Model Based Robot Software Development

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Motivation

- Robot complexity and task complexity is growing
- Costly development
- **How to handle the complexity?**
  - Modules
  - Models

Modules allow reuse – Models say how

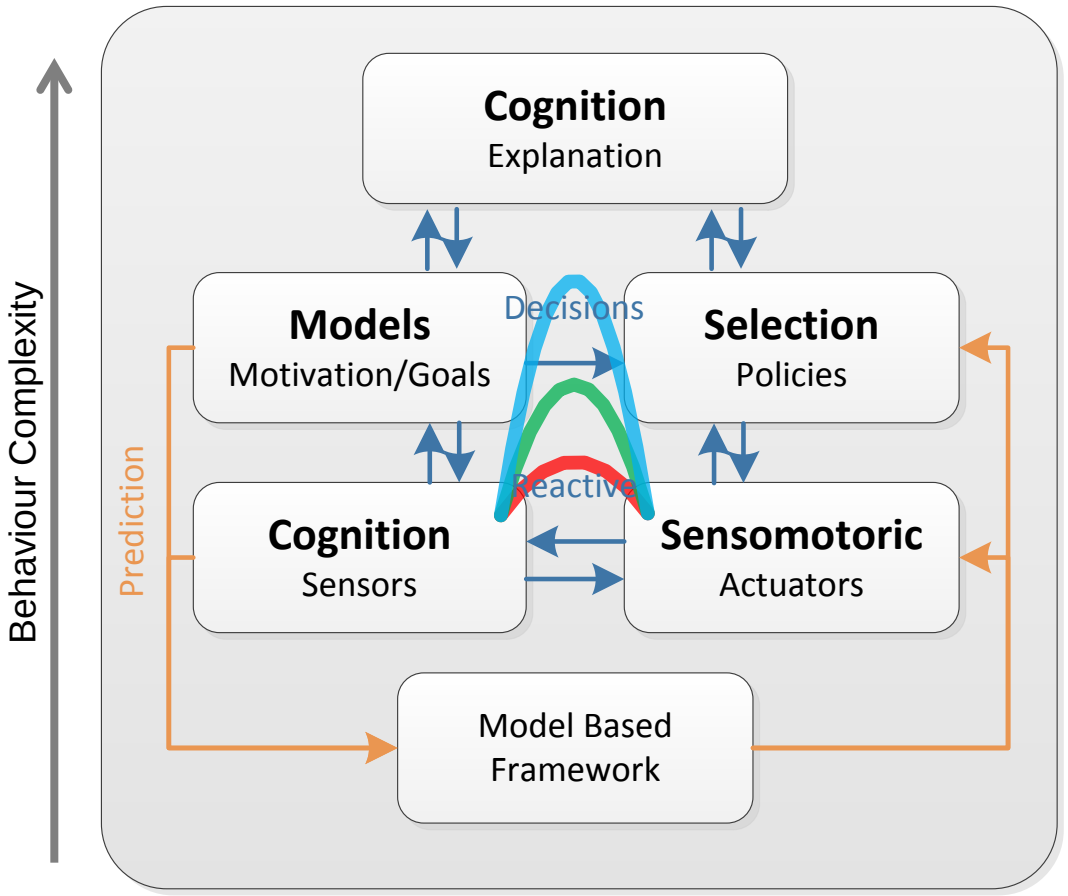
Robot Development

- Process should be
  - **Structured** – development process
  - **Reproducible** – design & behaviour
  - **Scalable** – in system and development complexity
  - **Dynamic** – on-line reconfigurability

- Three different views
  - Behaviour
  - Hardware
  - Software

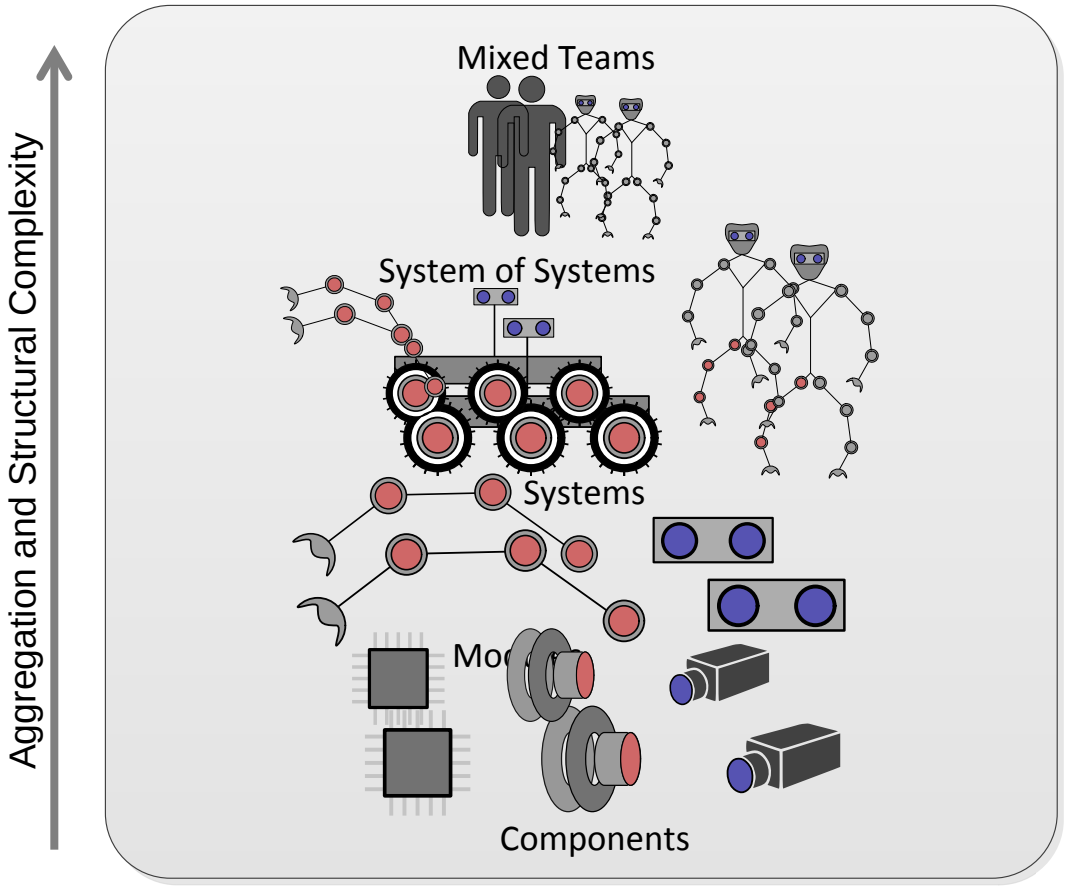
Robot Development - Behaviour

- Process should be
  - Structured
  - Reproducible
  - Scalable
  - Dynamic
- Three different views
  - **Behaviour**
  - Hardware
  - Software



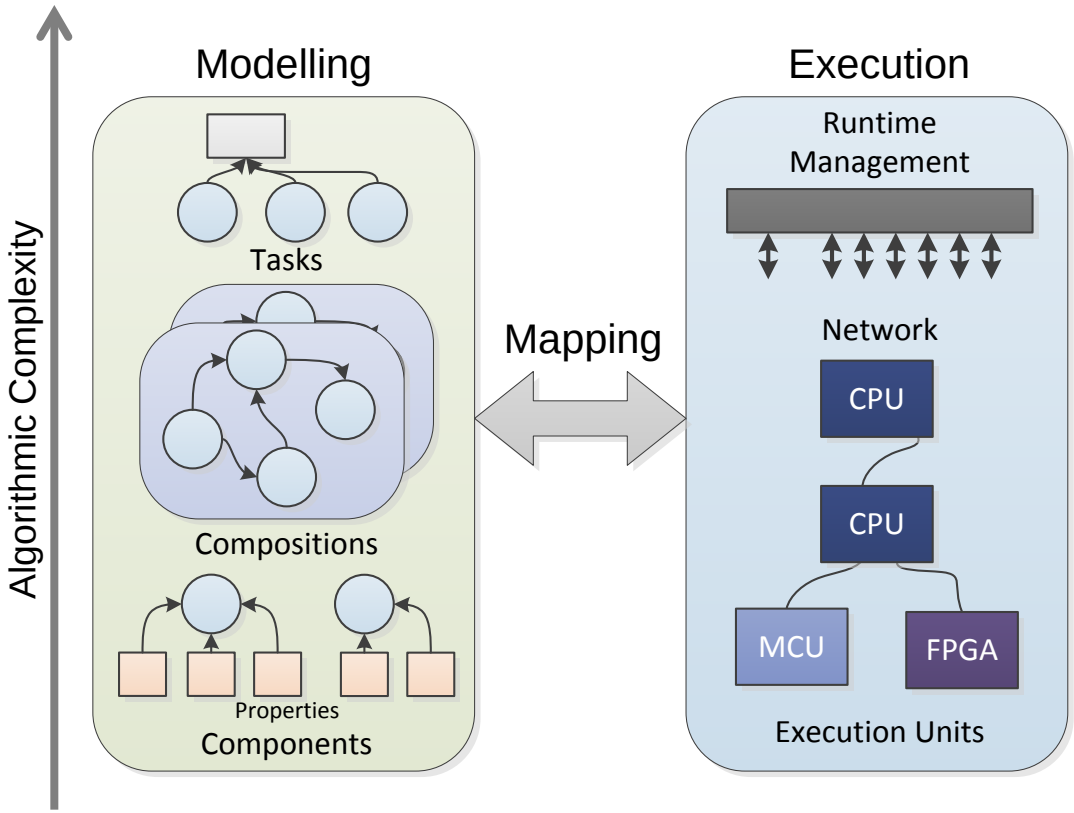
Robot Development - Hardware

- Process should be
  - Structured
  - Reproducible
  - Scalable
  - Dynamic
- Three different views
  - Behaviour
  - **Hardware**
  - Software

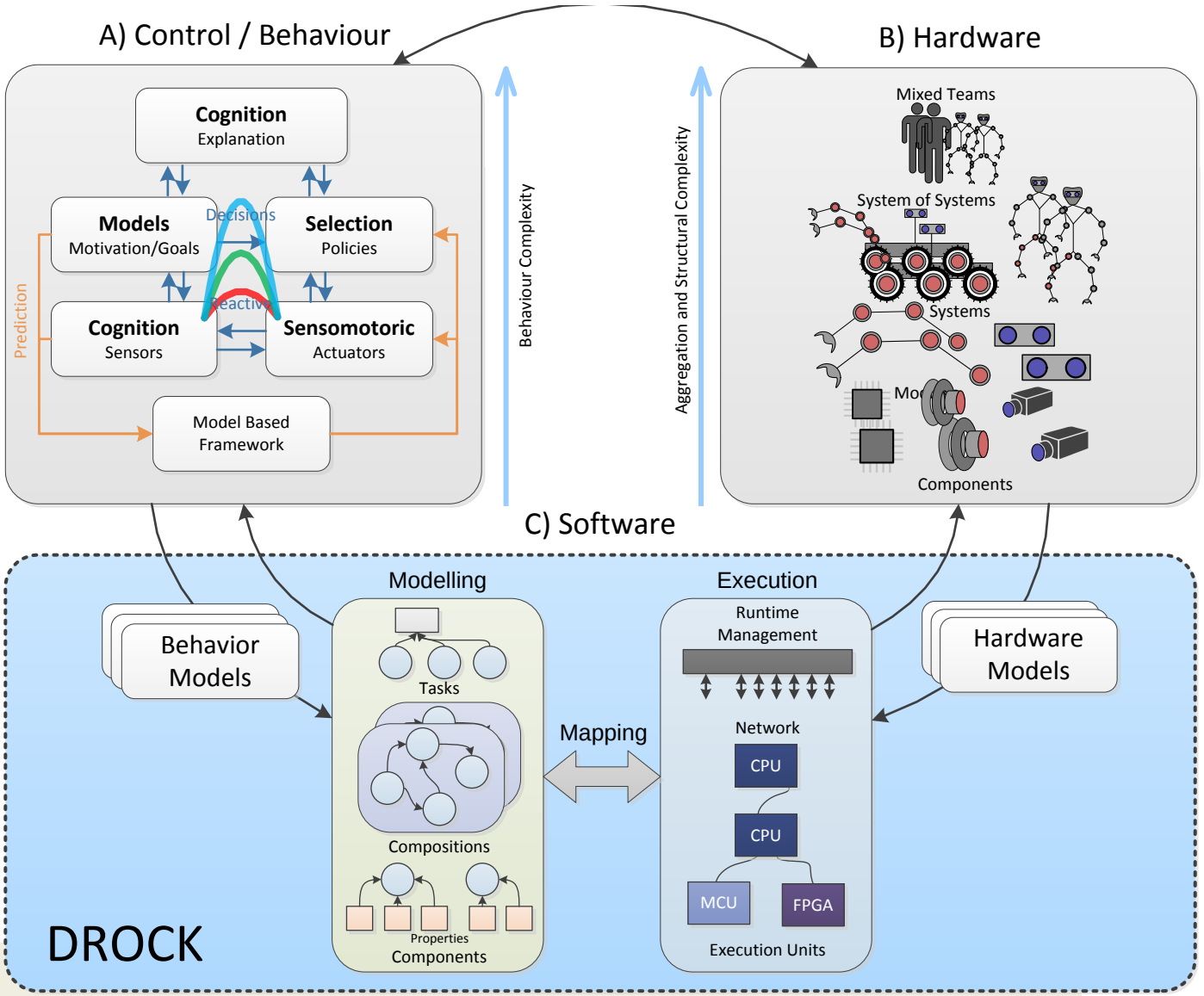


Robot Development - Software

- Process should be
  - Structured
  - Reproducible
  - Scalable
  - Dynamic
- Three different views
  - Behaviour
  - Hardware
  - **Software**



Development Relations



DROCK Project

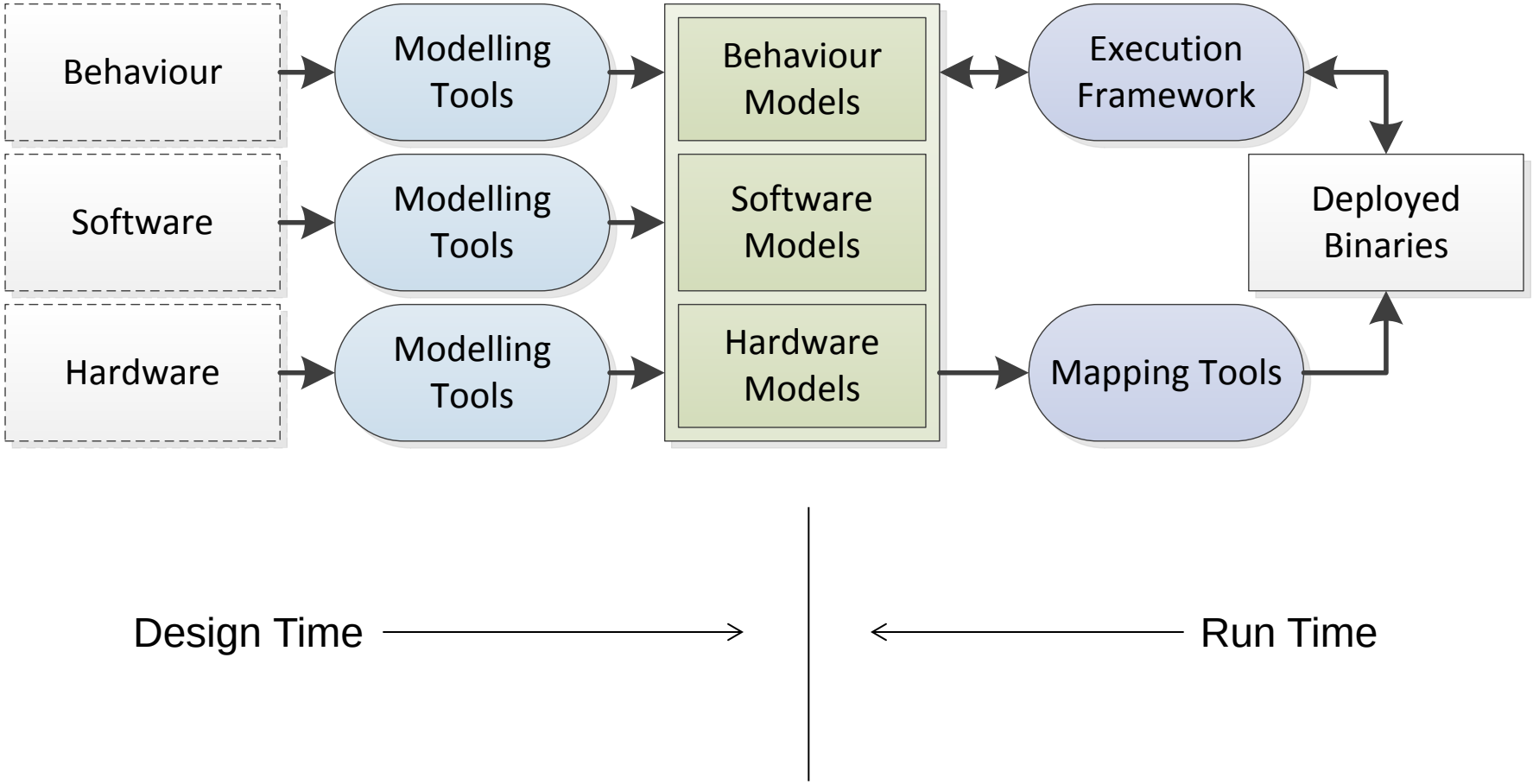
Goal: Design and implementation of a **framework** and **tools** for **robot programming**.

- Objectives:
  - **Modelling** of robotic structure
  - **Mapping** of tasks onto execution units
  - **Execution** and monitoring with dynamic reconfiguration
  - **Tools** to support the development
  - **Evaluation** of toolset in demo scenario and user study

Challenges

- Modelling
  - Consistent models
  - Practical focus on robotic problems
- Mapping
  - Requires robot specific heuristics
  - Deployment on heterogenous units (CPU, uC, FPGA)
- Execution
  - Monitoring in heterogenous environment
  - Decision on reconfiguration
  - Distributed supervision

Tools

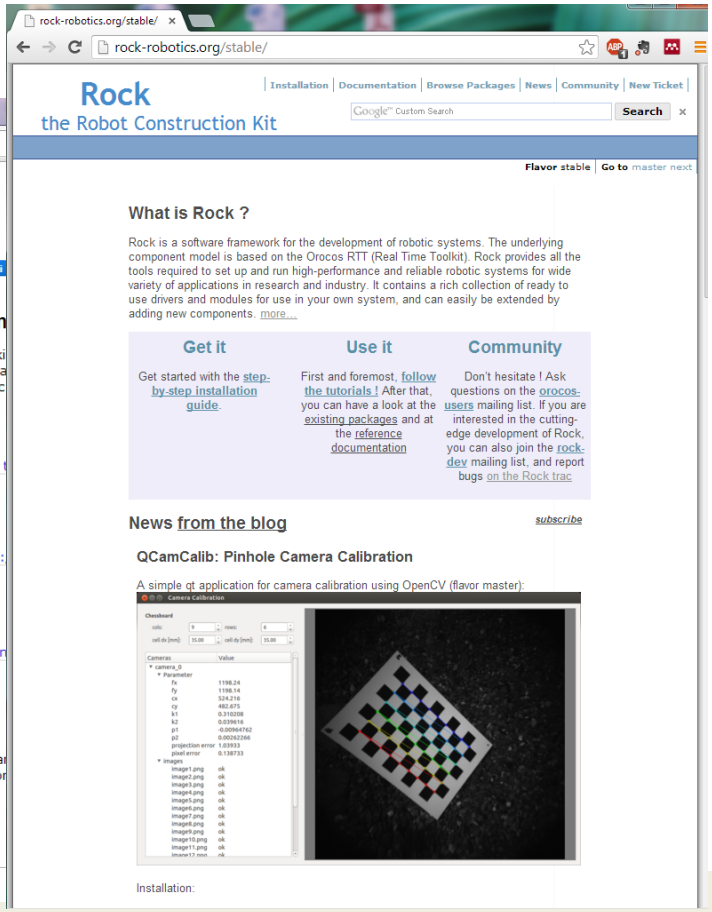

Behaviour
Software
Hardware
Modelling Tools
Modelling Tools
Modelling Tools
Behaviour Models
Software Models
Hardware Models
Execution Framework
Deployed Binaries
Mapping Tools
Design Time
Run Time

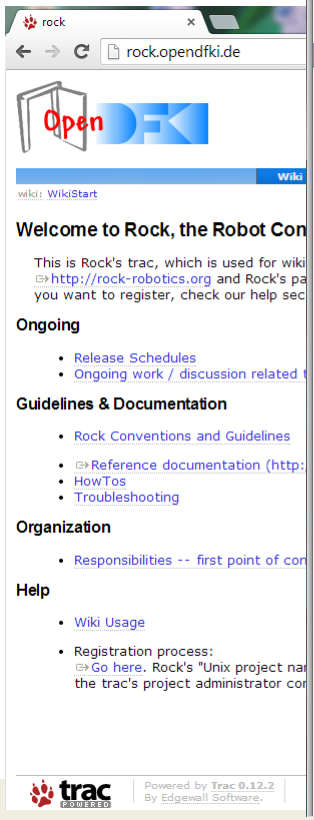
State of the Art

- ROS (Robot Operating System)
  - Implicit component model
  - Low-resistance workflow – ad-hoc development
  - Topic based communication
- Orocos RTT
  - Implicit component model
  - Point to point connections
  - Real-time capable
- GenoM
  - Explicit component model
  - Capable of generating Behaviour Interaction Priority (BIP)
- Rock
  - Explict component and network model
  - Orocos RTT as Middleware
  - Dynamic run-time reconfiguration

Robot Construction Kit (ROCK)

- www.rock-robotics.org
- rock.opendfki.de
- github



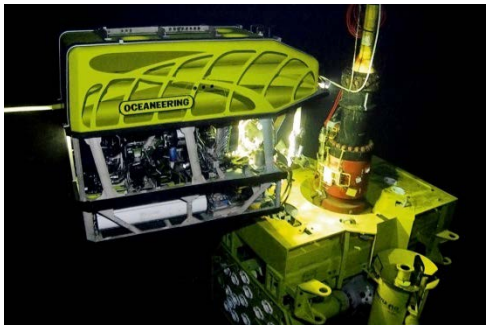


- Development started in 2008
- Running on more than 12 Robots at DFKI/RIC
- In use by ESA ESTEC, Space Applications, Marum, Geomar, etc.
- 199+ library packages (internal + external)
- 136+ component packages
- 80 messages / month on rock-dev@dfki.de
- 30 active members on mailing list in last 6 months

Industrial Applications

- Industrial robotics will change
- Complex tasks – human shared environments
- Model based approach
  - Robust
    - Generic instantiation
    - Generic failure handling
  - Verification
    - Component level testing
    - Correct by construction
    - Model inference
- Industrial Use
  - Space
  - Off-shore
  - Human shared

NASA / JPL



Oceaneering

BMW AG