RobMoSys

RobMoSys

Composable Models and Software for Robotics Systems

Follow up on
discourse.robmosys.eu

The RobMoSys Consortium
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ROS-Industrial Conference 2018
Dec. 11-13 2018, Stuttgart, Germany

cea

Hochschule Ulm
University of Applied Sciences

KU LEUVEN

TUM TECHNISCHE UNIVERSITÄT MÜNCHEN

COMAU

PAL ROBOTICS

SIEMENS

EUnited Robotics . European Robotics Association
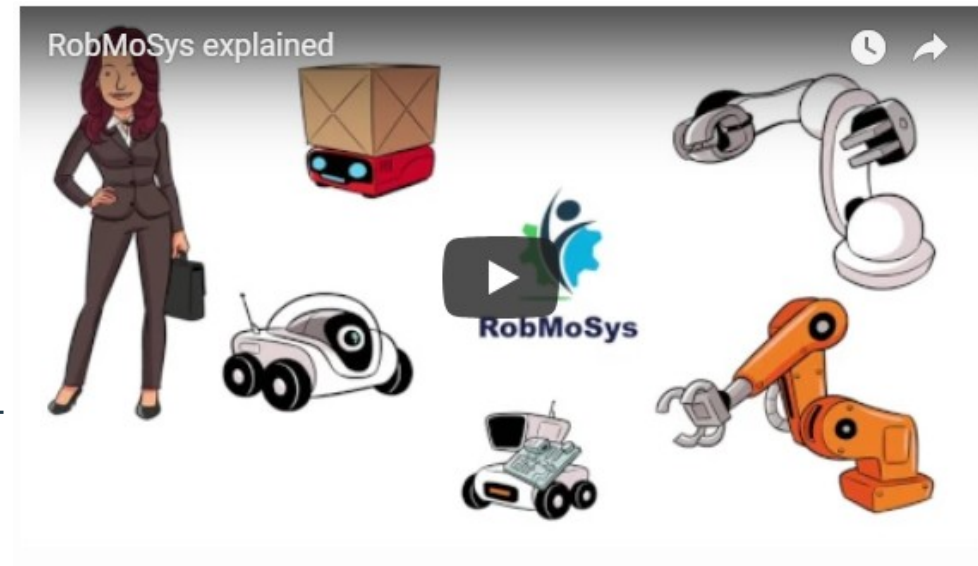
eclipse

RobMoSys Facts

- **RobMoSys**: Composable Models and Software for Robotic Systems
- In response to **H2020** Project – ICT-26- TOPIC : System abilities, development and pilot installations
- SubTopic c: **Innovation Action** on systems development technology.

  The "**System development tools**" sub-call

- **Start Date 01/01/2017**
- **End Date 31/12/2020**
- **Duration 4 Years**
- **Budget 8M,** where **4 M for Open-Calls**
- **Web Site http://robmosys.eu/**

https://youtu.be/8GUSDTNoGRM

RobMoSys
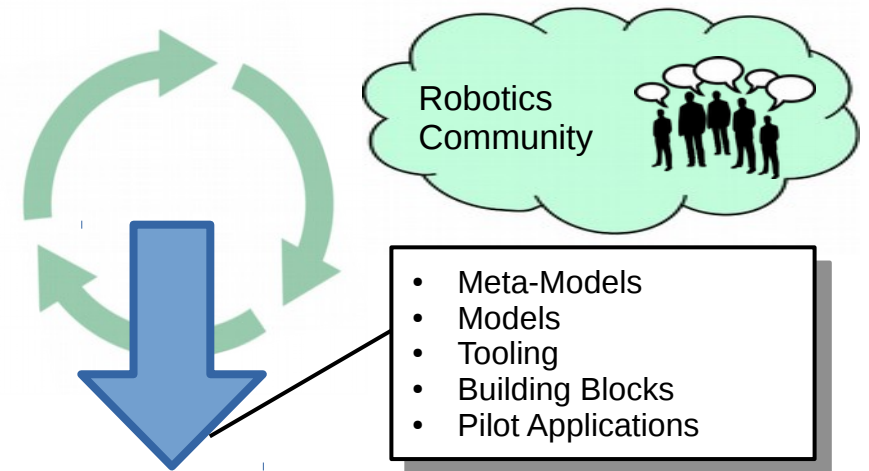# Contribution to EU Digital Industrial Platform for Robotics

RobMoSys is more than just another project...

- **RobMoSys as community moderator**

- **Join forces** to address the most challenging questions together

- Be **most inclusive**

- "Build a positive **atmosphere** and team spirit in the **community**"

- Release cycles and accessibility: **transparency has priority** over completeness (shown e.g. via the wiki)

*The EU H2020 RobMoSys Project coordinates the whole robotics community's best and consorted effort to realize a step change towards a European ecosystem for open and industry-grade **model-driven software development** for robotics.*
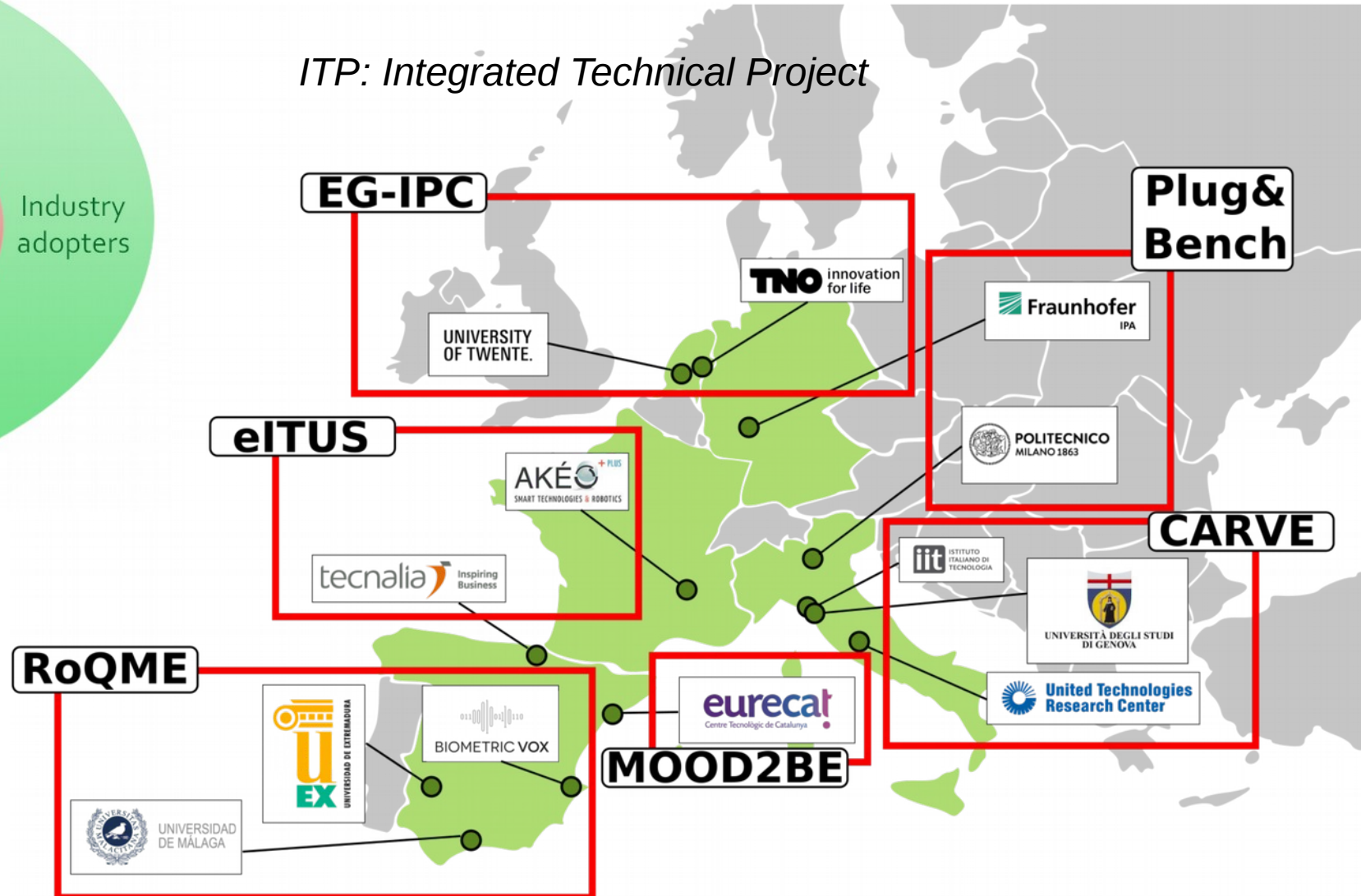
Robotics Community

- Meta-Models
- Models
- Tooling
- Building Blocks
- Pilot Applications

EU Digital Industrial Platform for Robotics
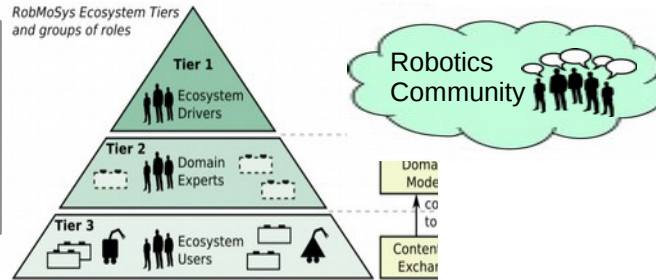
RobMoSys Ecosystem
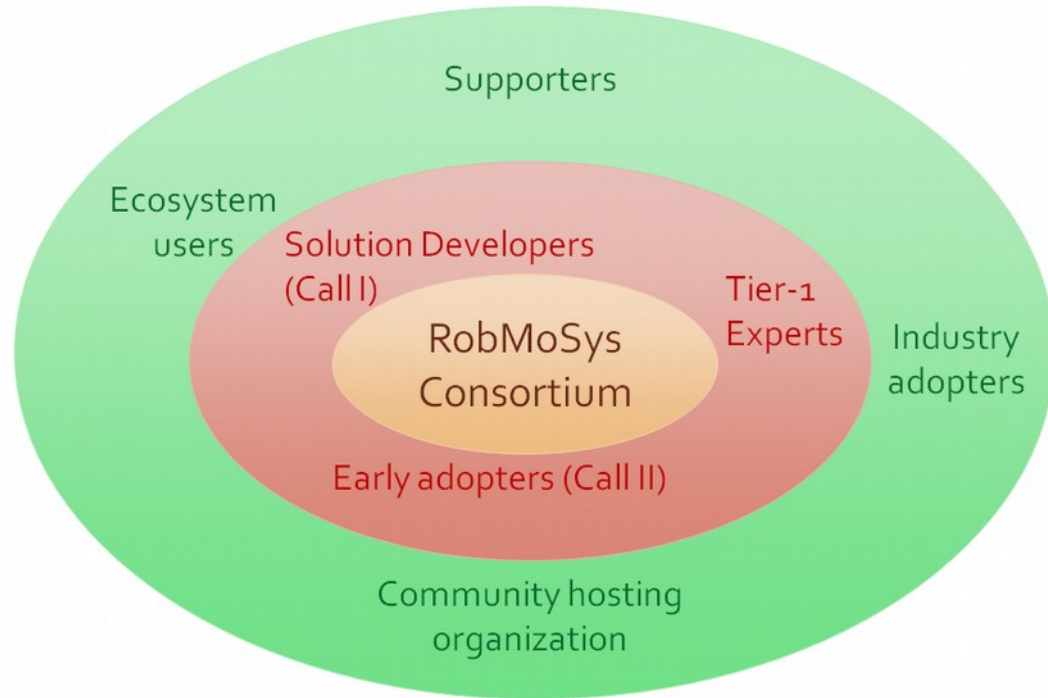
ITP: Integrated Technical Project

RobMoSys Roadmap – The Big Picture

- Meta-Models
- Models
- Tooling
- Building Blocks
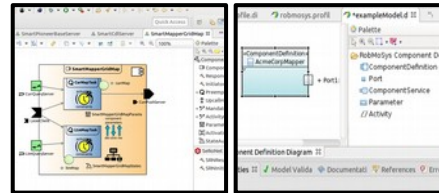- Pilot Applications

RobMoSys Ecosystem Tiers and groups of roles

Tier 1 — Ecosystem Drivers
Tier 2 — Domain Experts
Tier 3 — Ecosystem Users

Robotics Community

SmartMDSD Toolchain   Papyrus4Robotics

eclipse

component supplier — communication coordination configuration computation

behavior developer — task plots

system architect — constraints

system builder

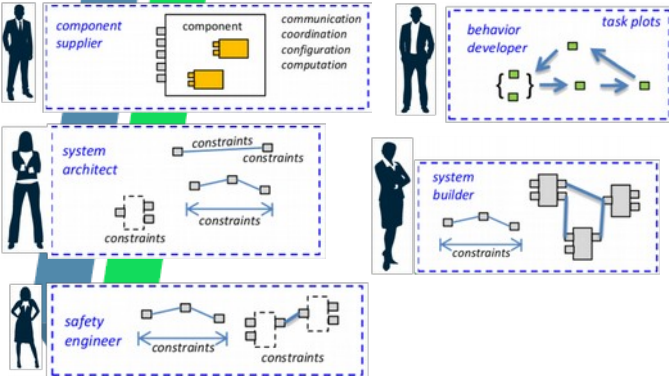safety engineer — constraints

today

best practices, models, tools, ...
well perceived, accepted, first adoptions, ...
first part of story successful

enabler for success stories which now need to become a tangible real thing

- populate the ecosystem with content
- make technical user stories a reality
- show benefits for robotics and beyond
- make step change tangible
- achieve take-up and trust

Open Call 1
6 projects running
03/2018 – 02/2019

Open Call 2 Open
01.02.19 – 30.04.19

Open Call 2 Projects Running

sustainable

2017   2018   2019   2020

EU Digital Industrial Platform for Robotics

ROS-Industrial Conference, December 2018, Stuttgart, Germany

5

RobMoSys Technical Aspects

Enable success stories and finally produce success stories: Technical User Stories and Benefits

Composition, Composability, Compositionality

- **composability** is the ability to combine and recombine *as-is building blocks* into different systems for different purposes. It requires that properties of sub-systems are invariant („remain satisfied") under composition.

- **compositionality** requires that the behavior of a system is predictable from its sub-systems and that of the composition „glue".

- **system composition (activity):** the activity of putting together a set of existing building blocks to match system needs with a focus on flexible (re-)combination.

- **system integration (activity):** the activity that requires effort to combine components, requiring modifications or additional actions to make them work with others.
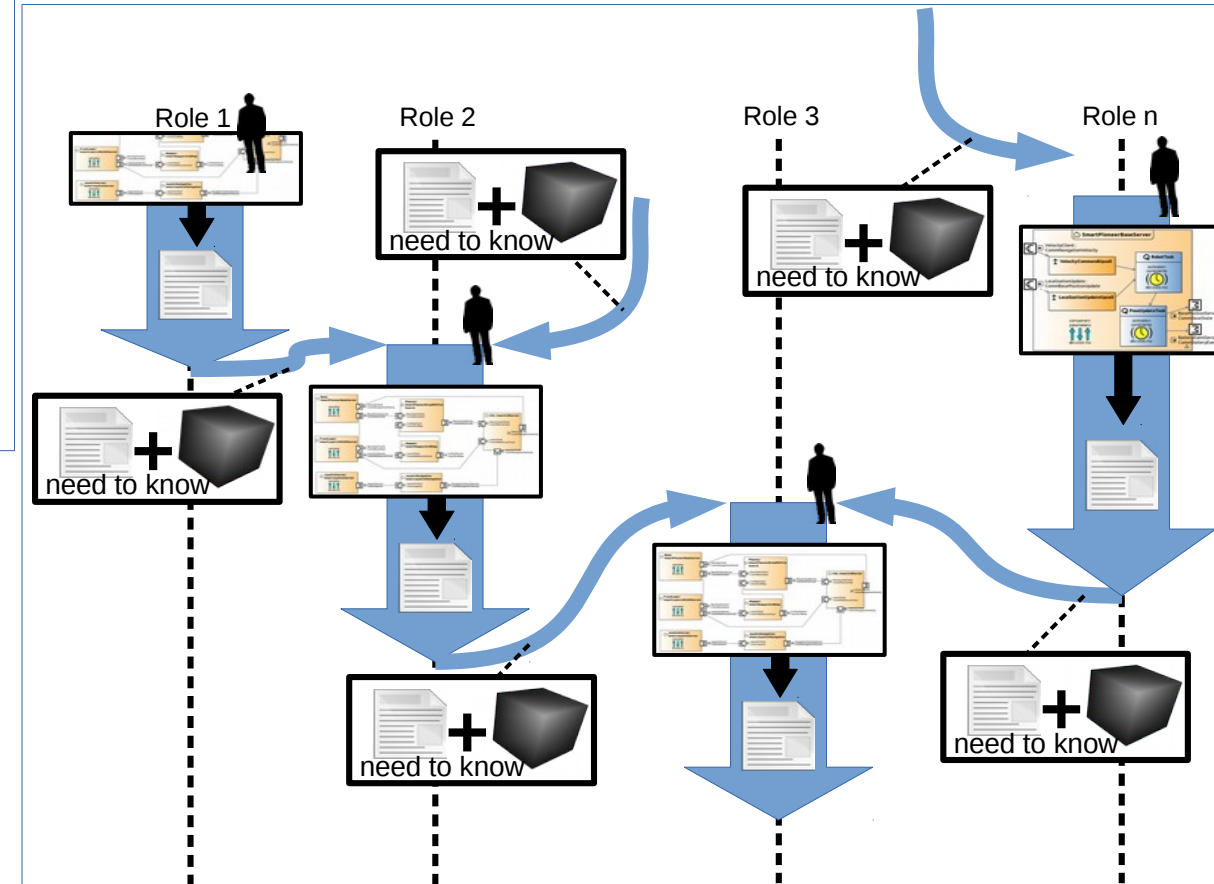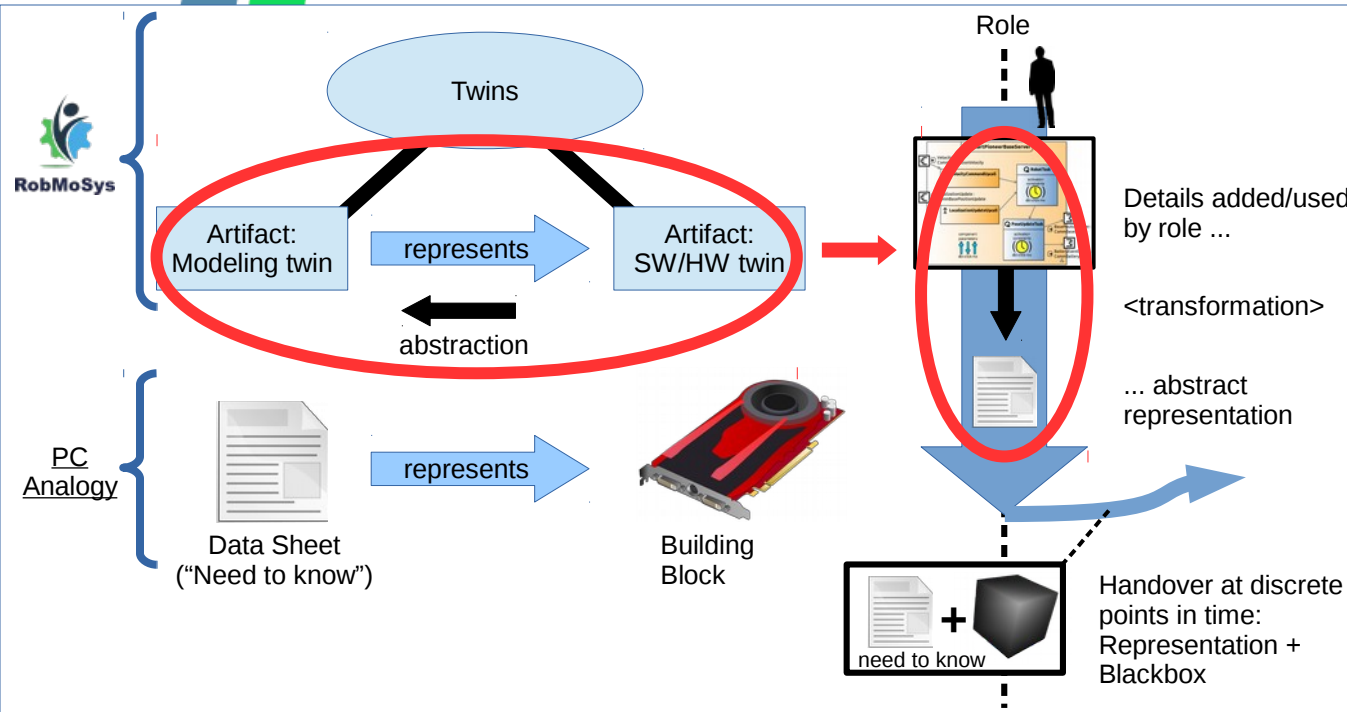
RobMoSys Roles e.g.
- Domain Experts
- Component Supplier
- System Builder
- Behavior Developer
- ..

Role

Twins

Artifact:
Modeling twin

represents

Artifact:
SW/HW twin

abstraction

Details added/used
by role ...

<transformation>

... abstract
representation

PC
Analogy

represents

Data Sheet
("Need to know")

Building
Block

need to know

Handover at discrete
points in time:
Representation +
Blackbox

See also next talk:

SeRONet

Role 1

Role 2

Role 3

Role n

need to know

need to know

need to know

need to know

need to know

The SeRoNet / RobMoSys Mixed Port Component: Keep existing Assets
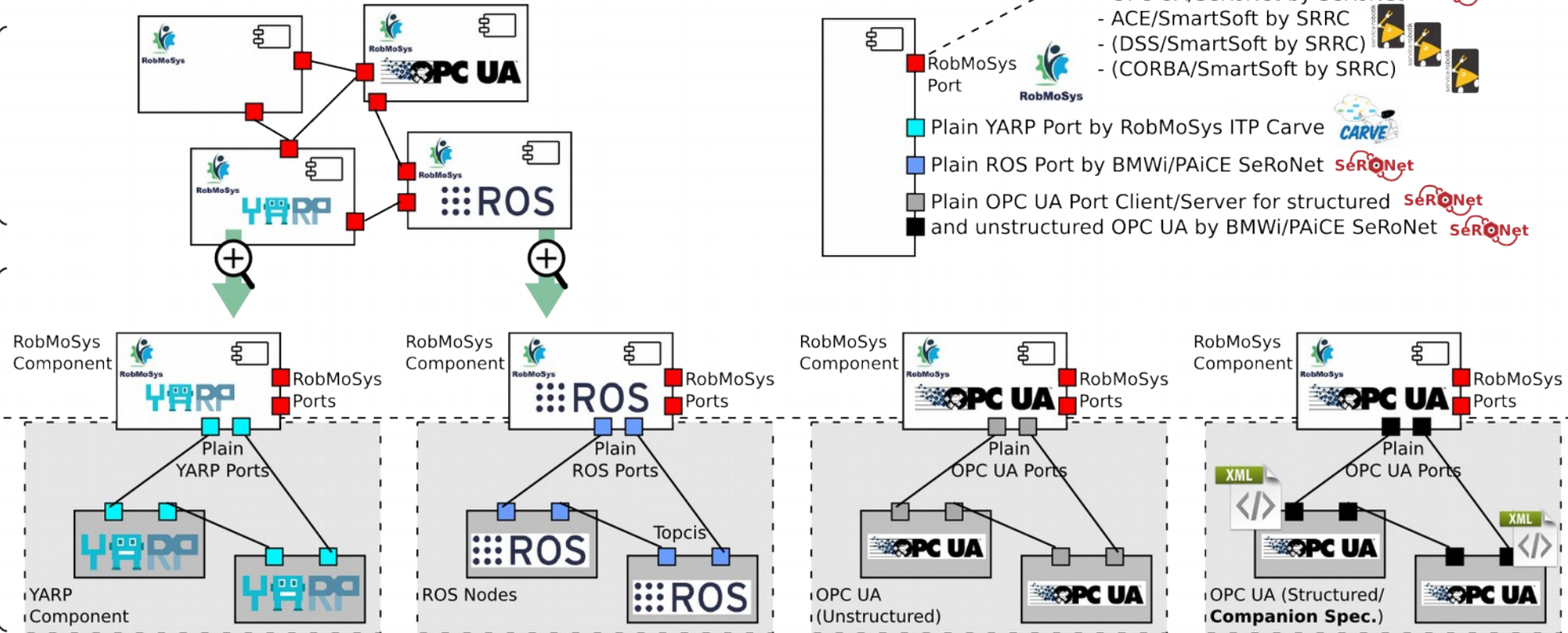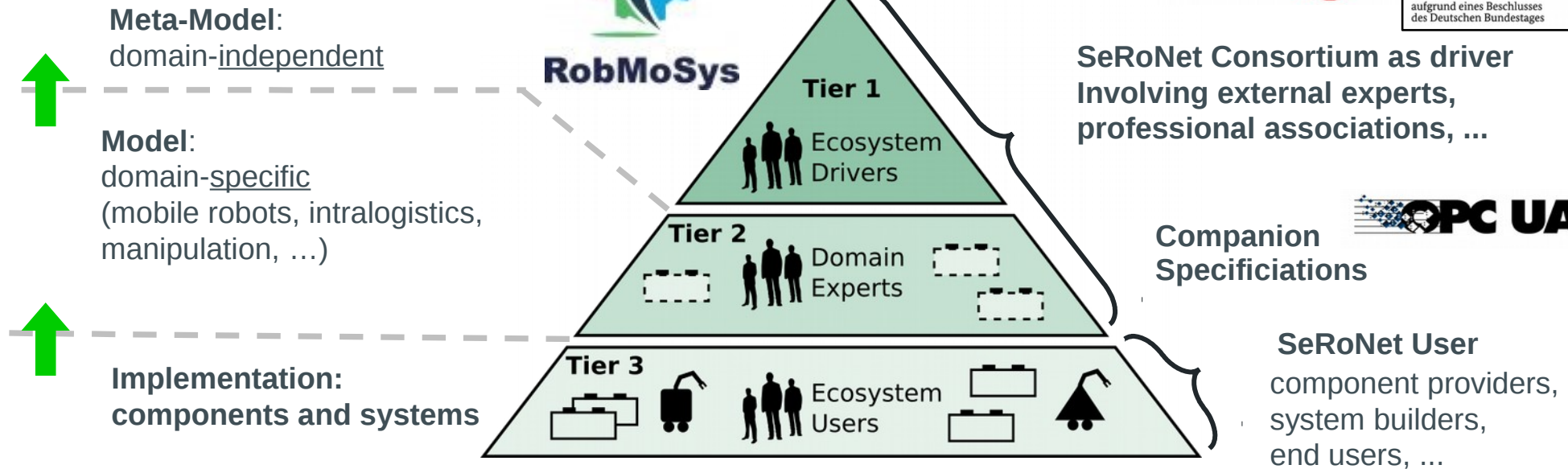

Example: robmosys.eu/wiki -> Community Corner

See also next talk:

EU H2020 RobMoSys, German BMWi PAiCE SeRoNet

RobMoSys (Composable Models and Software for Robotics Systems) Body-of-knowledge via model-driven structures

Meta-Model:
domain-independent

Model:
domain-specific
(mobile robots, intralogistics, manipulation, …)

**Implementation:
components and systems**

Tier 1 — Ecosystem Drivers

Tier 2 — Domain Experts

Tier 3 — Ecosystem Users

**SeRoNet Consortium as driver
Involving external experts,
professional associations, ...**

Companion Speciciations

OPC UA

SeRoNet User
component providers,
system builders,
end users, ...

SeRoNet is conform to superordinated structures consolidated at the European level via RobMoSys

EU Digital Industrial Platform for Robotics

- Technical Implementation with industry standard OPC UA - brokerage **platform**

See also next talk:

RobMoSys Open Call

RobMoSys Open Calls

Open Call 1

- 6 Integrated Technical Projects (ITP)

- 12 Months, one format

- Focus:
  - Platform and structure
  - Basic technologies
  - **Meta-Models**, software, and tooling
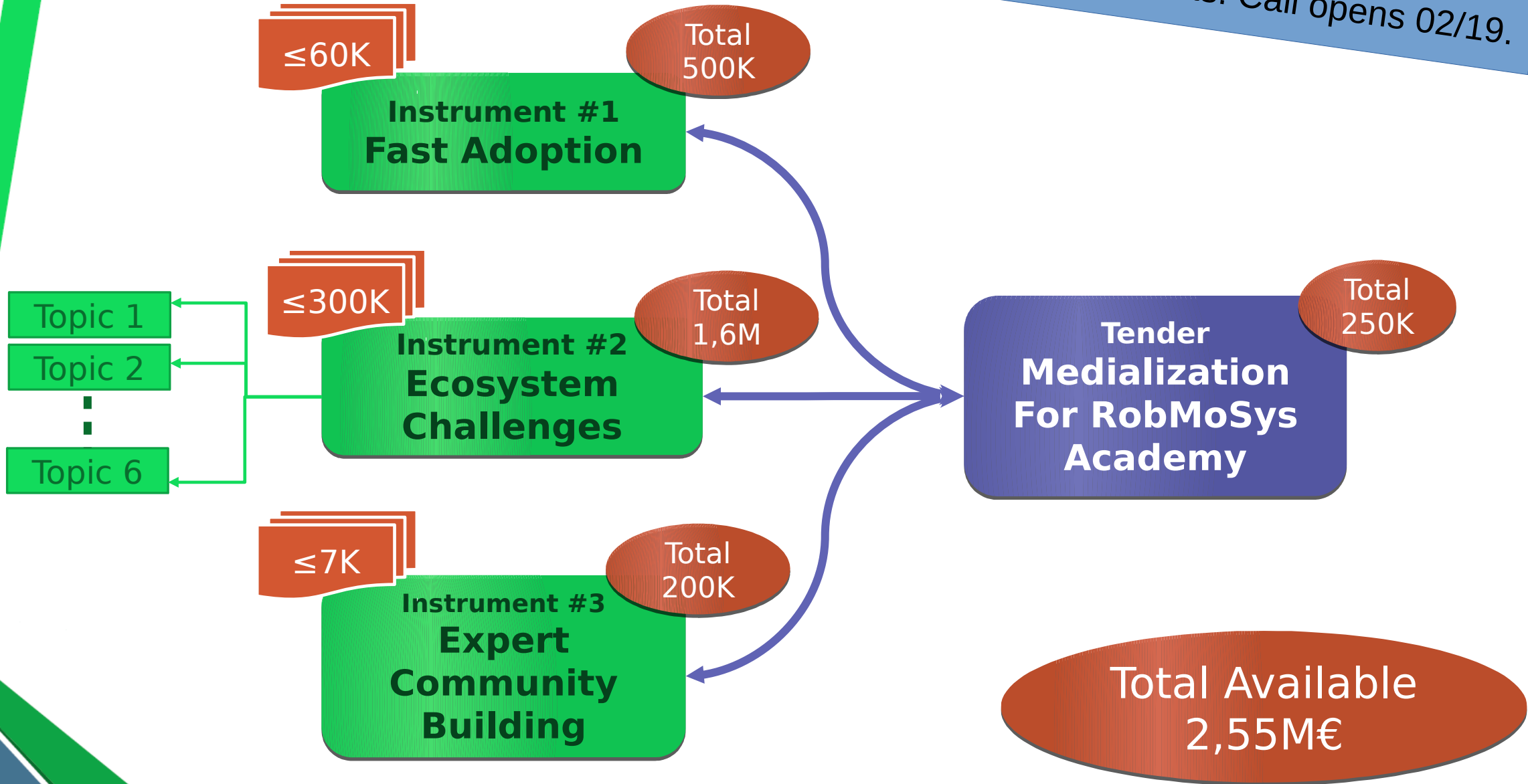
Open Call 2

- 2.55M€

- **Opens February 2019, Closes April 2019**

- Broader set of funding instruments

- **Coaching!**

- Focus:
  - Pilot Applications
  - Methodology and Baseline
  - **Models**, software, and tooling

- **Brokerage day 13.02.2019**, Munich

Call 2 Instruments

≤60K

Total 500K

Instrument #1 Fast Adoption

Topic 1

Topic 2

Topic 6

≤300K

Total 1,6M

Instrument #2 Ecosystem Challenges

Tender Medialization For RobMoSys Academy

Total 250K

≤7K

Total 200K

Instrument #3 Expert Community Building
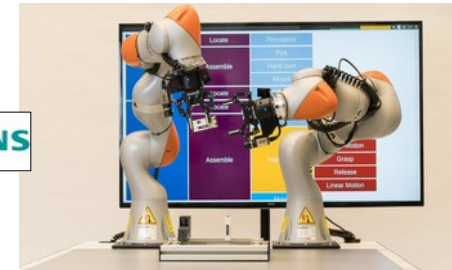
Total Available 2,55M€

RobMoSys Pilots:
Demonstrating the RobMoSys Approach

Intralogistic Industry 4.0 Robot Fleet
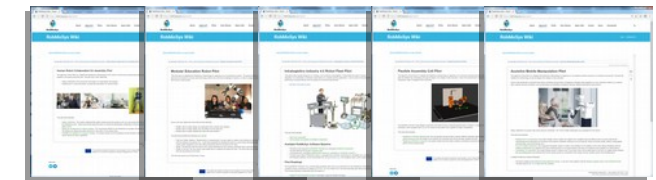

Healthcare Assistive Robot

Flexible Assembly Cell

Modular Educational Robot

Human-Robot Collaboration for Assembly

Broad description of all pilots on the RobMoSys wiki

- Pilots are used
  - to validate the methodology and
  - to **demonstrate the use of the approach** through the development of real applications

We provide pilot skeletons!

Conclusions and Takeaway Messages

- The overall goal of RobMoSys is to achieve a "**EU Digital Industrial Platform for Robotics**" where robotic systems are built from composable models and software and where different roles can collaborate.

- RobMoSys is a **community moderation** activity.

- RobMoSys provides a solid **framing structure and according software baseline.**

    - It is being **extended by the robotics community** in open calls.

    - **We provide 2.55M€ funding:** Open Call II in February 2019

- "… but this is a ROS-conference, I use **ROS?**" - Fine, you can use it along and join us!

Follow up on
discourse.robmosys.eu

Become Part of RobMoSys...

- RobMoSys Web Page => https://www.robmosys.eu
  - access point which guides you to more information according to your role and interest
  - role-specific entry points will be improved with respect to Open Call 2

- Subscribe to Newsletter
  - easiest way to follow at a high level of abstraction
  - be kept informed about major milestones and activities

- RobMoSys Wiki => https://www.robmosys.eu/wiki
  - first reference for in-depth information about the approach etc.
  - additional content to reflect the current state of the overall big picture and the according available baseline follows during the course of the preparation of the Open Call 2
  - additional content will also make it easier to find role specific / interest specific information

- Discourse Platform => https://discourse.robmosys.eu
  - the community platform to talk about models, tools, software for robotics, just get involved

- Open Call 2
  - cascade funding for ITPs (integrated technical projects)
  - 01.02.2019 opening of the RobMoSys Open Call 2, open for 3 months until 30.04.2019
  - after proposal review, selection, contracting: start of selected ITPs autumn 2019
  - Brokerage day 13.02.2019, Munich City Center

- Try it out
  - tooling, building blocks, simulation, real robots, ..

Follow up on discourse.robmosys.eu

RobMoSys

Backup slides

RobMoSys

- Maximum budget granted to one experiment: € **300,000**

- Max. budget per institution cross-experimental: € **250,000**

- Funding rate – 100% (non-profit), 70% (for-profit) of direct costs

  - plus 25 % overheads

- 25% of prefunding

- Duration of participation: **12 months**

RobMoSys Ecosystem Organization: Analogy with the PC Domain

RobMoSys
Ecosystem Tiers
and groups of roles

Tier 1 — Ecosystem Drivers

Tier 2 — Domain Experts

Tier 3 — Ecosystem Users
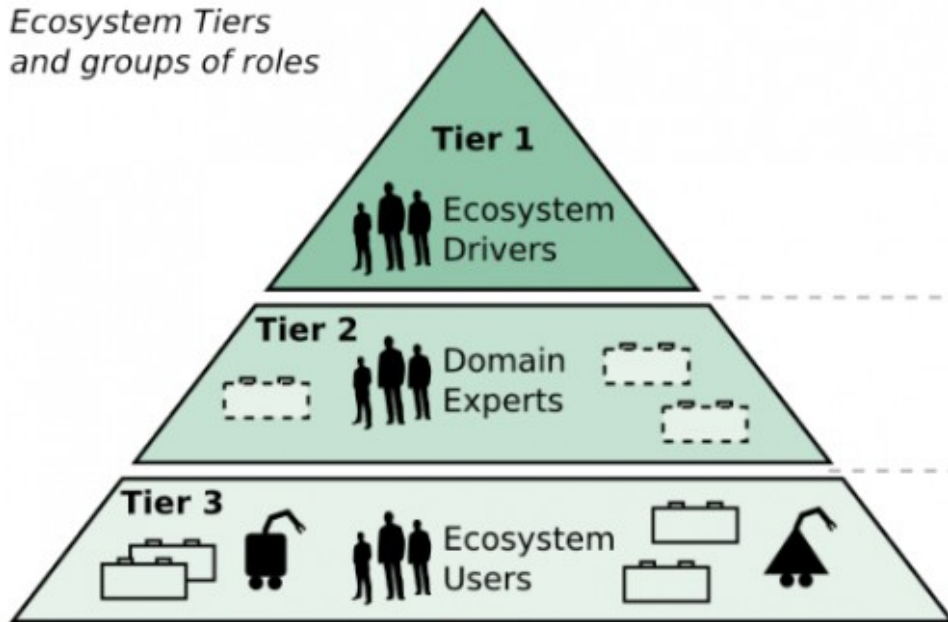
Examples of the PC Analogy:

e.g. Semiconductor standards, computer architecturve, USB, PCIe, modern use of ethernet, etc.

e.g. laptop PC, desktop PC, industry PC, ATX, ITX, Mini-ITX, VGA, HDMI, SATA, IDE, CPU socket, GPU socket, etc.

e.g. graphics card, CPU, TPM, Memory, power supply, etc.

Examples of Robotics:

e.g. robotics architectural patterns and robotics composition structures (service-oriented software component model, robotics task models etc.)

e.g. Flexible Navigation Stack, Active Object Recognition, Motion Stack, Perception Stack etc.

e.g. robotics software components (Motion Planning, SLAM, Object Recognition), robotics functional libraries (MRPT, OpenCV, PCL), applications (Pilots, Logistics Fleet, Production Cell, Healthcare Servicerobot), etc.

AMBITION

RobMoSys will coordinate the whole community's best and consorted efforts to realize **a step-change towards an industry-grade software development European ecosystem**

- open
- sustainable
- industrial quality

RobMoSys part of the effort on **Digital Industrial Platforms for Robotics (together with ROSIN)**

APPROACH

Model-driven engineering as key enabler for
- complex software and system integration
- high-quality standards compliance
- integrating existing technologies

Expected results
- repository of formal models for robotics
- tooling for correct-by-construction composition and code generation
- open-source software and tools "track"

Community Involvement
- Workshops Series (e.g. ERF) and Summer Schools
- Funding: **Open Calls (better tools, models, and systems)**

What is the aim of RobMoSys?

Composable Models and Software for Robotics Systems:
Towards an EU Digital Industrial Platform for Robotics

- **RobMoSys** envisions an integrated approach built on top of the current code-centric robotic platforms, by applying model-driven methods and tools.
- **RobMoSys** will enable the management of the interfaces between different robotics-related domains in an efficient and systematic way according to each system's needs.
- **RobMoSys** aims to establish Quality-of-Service properties, enabling a composition-oriented approach while preserving modularity.
- **RobMoSys** will drive the non-competitive part of building a professional quality ecosystem by encouraging the community involvement.
- **RobMoSys** will elaborate many of the common robot functionalities based on broad involvement of the community via two Open Calls.

Better models, as the basis for better tools and better software, which then allow to build better robotic systems
*The project is open for constructive suggestions from the community, as long as "platform", "composability" and "model-tool-code" are first-class citizens of those suggestions*
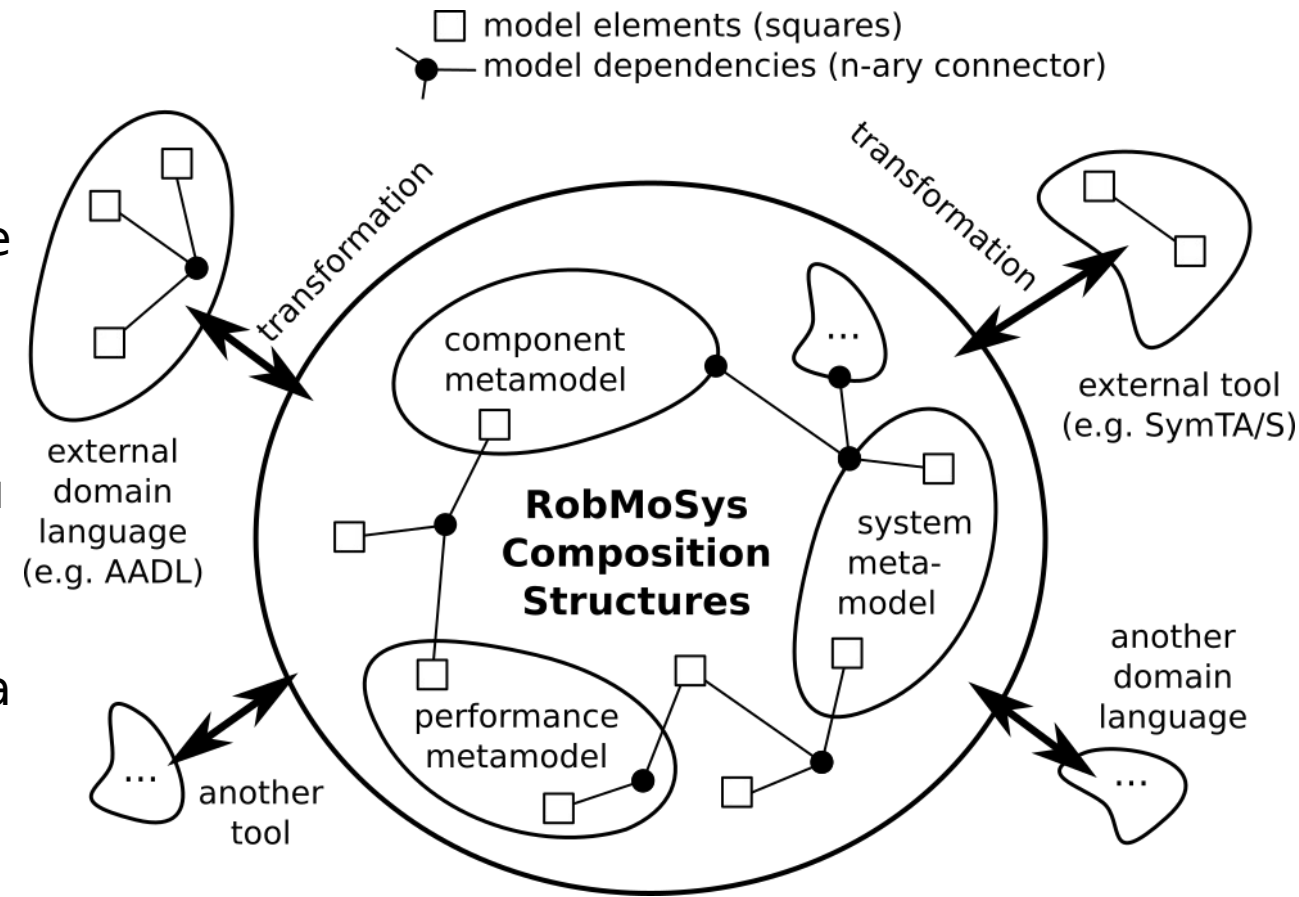
Ecosystem, Separation of Roles, Composition

- **RobMoSys enables the composition of robotics applications with managed, assured and maintained system-level properties via model-driven techniques**

- RobMoSys enables **communication of design intent**, **analysis of system design** before it is being built and **understanding of design change impacts**

- RobMoSys enables systems **correct by construction**

- RobMoSys supports management (design, assurance, traceability) of **(extra-functional) system properties** (e.g. resources, safety, QoS, accuracy, adequateness, etc.) in all development phases and at run-time:
  – deliver goods in time
  – trade-off energy consumption, speed, safety, etc.

Component Supplier

Task Expert

System Builder

HW & Deployment

Application Expert

…
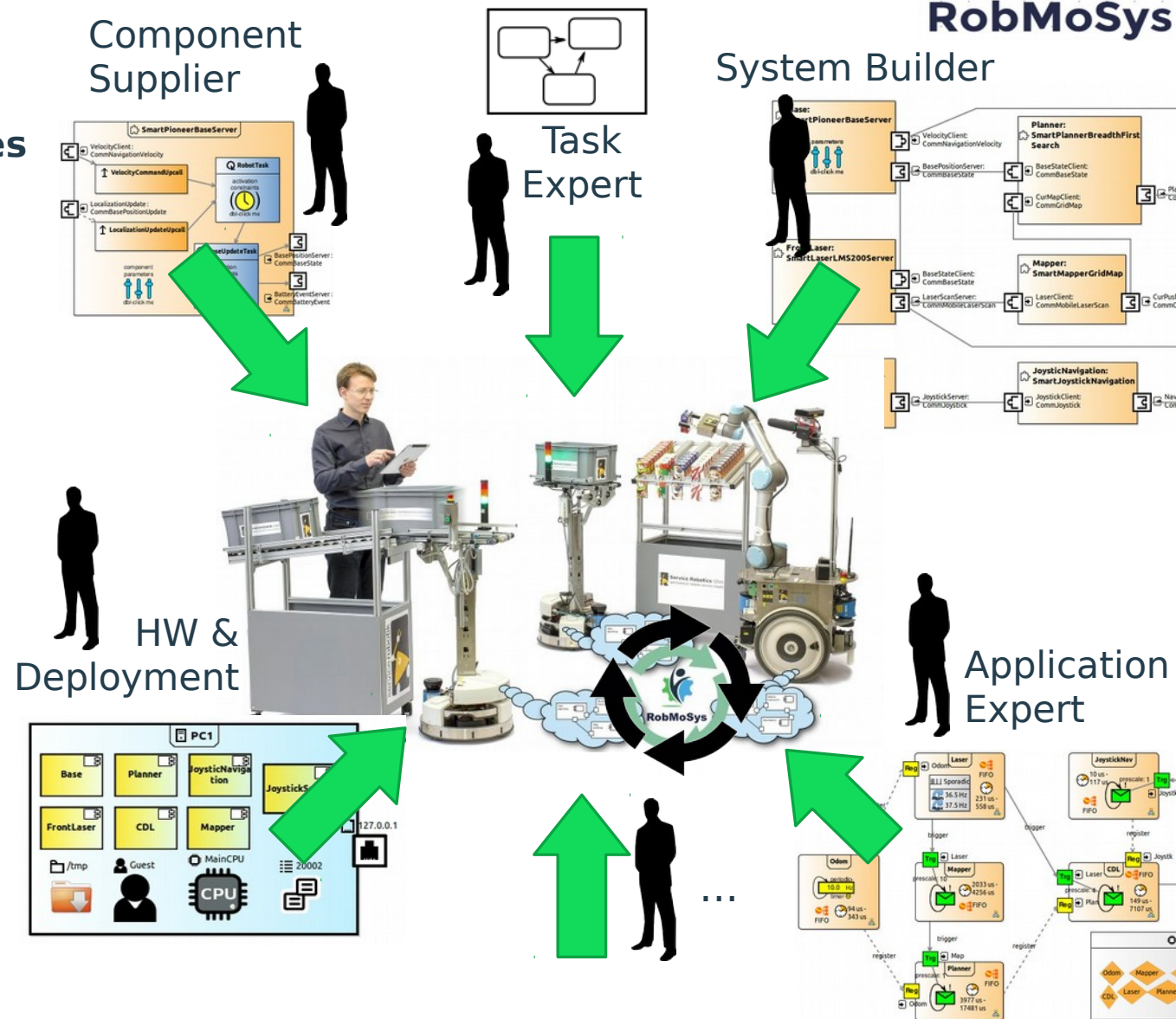
How to build models for different parts and different aspects of a robotic system?
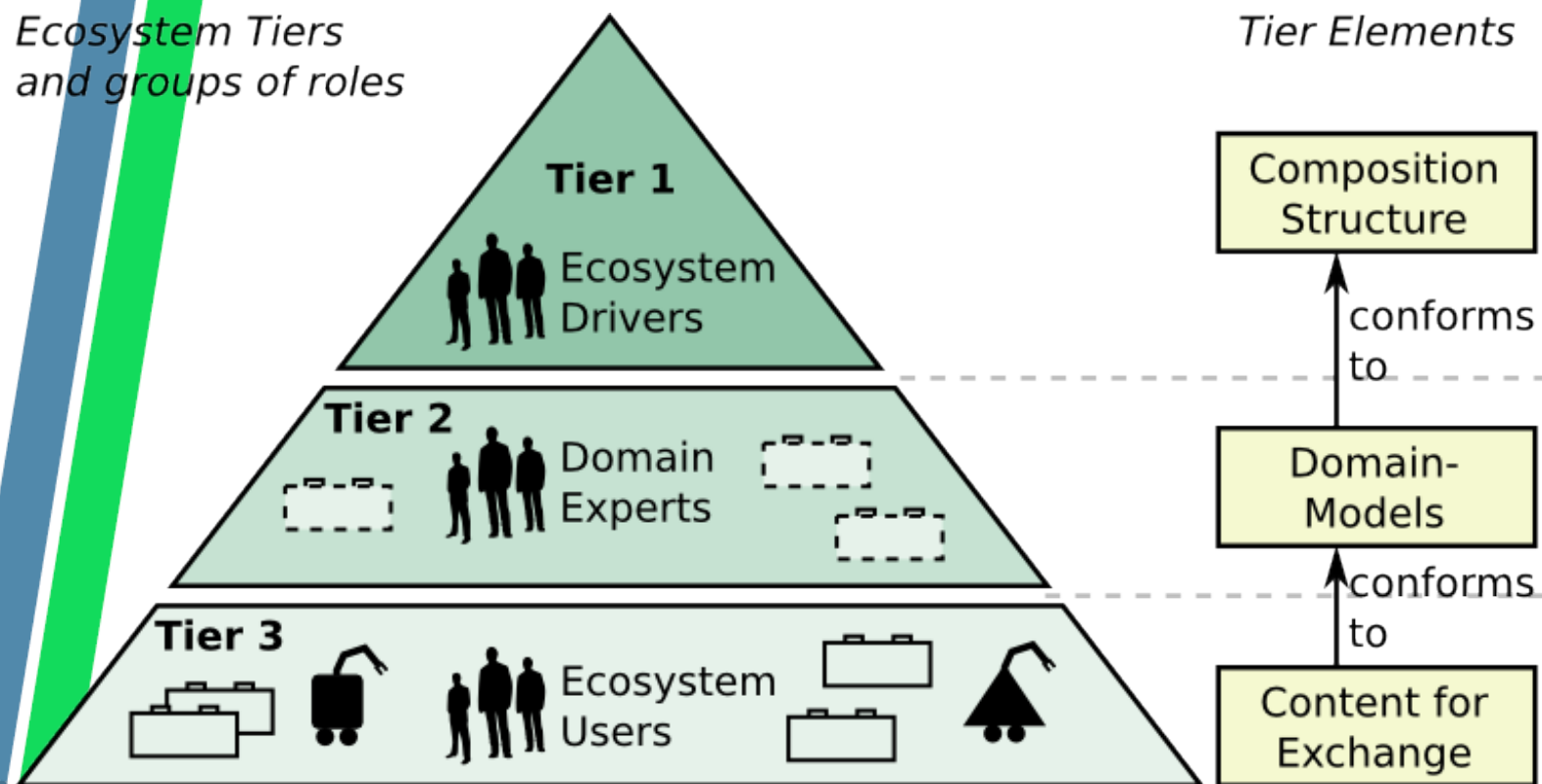
- be able to correctly **compose models**

- be at least as detailed as needed for a certain level of confidence into the properties of the outcome (by simulation, by testing, by reasoning, …)

- cannot be done easily as long as you do not adopt to a notion of Meta-Models

- Meta-Models allow to **transform** in a consistent way **between models** including constraints, tolerances etc.

- model elements (squares)
- model dependencies (n-ary connector)

transformation

transformation

external domain language (e.g. AADL)

component metamodel

…

external tool (e.g. SymTA/S)

RobMoSys Composition Structures

system meta-model

performance metamodel

another domain language

…

…

another tool

RobMoSys Ecosystem Organization

Ecosystem Tiers
and groups of roles

Tier 1 — Ecosystem Drivers

Tier 2 — Domain Experts

Tier 3 — Ecosystem Users

Tier Elements

Composition Structure

conforms to

Domain-Models

conforms to

Content for Exchange

RobMoSys envisions a robotics **business ecosystem** in which a large number of loosely interconnected participants depend on each other for their mutual effectiveness and individual success. The **modeling foundation guidelines** and the meta-*-model structures are driven by the needs of the typical tiers of an ecosystem and the needs of their stakeholders. The different **tiers are arranged along levels of abstractions**.

See: http://robmosys.eu/wiki/general_principles:ecosystem:start

RobMoSys Ecosystem Organization

- **Tier 1:** structures the ecosystem in general for robotics. It is shaped by the drivers of the ecosystem that define an overall composition structure which enables composition and which the lower tiers conform to (similar to, for example, the ecosystem of the Debian GNU/Linux OS and its structures). Tier 1 is shaped by few representative experts for ecosystems and composition. This is kick-started by the RobMoSys project.

  – Structures defined on Tier 1 can be compared to structures that are defined for the PC industry. The personal computer market is based on stable interfaces that change only slowly but allow for parts changing rapidly since the way parts interact can last longer than the parts themselves and there is a huge amount of cooperating and competing players involved. This resulted in a tremendous offer of composable systems and components.

- **Tier 2:** conforms to these foundations, structuring the particular domains within robotics and is shaped by the experts of these domains, for example, object recognition, manipulation, or SLAM. Tier 2 is shaped by representatives of the individual sub-domains in robotics.

- **Tier 3** conforms to the domain-structures of Tier 2 to supply and to use content. Here are the main "users" of the ecosystem, for example component suppliers and system builders. The number of users and contributors is significantly larger than on the above tiers as everyone contributing or using a building block is located at this tier.