

2.3 'The Artemis Rover as an Example for Model Based Engineering in Space Robotics' (FS-T-03)

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Abstract

Future application of robotic missions in the space context will require the systems to have both mobility and manipulation capabilities. The limited direct communication with the systems due to visibility, and severe time delays also make it a requirement for the system to perform its actions mainly autonomously. The increasing complexity of the task, as well as the strict requirements for reliability and fault tolerance pose a significant challenge to both engineering and research activities. The SpaceBot Cup was held in November 2013 to probe those capabilities in the context of a competition. In this paper we present the Artemis rover and its software architecture as well as the competition results and lessons learned. Special attention is given to the modular design based on the Robot Construction Kit (Rock); a component based software framework, which uses a component model based on the Orocos Real-Time-Toolkit (RTT).



The Artemis Rover as an Example for Model Based Engineering in Space Robotics

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presented by Stefan Haase

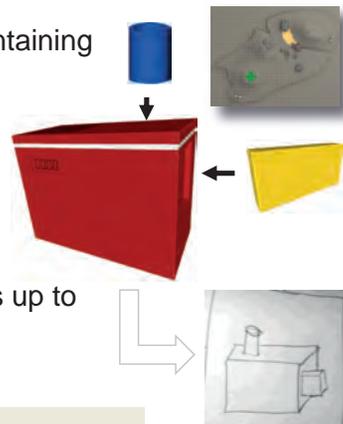
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The Spacebot Cup



- Development of an autonomous mobile manipulation system within 8 month
- Task:
 - unknown exploration area (21x21.5m²) containing three target objects
 - find and collect two objects
 - find main object and assemble all
- Constraints:
 - remote operation allowed up to three times up to 5 minutes each
 - communication delay of 2s (one-way)



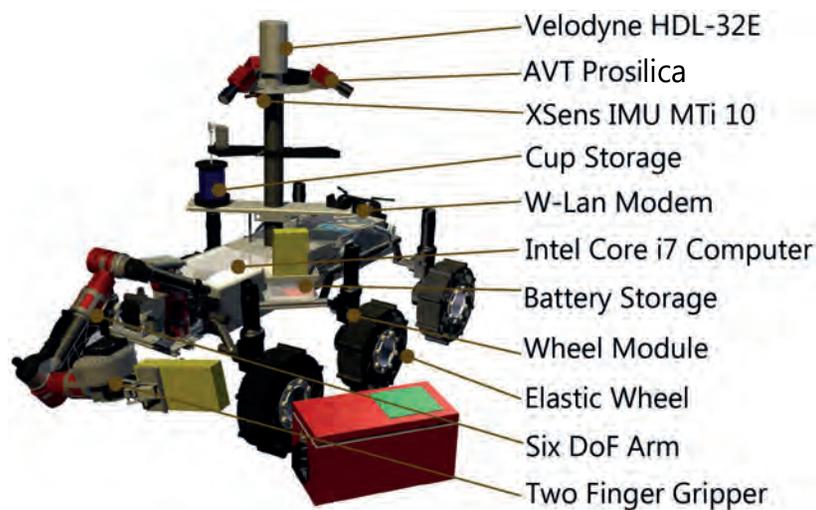
Development approach



- Top down
 - high-level mission decomposition and identification of required capabilities
 - distribution of tasks to specialized (sub-)teams
 - maximization of component and library reuse
- Main development lines / (sub) teams

<ul style="list-style-type: none"> ▪ Hardware <ul style="list-style-type: none"> ▶ Arm ▶ Manipulator ▶ Rover ▶ Wheels 	<ul style="list-style-type: none"> ▪ Software <ul style="list-style-type: none"> ▶ Navigation ▶ Manipulation ▶ Exploration ▶ Object detection ▶ Integration
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Artemis - Hardware



Model-based Components

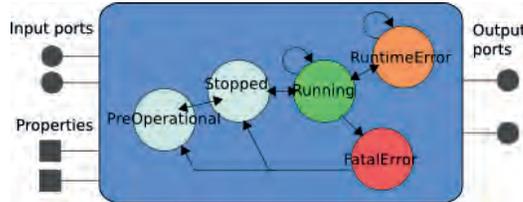


- Specification uses a domain specific language (DSL)
 - Orocos RTT as component model

```

name "message_producer"
using_library "message_driver"
import_types_from "message_driver/Message.hpp"

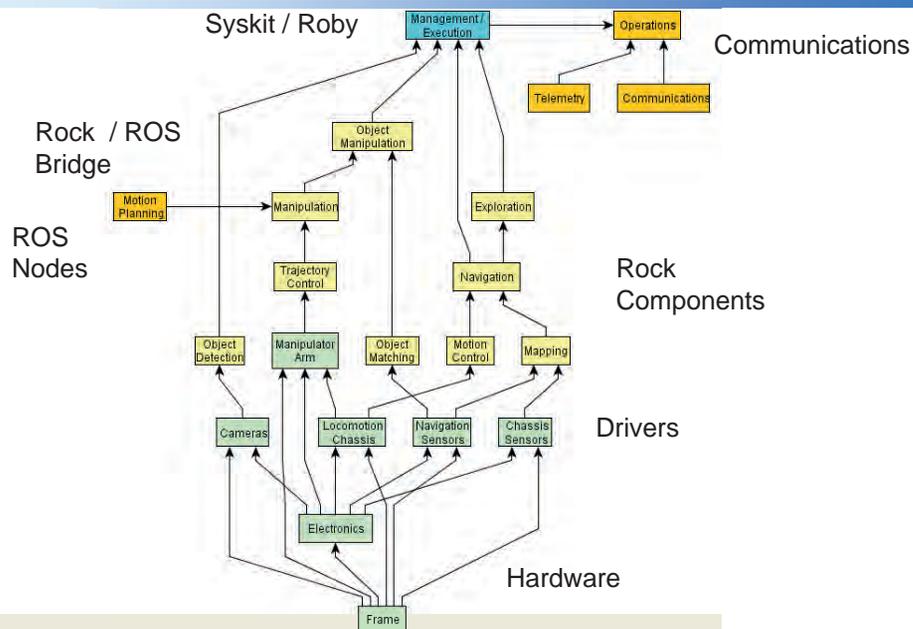
task_context "Task" do
  output_port "messages", "message_driver/Message"
  periodic(1.0)
end
    
```



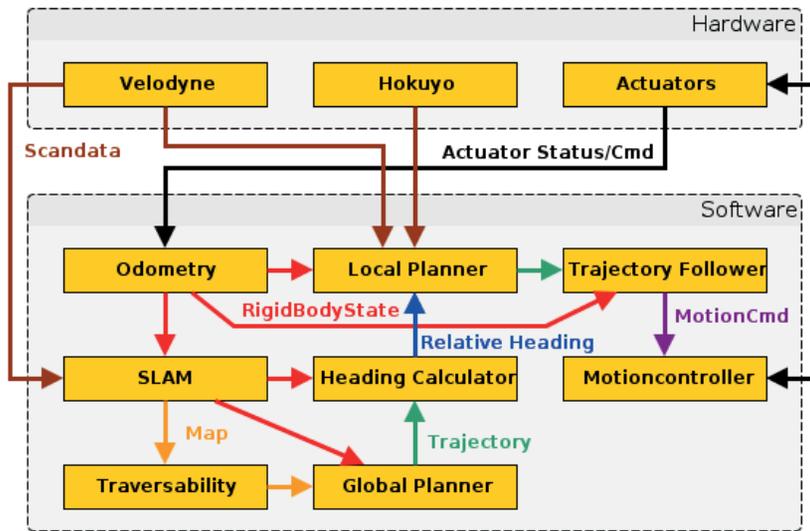
- Specification is applicable to other component models, e.g. ROS Nodes

Orocos	ROS
Task Context	Node
Port	Topic
Deployment	Launcher

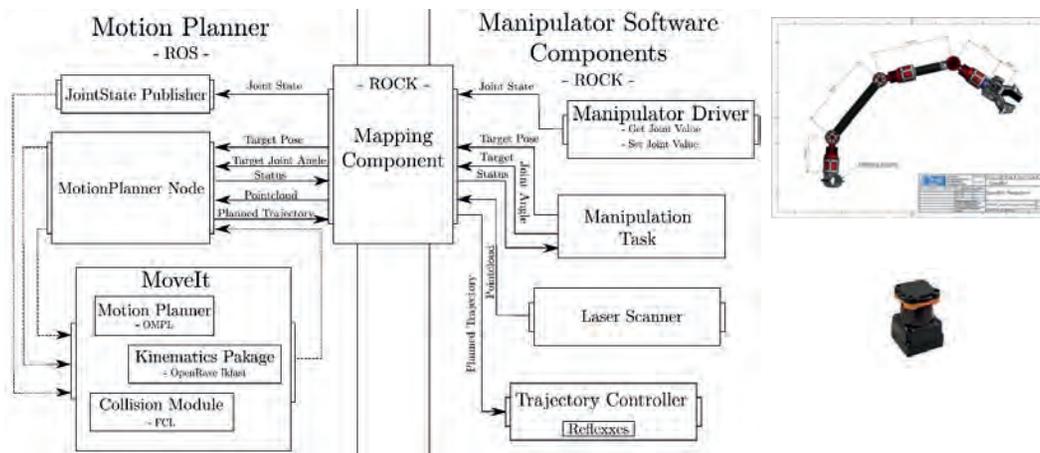
Artemis - Overview



Navigation



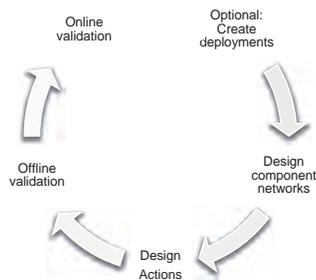
Manipulation



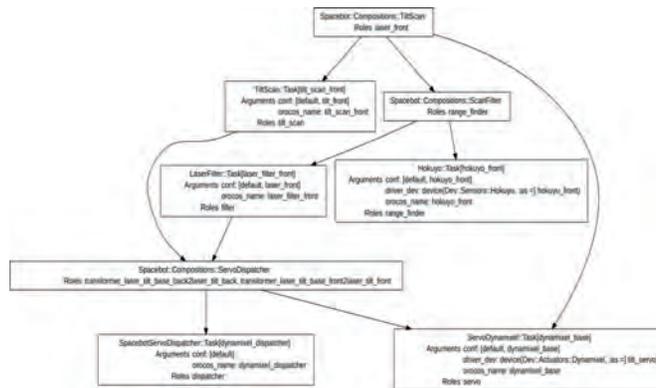
Systems Management



Workflow



Manage compositions (aka component networks)



An Overview



Component development

- autoproj** Build system
- RTT** C++ component implementation (Orocos RTT)
- oroGen** Model-based component development
- typegen** Standalone typekit generation

Management of complex systems

- orocos.rb** Ruby-interface for components
- Syskit** Model-based deployment and system supervision

Data analysis

- data_logger** High-performance data logging
- pocolog** Log file handling
- vizkit** Data visualization and log replay

Summary



- Artemis served to validate the current state of our model-based development approach
 - It showed to us that we made a good step towards a 'less painful' integration process for robotics
- Our robotic systems will become more complex
- Managing complexity will be our main challenge

- Rock is open-source:

<http://rock-robotics.org>

Outlook



- DLR announced the next SpaceBot Cup in 2015!!
- Possibility to test the systems in a Mars like environment in October 2014 in Noordwijk (ESA's ESTEC technical centre)





Thank you!

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