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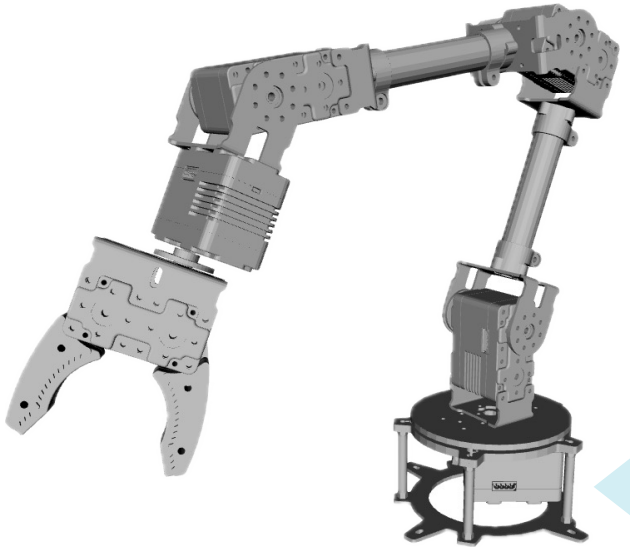
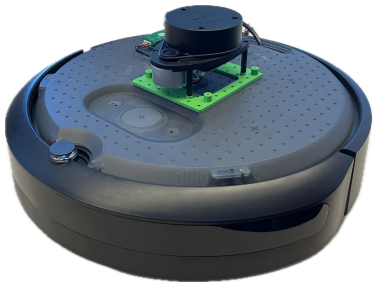
ROS.HScode: Hardware/Software Co-Design of Distributed Robotics Systems



Computer Engineering Group
WS 2025/26 + SoSe 2026 Project Group Presentation



Open for CE and CS students

Alexander Nowosad, M.Sc.

21.07.2025

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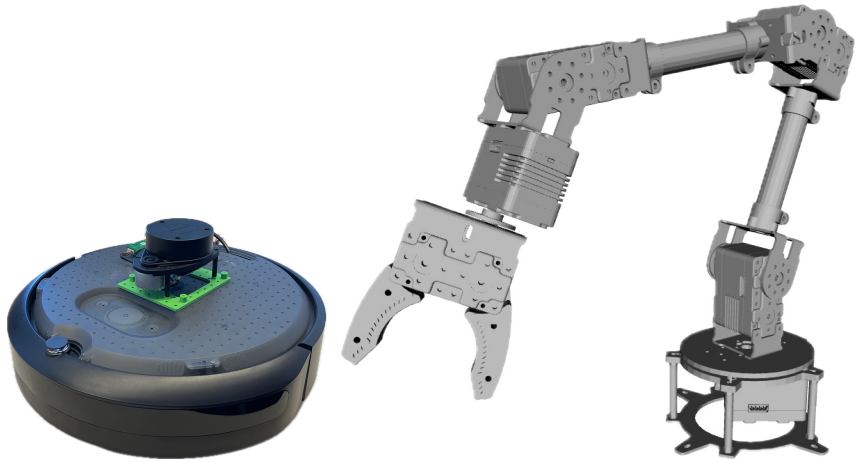
Robotics Challenges

Localization

Planning

Perception

Navigation



Sensor Fusion

Control

Computation on CPU/GPU

- Sometimes lack of performance (latency)
- High energy consumption

Computation on FPGA

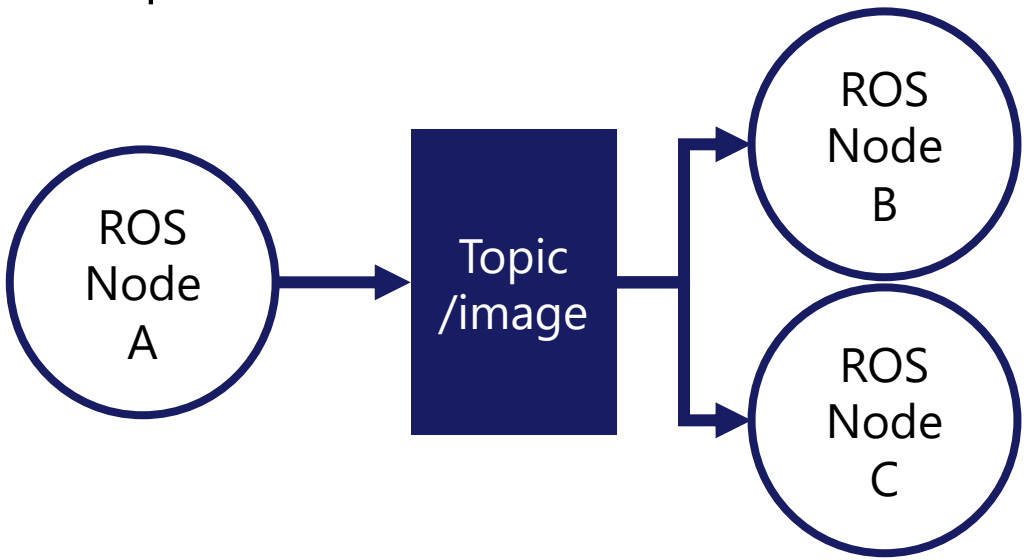
- Highly parallel data processing → high performance (especially low latency)
- Low energy consumption

How to integrate FPGAs hardware into the robotics software development flow?

Background: Robotics and Hardware-Acceleration

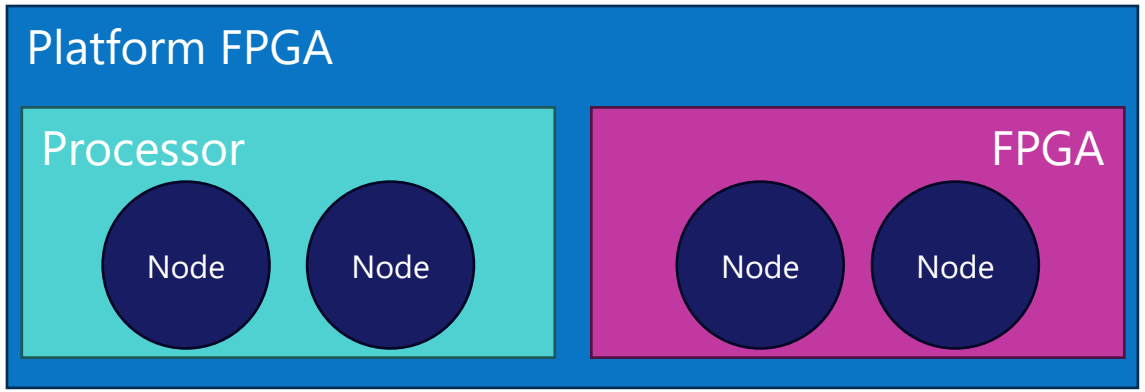
Robot Operating System 2 (ROS 2)

- Open-source SDK for robotics
- Middleware, algorithms, and developer tools
- Organizes a robotics application into different components, so-called, nodes



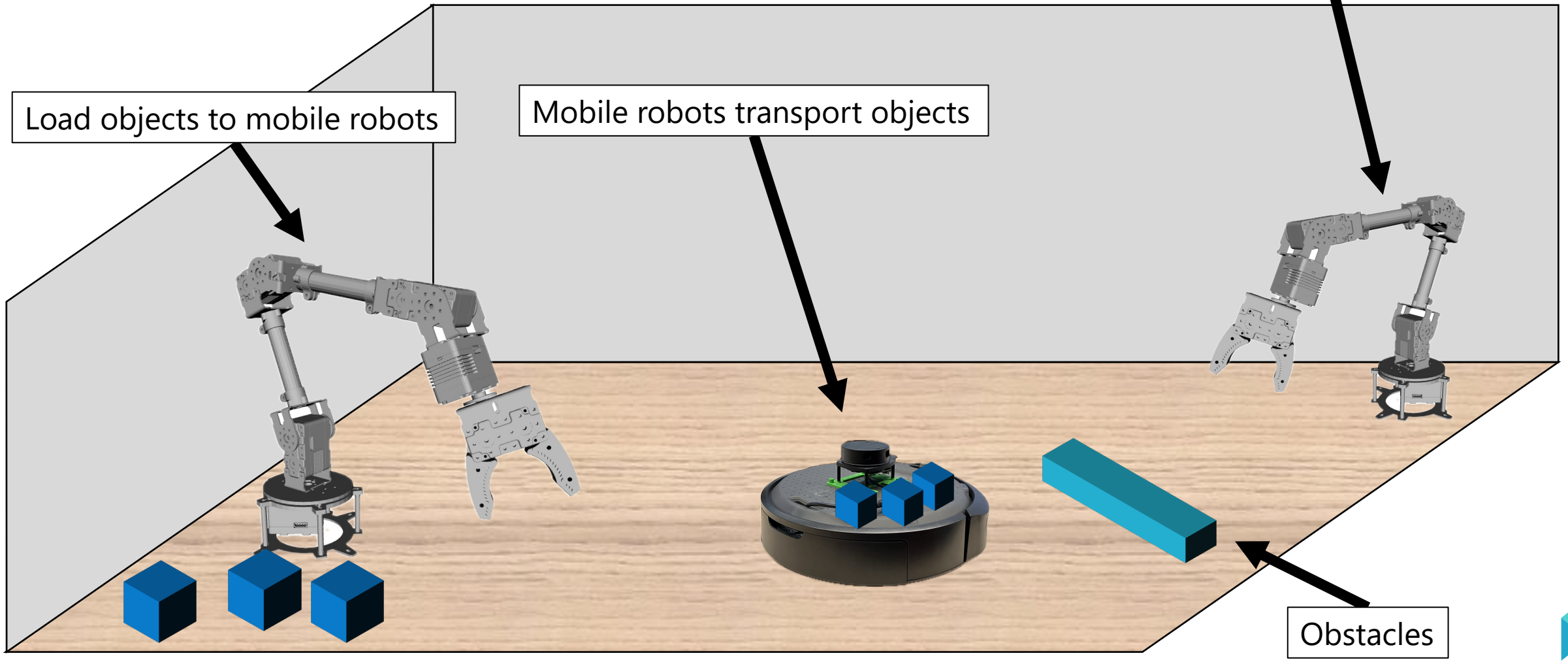
ReconROS Research Project

- Integrates platform FPGAs into ROS 2
- Allows nodes to run in software or accelerated in hardware



- Current research: Development flow and tool support to make creation of hardware-accelerated robotics applications easier

Planned: Create Testbed



Objects not to scale!

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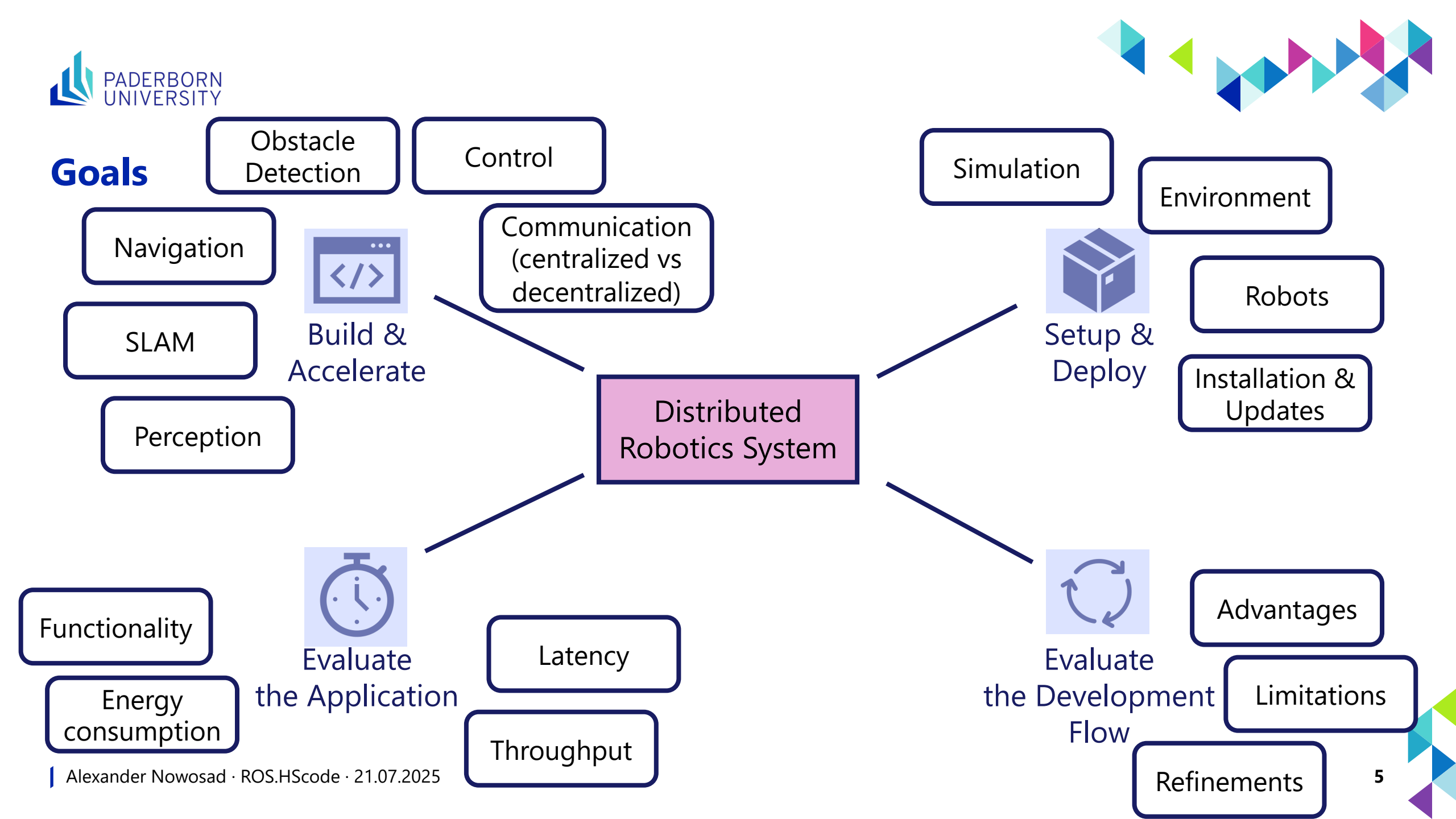
Goals



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Prerequisites / Learning

What you should bring

Interest in
- Robotics and robotics algorithms
- FPGA-based hardware-acceleration

Knowledge
- Basic knowledge of C/C++
- Knowledge of HDLs (VHDL/Verilog), HLS, Xilinx Tools (Vivado, Vitis HLS), and FPGAs in general is a plus

Application process: individual interviews

What you will learn

Algorithms and Software for Robotics
- State-of-the-art algorithms for perception, localization, navigation, and control
- Design and program with ROS 2

Hardware-acceleration
- Practical experience with FPGA-based acceleration of robotics functions

Practical Design of Robotics Systems
- Leveraging and extending a novel development hardware/software flow for robotics systems
- Testbed creation and system evaluation

Thank you for the attention!

Contact Information

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