innovation in robotics software and system engineering (via metamodels, domain models and services).

HS Ulm was working in the establishment of the concept of Stewardship within euRobotics. After some meeting with euRobotics members (Rich Walker, José Saenz and Reinhard Lafrenz). As a result, the following citation was stated by these euRobotics members:

> *euRobotics' presence as the "centre of gravity" for European roboticists, spanning research, industry and policy, makes it natural that euRobotics champion the Stewardship of "community knowledge".*
>
> *Historically, euRobotics has "led the charge" to develop the Multi-Annual Roadmaps and the Strategic Research Agendas for the European robotics community, whilst at the same time setting up and enabling Topic Groups to do the community engagement and technical work to drive these processes.*
>
> *Stewardship of the consolidated "body of knowledge" and steering and trusteeship of the community's "de facto" standards is a natural follow-on to this, and will form part of the Topic Group refresh process that euRobotics Directors José Saenz and Rich Walker are leading.*

A working meeting with the Systems Engineering TG represented by Christian Schlegel and Dennis Stampfer, has set out a process to establish Stewardship within euRobotics in a formal way, and the Secretary General, Reinhard Lafrenz, will prepare suitable motions and briefings for the next Board of Directors meeting in late November 2019.

The vision is to have the software systems engineering body-of-knowledge as first example of a euRobotics Stewardship Body in place by the ERF 2020.

It is important to note that this is an excellent step into the absolutely right direction. The next step will be by the full Board of Directors within their meeting in November 2019.

The goals of the Eclipse Working Group for Industrial Robotics (Tier 2) is to develop an open source platform and open source specifications for industrial robotics or for what is sometimes called Industry 4.0. This working group would leverage connections with other Eclipse working groups like IoT, Edge Computing as well as connections with leading Eclipse technologies like Eclipse Modeling in order to address the challenges of software for industrial robotics, including composability, interoperability, etc.

This Working Group will interact with the European research ecosystem, especially with euRobotics AISBL, a Brussels based international non-profit association for all stakeholders in European robotics. euRobotics is a key initiative that collaborates with the European Commission to develop and implement a strategy and a roadmap for research, technological development and innovation in robotics. euRobotics was formed to engage from the private side in a contractual Public-Private Partnership, SPARC, with the European Union as the public side. euRobotics already hosts some groups that identify gaps and challenges, describe the desired paths towards solutions, milestones to be reached at specified instants in time and with a specified quality.

In addition to that, the working group will connect the strong Ecosystem of research projects addressing some of the main Industrial concerns in the industrial Robotics' field. This integration is open to all projects that want to publish open source results in this context.

As a starting point we identified several projects that fit well in the scope of the Working Group:

- SeRoNet aims to significantly simplify the design, development, and deployment of service robots in a variety of areas
- BaSys provides a virtual middleware for industrial automation, which implements Industry 4.0 concepts leading to efficient changeability and adaptability in production processes.
- RobMoSys aims to promote open and sustainable industry-grade software development for robotics based on composable model-driven methods and tools
- ROSIN offers ROS-industrial quality assured robot software components

All of these projects and initiatives conform the EU Digital Industrial Platform for Robotics. The platform is built on top of a huge body of knowledge coming from research projects, European bodies and academia involved in the industrial robotic research. Such body of knowledge is maintained and managed by euRobotics, and should ideally issue several open standards with their compatible implementations.