

*Tutorial “Model-Driven Software Engineering in Robotics:
Models, Tools, Systems, Solutions, Challenges”*

Interactive Tool Demo: Piecing together software components to robotics pilot applications



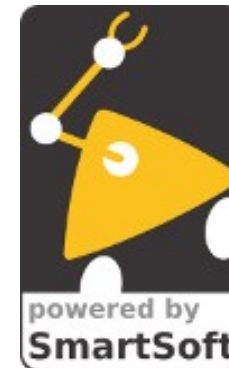
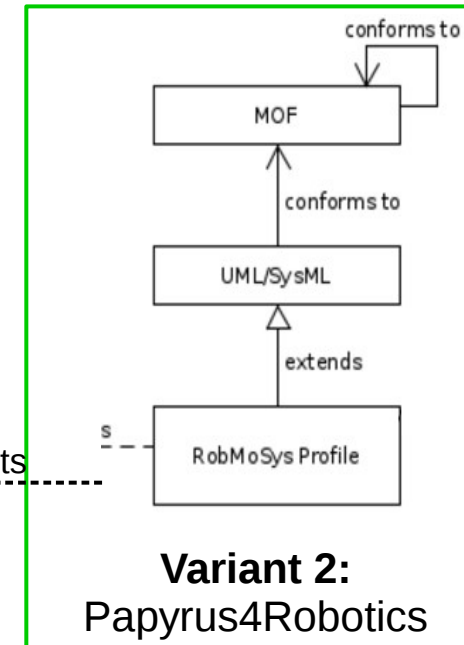
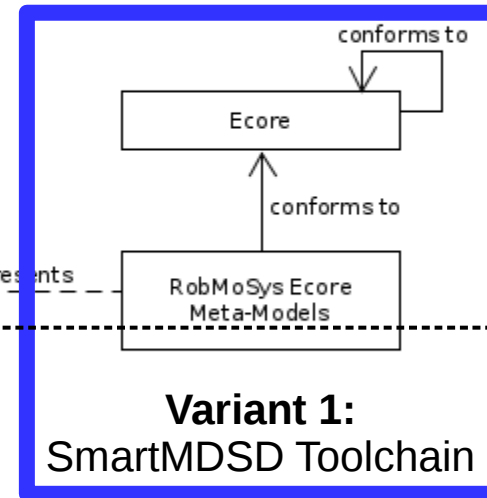
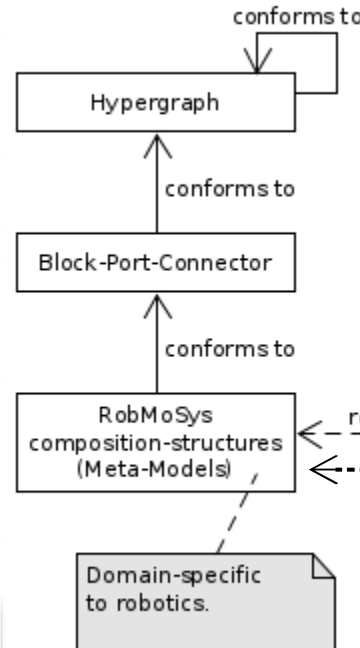
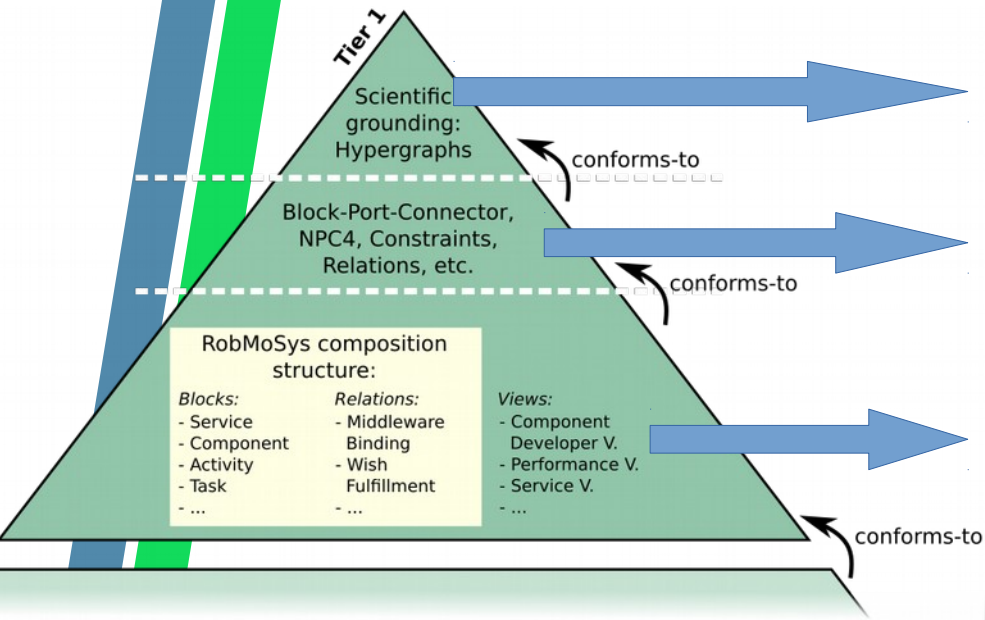
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 732410.



Outline

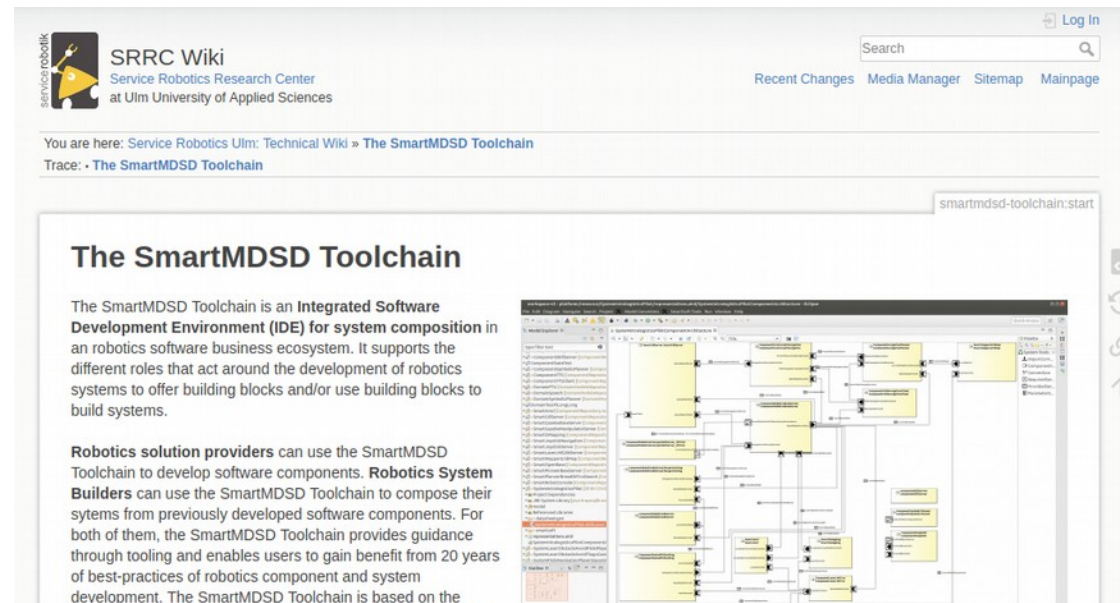
- Introduction
- Modeling systems
- Modeling and implementing components
- The Digital Data Sheet

RobMoSys Tooling: Realization alternatives



Where to get the SmartMDSD Toolchain

- **SmartMDSD Toolchain easy entry:**
 - Available as standalone installation
 - and **pre-installed/ready-to-go virtual machine image!**
 - https://robmosys.eu/wiki/baseline:environment_tools:smartsoft:start
- **Tutorials**
 - <https://wiki.servicerobotik-ulm.de/tutorials:start>
 - <https://wiki.servicerobotik-ulm.de/how-tos:start>

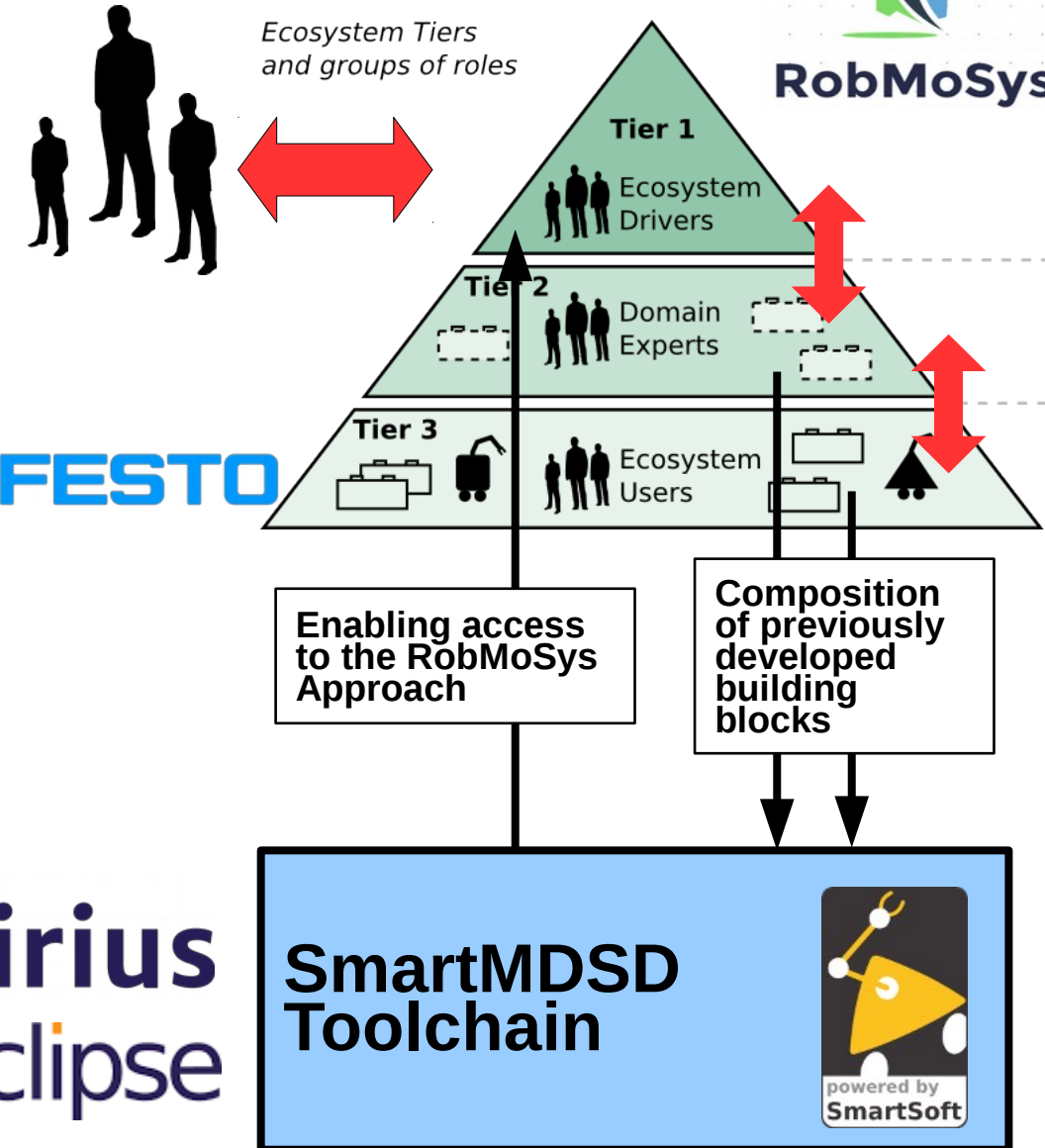


SmartMDSD Toolchain

- The SmartMDSD Toolchain is an Integrated Development Environment (**IDE**) for robotics software to support system composition according to the structures of RobMoSys.
- Strong in building **real systems**
- Very **mature**, Used in Products delivered by **FESTO**



Industry 4.0 Intralogistics Pilot

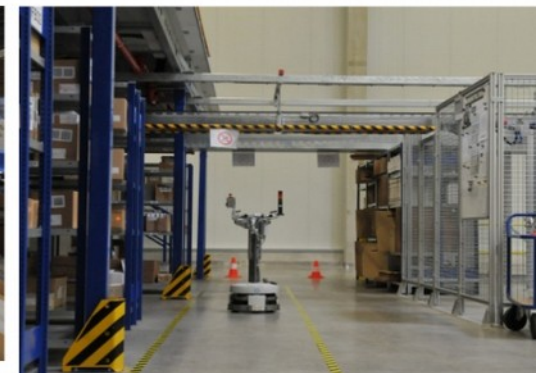
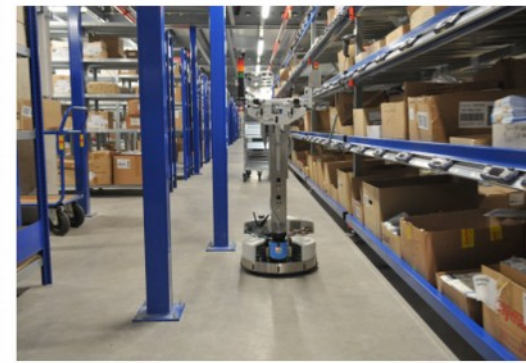
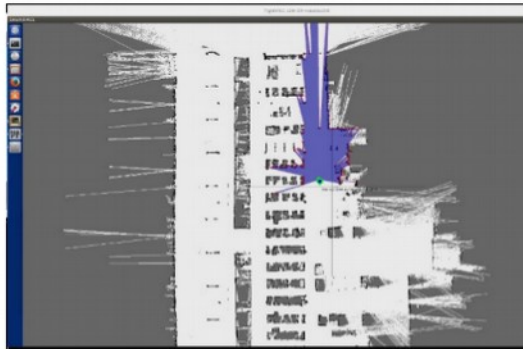


Applications built with the SmartMDSD Toolchain

<https://www.youtube.com/user/RoboticsAtHsUlm>



RobMoSys





YouTube^{DE}

Search



RobMoSys

Robot
Quality
MΣtries



The operator places a box on top of the robot and presses a button to indicate it is ready to proceed to the delivery position.

1:44 / 4:30

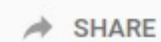
RoQME

SAFETY

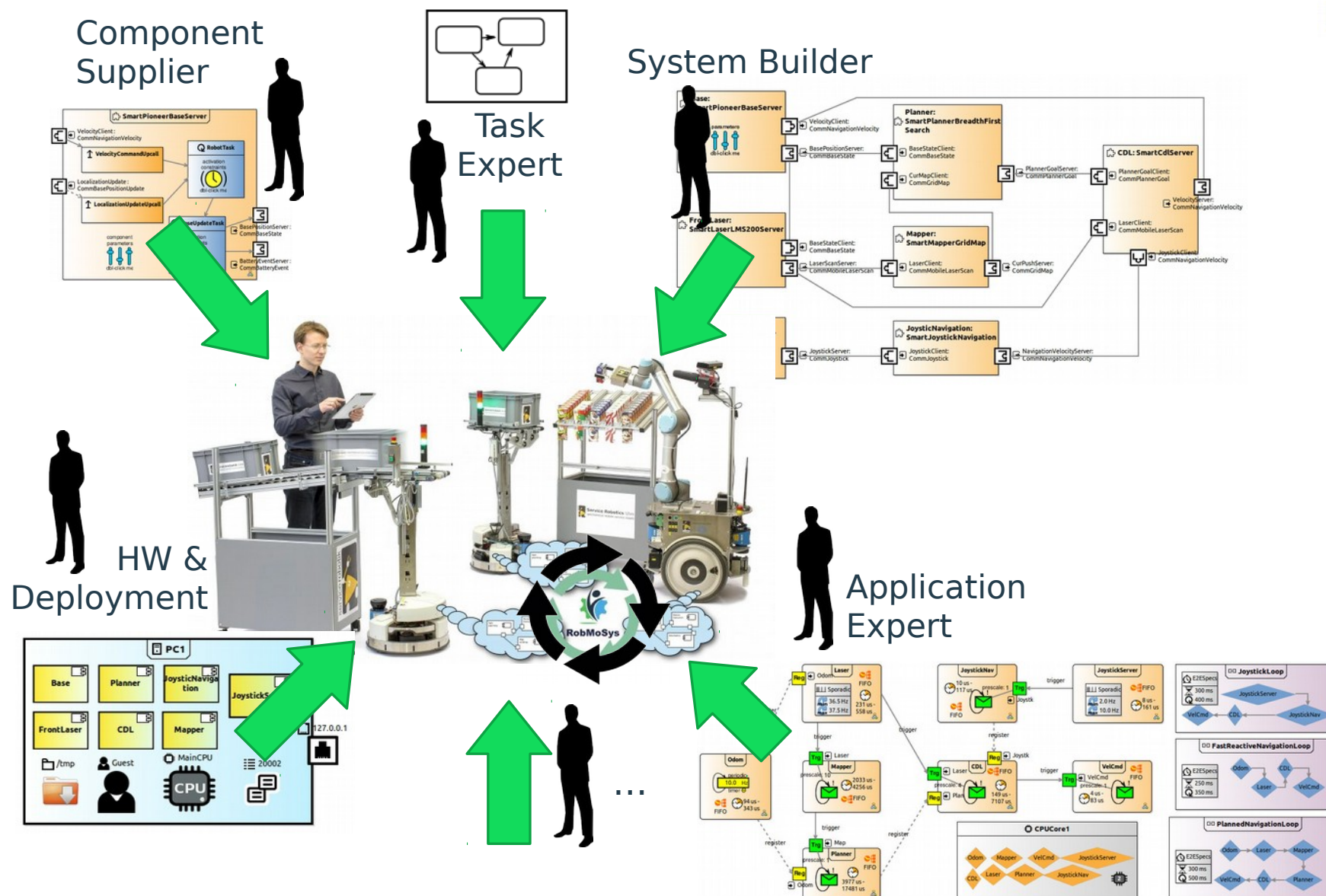
PERFORMANCE

Dealing with Metrics on Non-Functional Properties in RobMoSys

43 views



Ecosystem, Separation of Roles, Composition



RobMoSys Modeling Directory



RobMoSys Wiki
<http://www.robmosys.eu>

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You are here: [RobMoSys Wiki](#) » [RobMoSys Model Directory](#)

RobMoSys Model Directory

A list of domain models, software components and systems for use with RobMoSys Tooling. Please see end of page for a legend.

Tier 2 Domain Models

Name	Description	Purpose	Vendor	Tooling	Status
 CommBasicObjects	A collection of very basic service definitions and communication objects for use in almost every robotics system.	Universal	HSU	SmartMDSD Toolchain v3	Ready
 CommNavigationObjects	A collection of domain models for navigation .				
 CommRobotinoObjects	A collection of domain models for the Robotino robot.				
 CommLocalizationObjects	A collection of domain models for localization .				
 CommManipulationPlannerObjects	A collection of domain models for manipulation .				
 CommManipulatorObjects	A collection of domain models for manipulation .				
 CommObjectRecognitionObjects	A collection of domain models for object recognition .				

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- ♦ [Tier 2 Domain Models](#)
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- ♦ [Tier 3 Systems](#)
- ♦ [Explanation/Legend](#)

Tier 3 Component Models

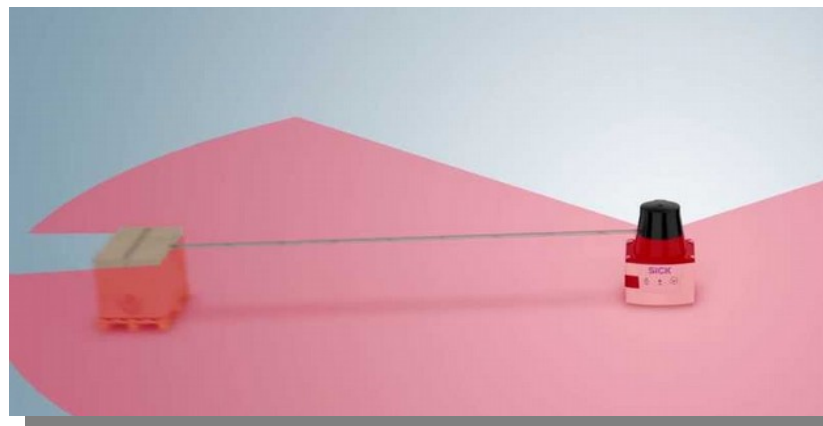
Name	Description	Purpose	Vendor	Tooling	Status	Fig
 SmartCdlServer	Implements the Curvature Distance Lookup (CDL) algorithm for fast local obstacle avoidance. It considers the dynamics and kinematics of the robot.	Navigation	HSU	SmartMDSD Toolchain v3	Ready	   
 ComponentLaserObstacleAvoidance						
 ComponentPlayerStageSimulation						
 ComponentSymbolicPlanner						

Tier 3 Systems

Name	Description	Purpose	Vendor	Tooling
 SystemTiagoNavigation	A pilot skeleton that covers the navigation aspect of the Intralogistics Industry 4.0 Robot Fleet Pilot and Assistive Mobile Manipulation Pilot. This system covers the TIAGo Robot in simulation/Gazebo.	Navigation	HSU	SmartMDSD Toolchain v3
 SystemP3dxNavigationRealWorld	A pilot skeleton that covers the navigation aspect of the Intralogistics Industry 4.0 Robot Fleet Pilot and Assistive Mobile Manipulation Pilot. This system covers the P3dx Robot in real world.	Navigation	HSU	SmartMDSD Toolchain v3

<https://robmosys.eu/wiki/model-directory:start>

Replacement of Components



Replacement of Components

THU

SmartMDSD Toolchain

Modifying a Robot System: Exchanging Sensor




0:02 / 1:41

SmartMDSD Toolchain - Modifying a Robot System: Exchanging Sensor

34 views

1 0 SHARE SAVE ...

<https://www.youtube.com/watch?v=RHvvb6lTHG4>

Demo:

Piecing together software components

Example: Simple Navigation Example

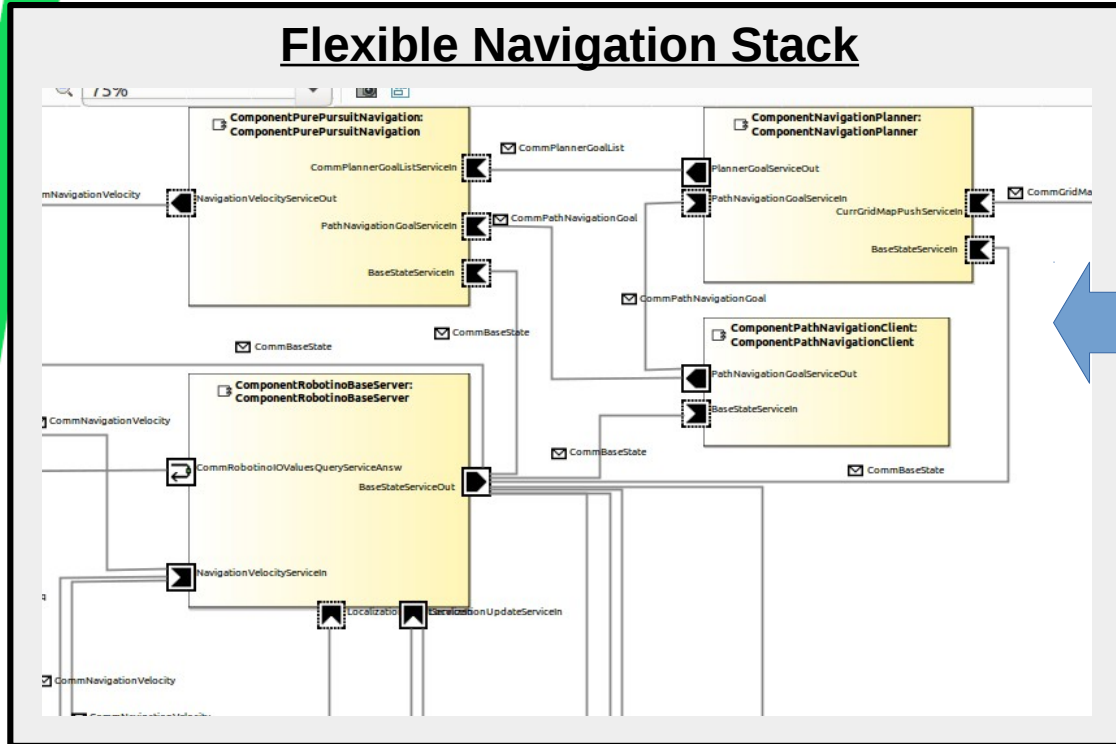
Tutorial and screencast to reproduce at home:

<https://wiki.servicerobotik-ulm.de/tutorials:develop-your-first-system:start>

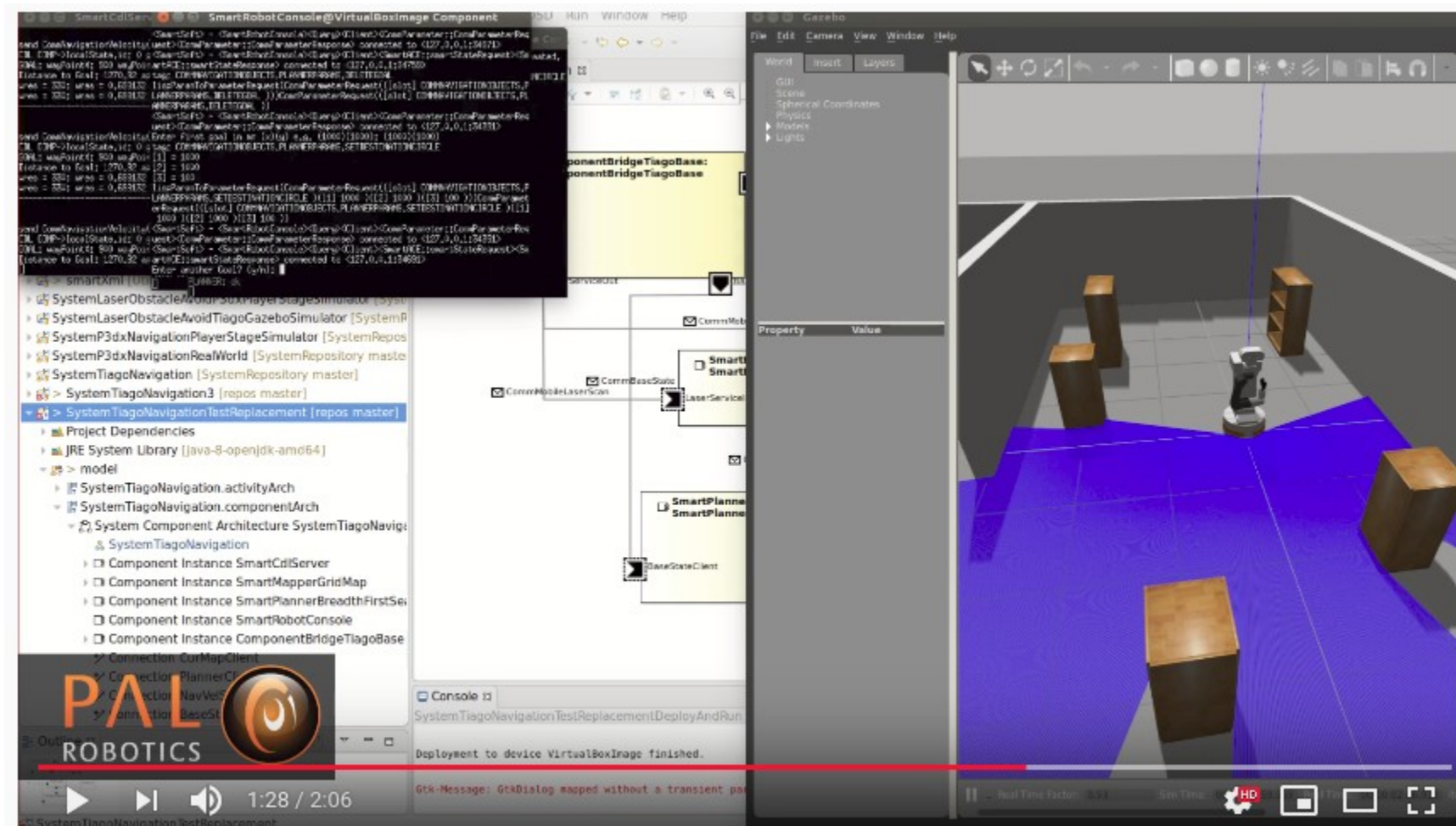
<https://wiki.servicerobotik-ulm.de/tutorials:laser-obstacle-avoid-scenario:start>

<https://wiki.servicerobotik-ulm.de/tutorials:flexible-navigation-task:start>

Replacement of Components: **Flexible Navigation Stack**



Replacement of Components

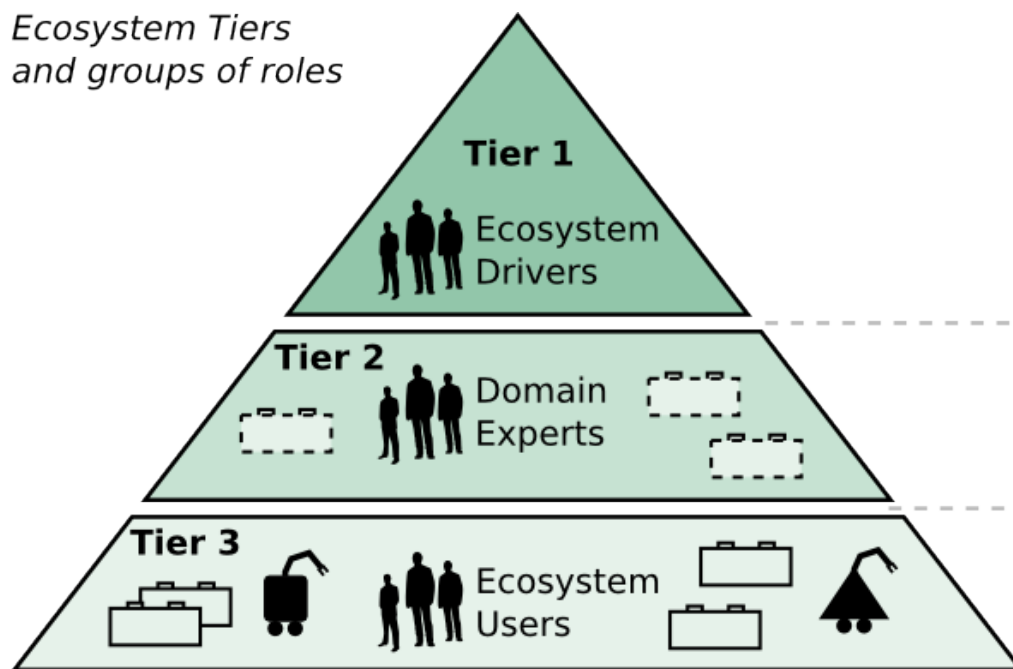


RobMoSys tooling in TIAGo robot

<https://www.youtube.com/watch?v=FCvK9dAZXPo>

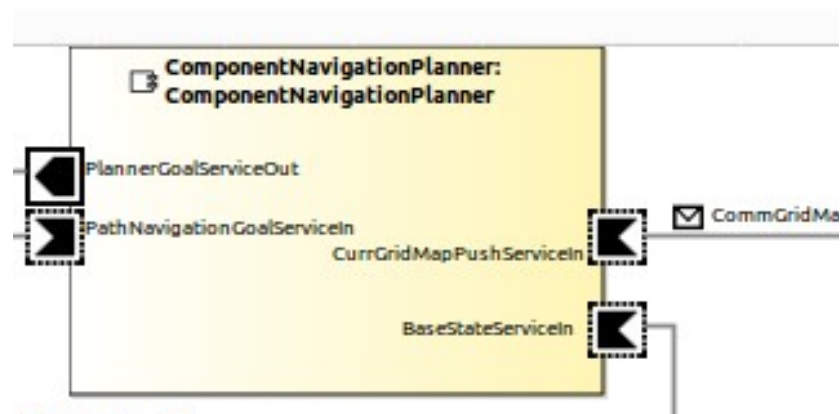
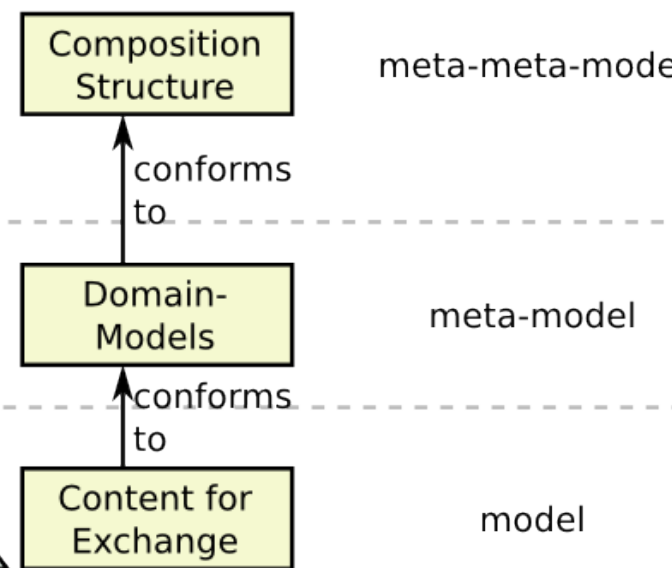
Ecosystem Organization

*Ecosystem Tiers
and groups of roles*



Tier Elements

In terms of modeling



Demo:

Modeling and implementing a Software Component

Example: Simple Obstacle Avoidance Component

Tutorial and screencast to reproduce at home:

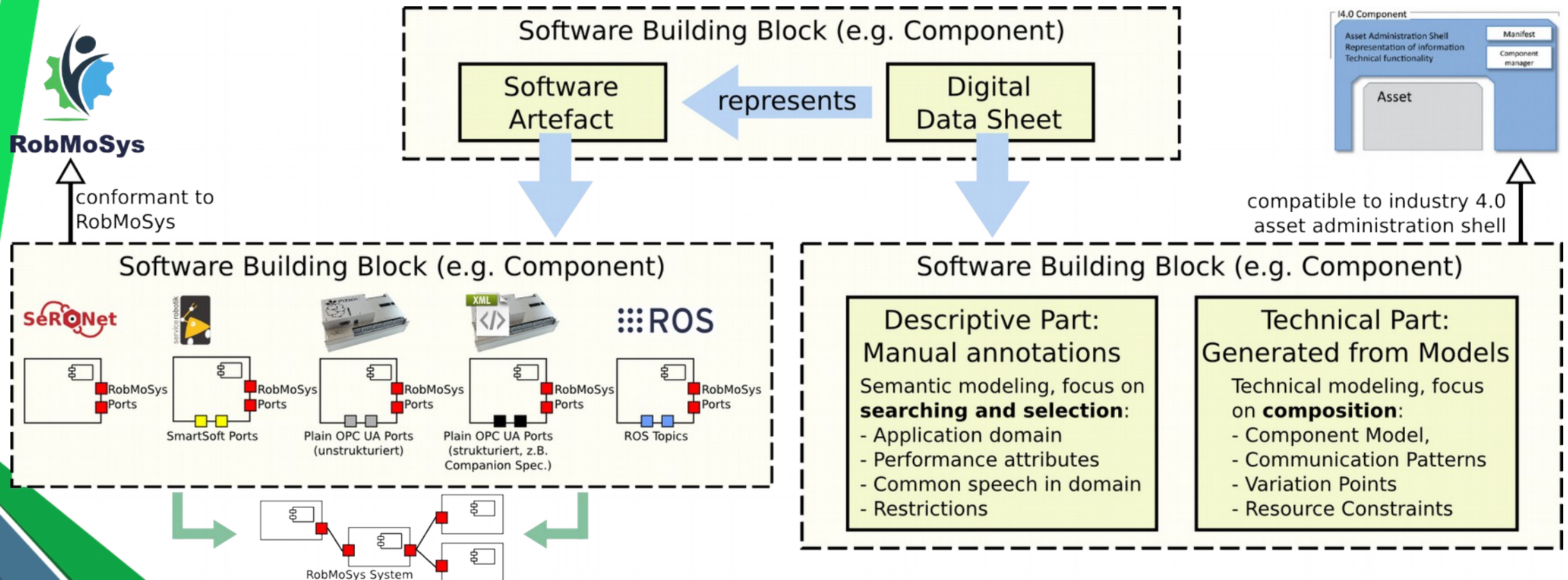
<https://wiki.servicerobotik-ulm.de/tutorials:develop-your-first-component:start>

<https://wiki.servicerobotik-ulm.de/tutorials:develop-your-first-domain-model:start>

Outline

- Introduction
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- Modeling and implementing Components
- **The Digital Data Sheet**

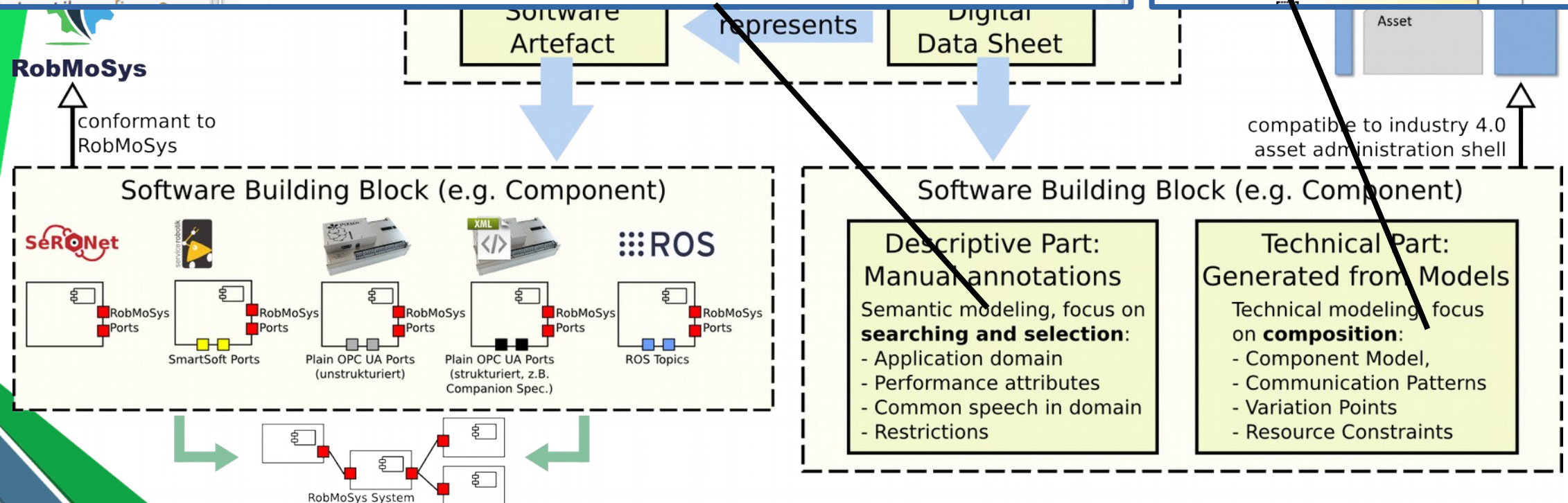
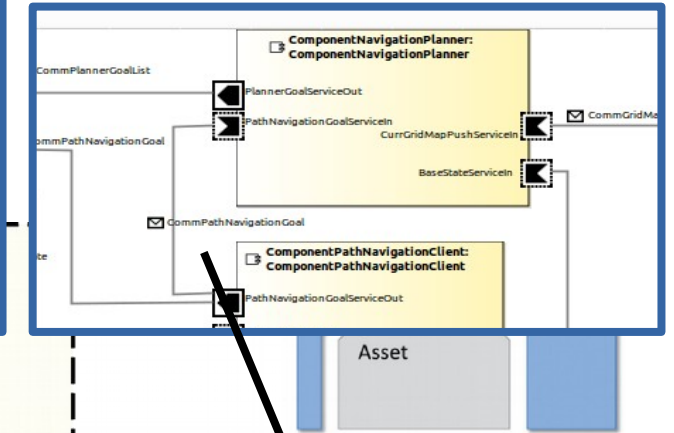
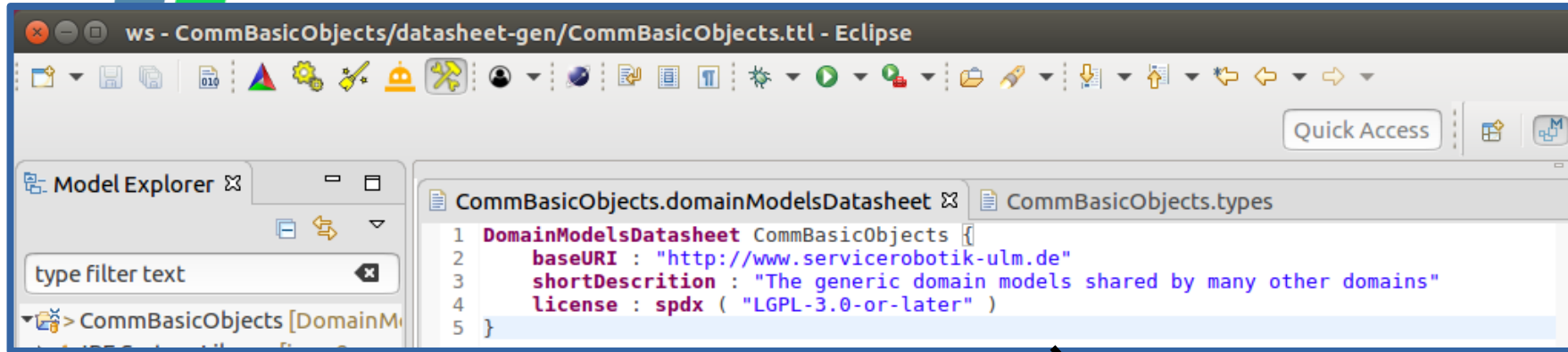
Digital Data Sheet



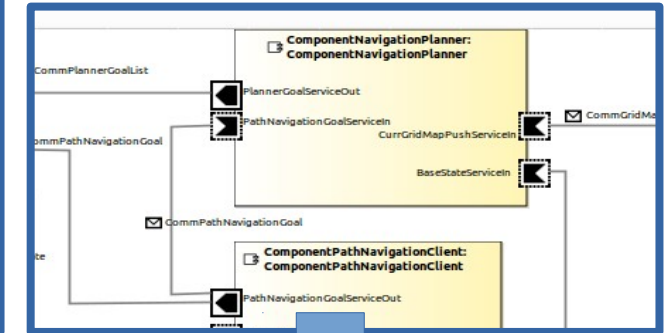
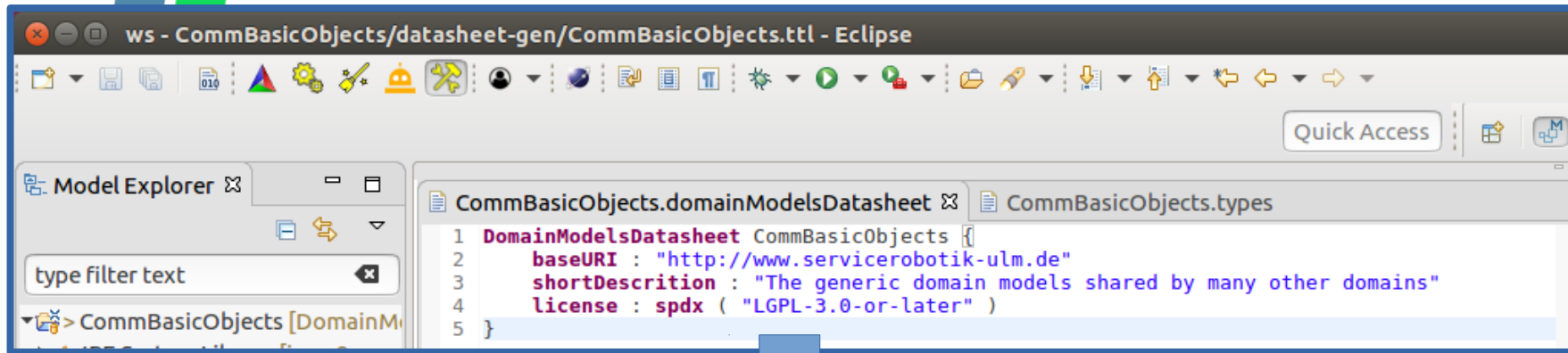
Digital Data Sheet



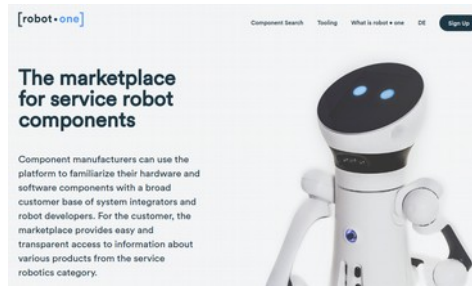
RobMoSys



Digital Data Sheet



RDF, Ontologies, ...



Documentation
for humans

Component Parameters SmartCdlServerParams

InternalParameter PathNav

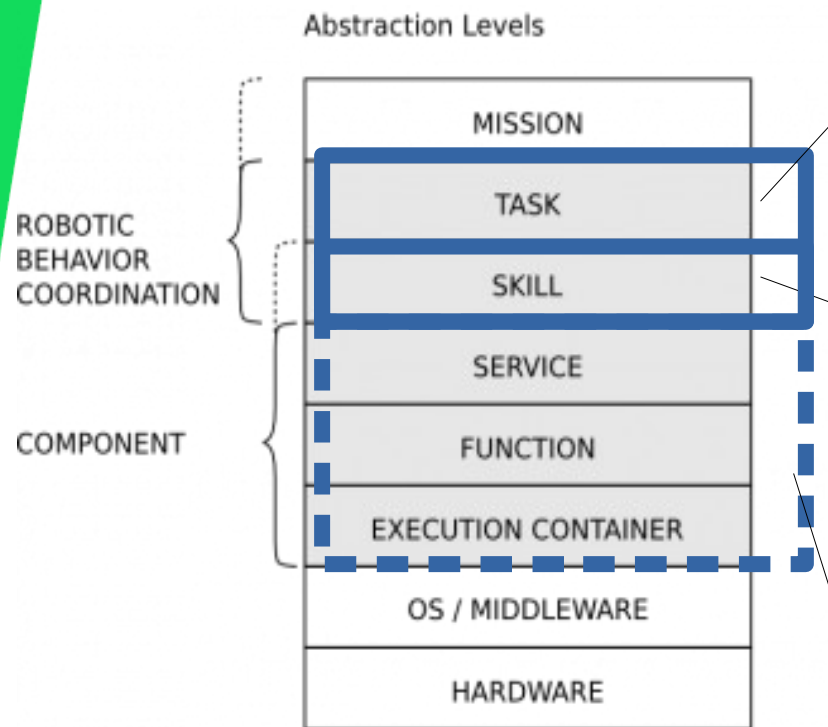
Attribute Name	Attribute Type	Description
pathNavPredictedGoalPose_control1_dist	Double	
pathNavPredictedGoalPose_control1_speed	Double	
pathNavPredictedGoalPose_control2_dist	Double	
pathNavPredictedGoalPose_control2_speed	Double	
pathNavPredictedGoalPose_control3_dist	Double	
pathNavPredictedGoalPose_control3_speed	Double	
pathNavPredictedGoalPose_minDist	Double	
pathNavRecover_max_dist	Double	
robotBlocked_event_timeout	UInt16	timeout for robot being block in seconds

InternalParameter Cdl

Tooling
Interoperability



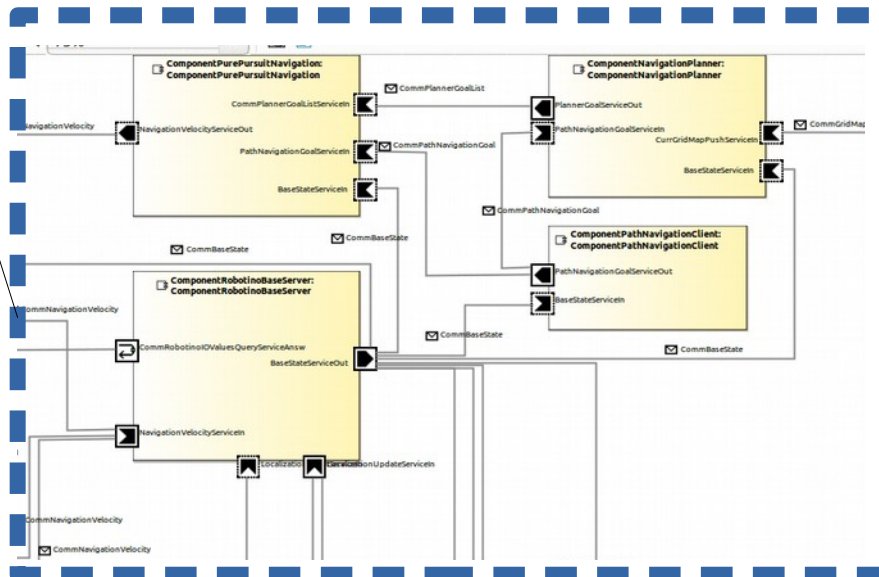
Behaviour Coordination



Tasks
Delivery



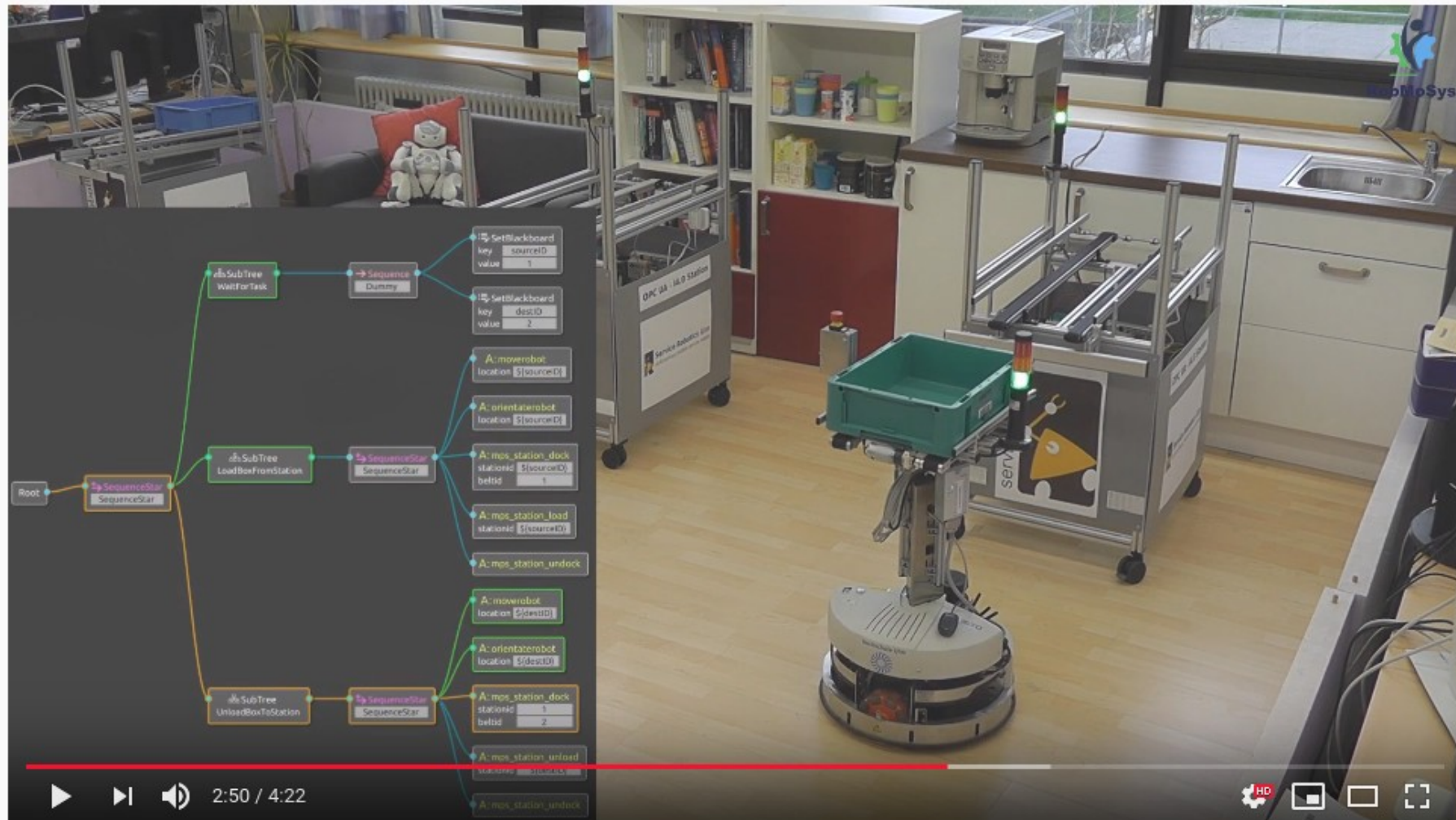
Skills:
pick up box
go to
drop box



Behaviour Coordination



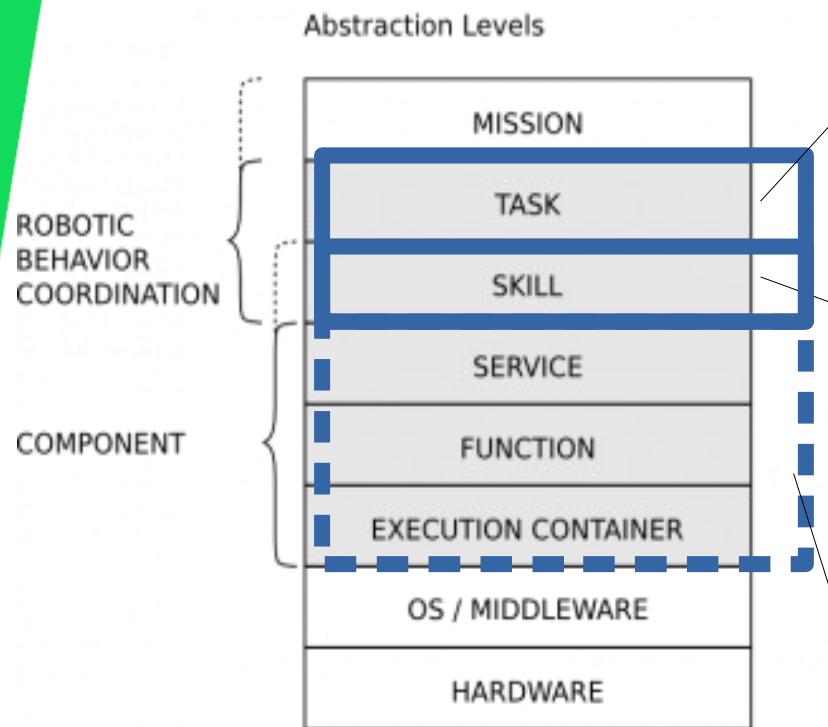
RobMoSys



Robotic Behavior in RobMoSys using Behavior Trees and the SmartMDSD Toolchain

https://www.youtube.com/watch?v=54_skOuHsds

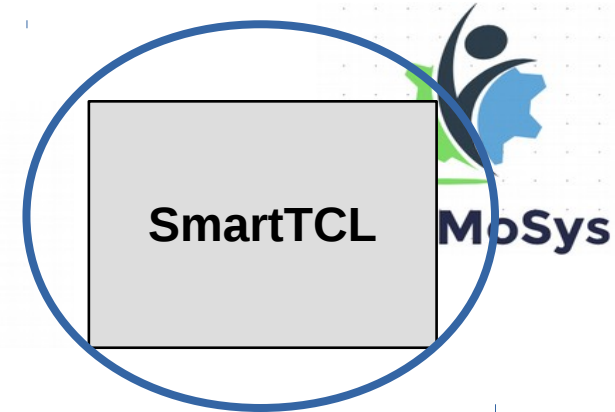
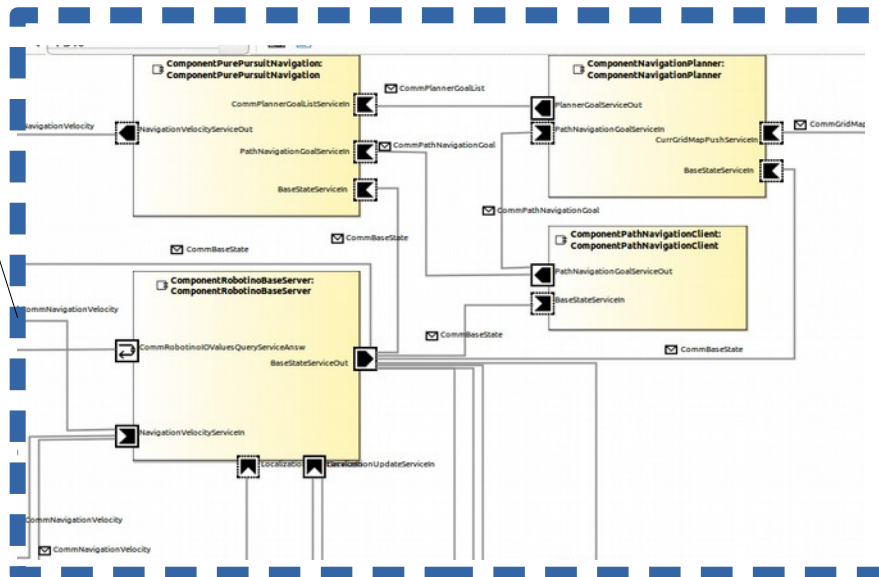
Behaviour Coordination



Tasks
Delivery



Skills:
pick up box
go to
drop box



Behaviour Coordination



Intralogistics Scenario: Flexible Context Model Adaptation for Robotic Order Picking

<https://www.youtube.com/watch?v=5116bGhXBr8>