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Digital Twins & Virtual Commissioning

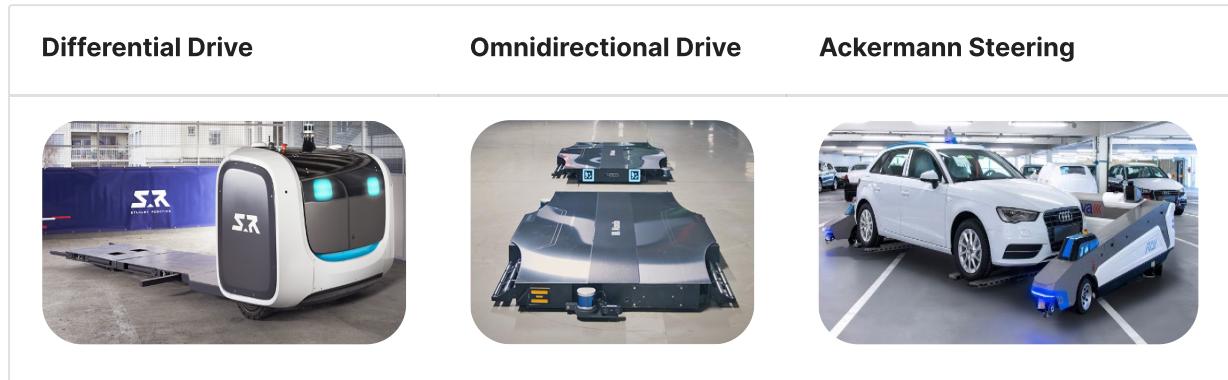
Motius GmbH
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Digital Twins & Virtual Commissioning



Our automotive customer needed to automate the movement of cars coming off the production line to various stations in the factory.

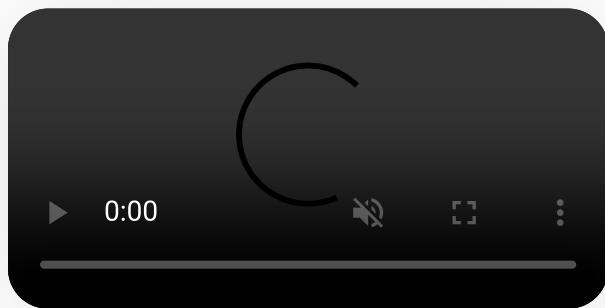


Various robots and even tele-operation solutions exist, but exploring them all with pilot projects would have taken too long, been too costly and it would have disrupted the production line.

Simpler scenario calculations did not answer the really important questions:

1. **How many robots** do we need to cover all shifts and all stations?
2. How do the robots behave in a realistic environment, including **limited space**, limited battery life, and other traffic?
3. How can we **adapt our factory layout** to optimize the flow of robots and cars? How does this change the number and type of robots we need?

Approach



We built a simulation environment in NVIDIA's Isaac Sim to answer these questions, and to simulate the behavior of different types of autonomous mobile robots (AMRs) in a factory setting.

Using the library of open source robot models for ROS and synthetic data generation capabilities of Omniverse, the Motius team put together realistic simulations of each robot

Software Architecture

Next to Isaac Sim, we needed a central fleet manager to realistically control the robots. The scenarios also needed to be controlled and monitored.

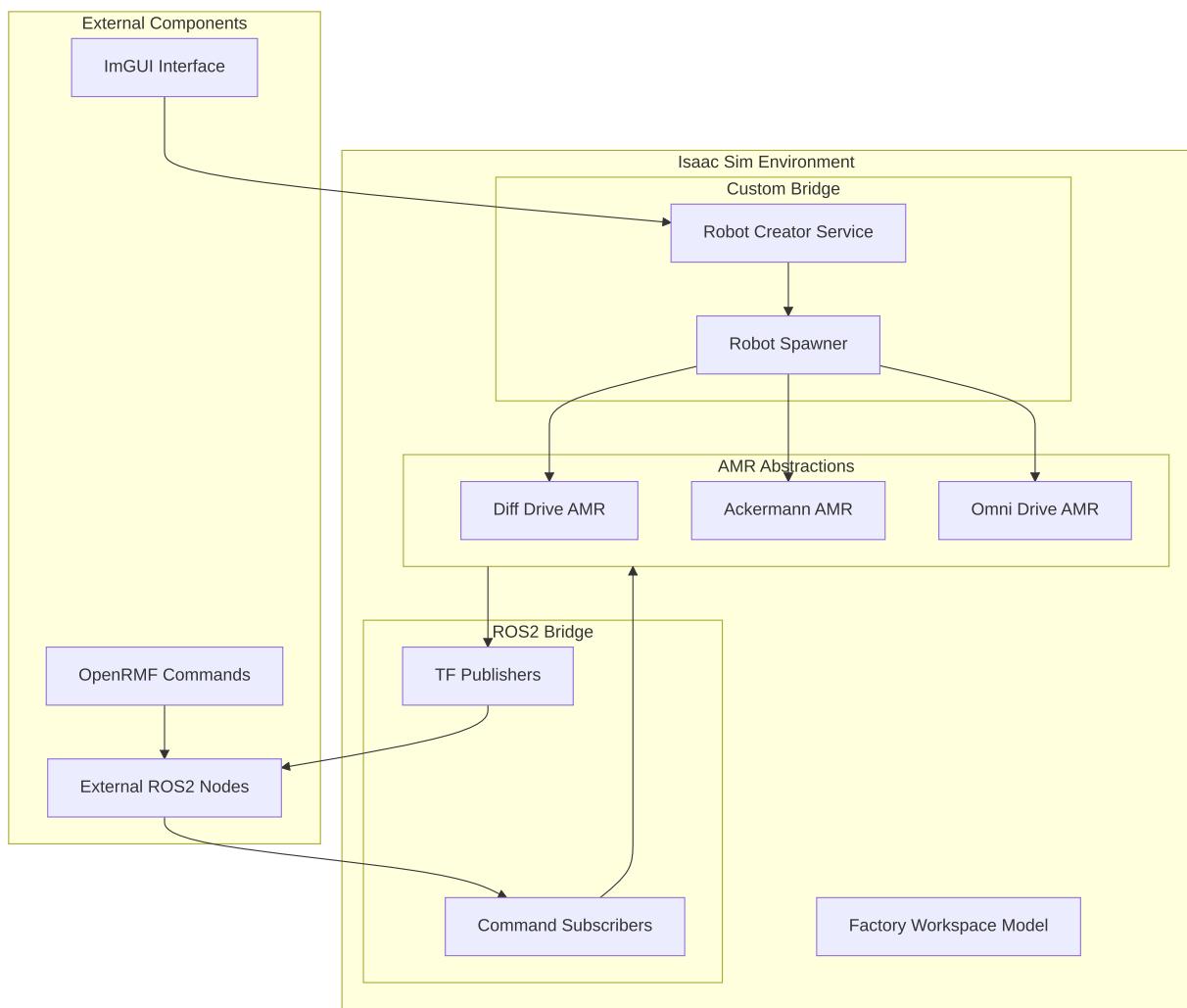
Isaac Sim Environment

The simulation environment is built using NVIDIA's Isaac Sim, which provides a realistic physics engine and rendering capabilities for simulating autonomous mobile robots (AMRs) in a factory setting.

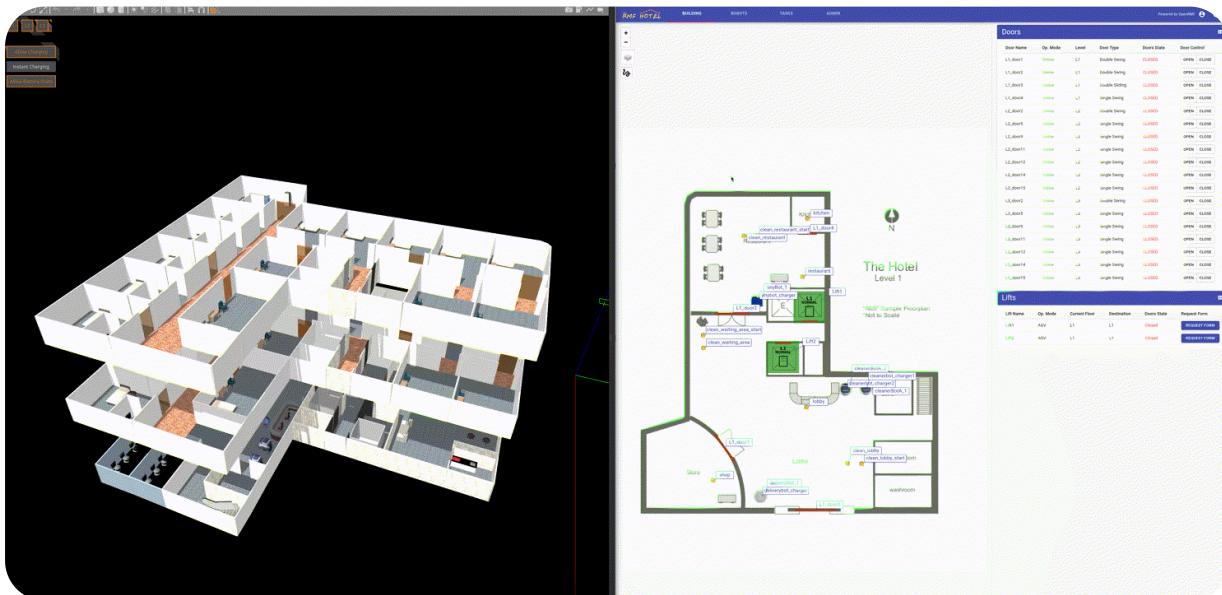
Integration Points

OpenRMF integrates with the simulation environment to send commands, create robots dynamically, and provide real-time feedback on robot poses.

Finally, results of the simulation (robot types, number, performance, etc.) needed to be logged and analyzed.



OpenRMF



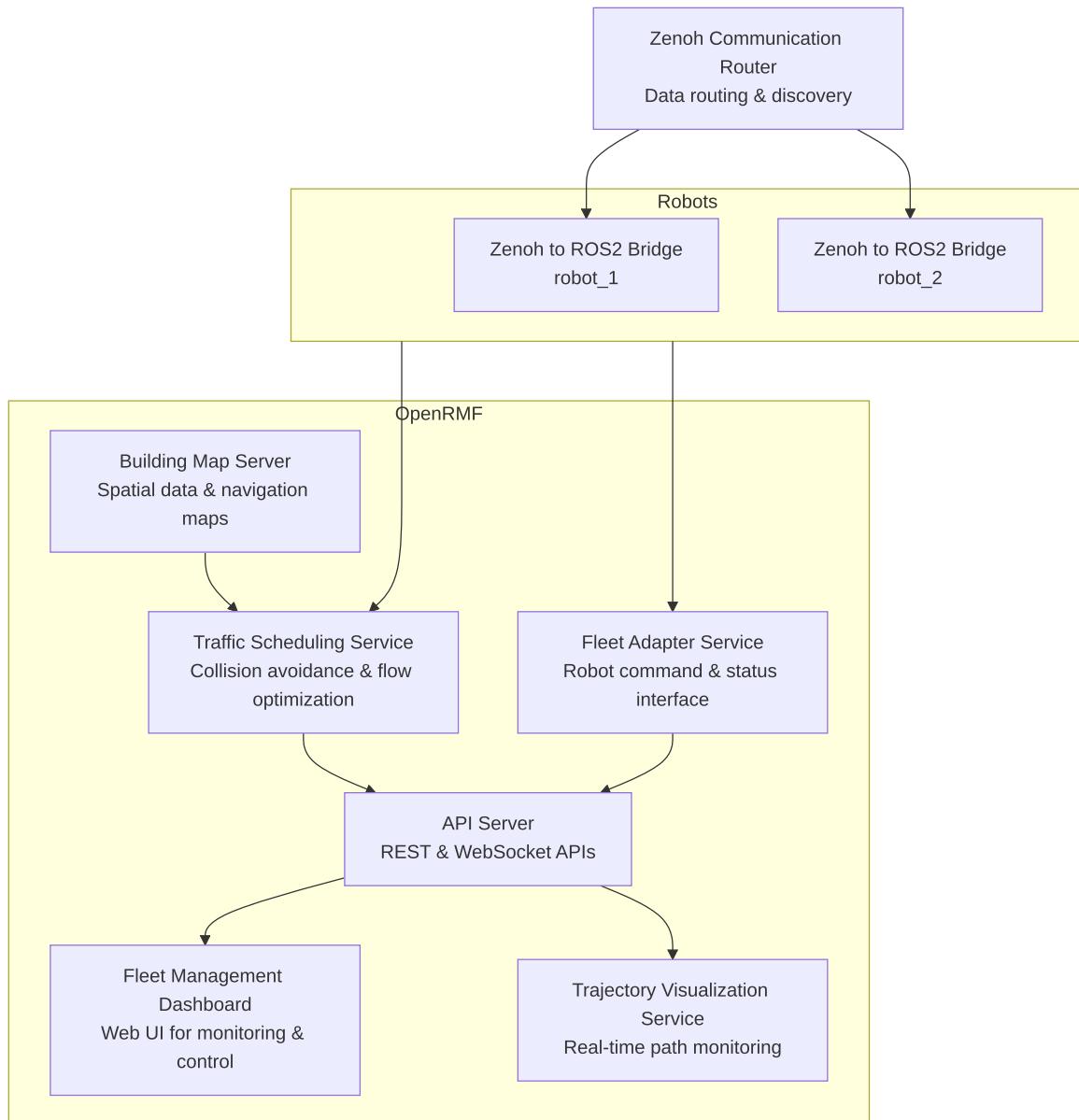
Demo video of Open RMF in a multi-story office building

OpenRMF is used as a fleet management system and central map server:

- Each robot gets its own Zenoh bridge for isolated control
- Traffic Management prevents AMRs from crashing into each other using the building map and tracks where each robot is going
- Web dashboard lets operators the status of the robot and task execution
- We built tools to import maps and define zones of interest



OpenRMF Architecture

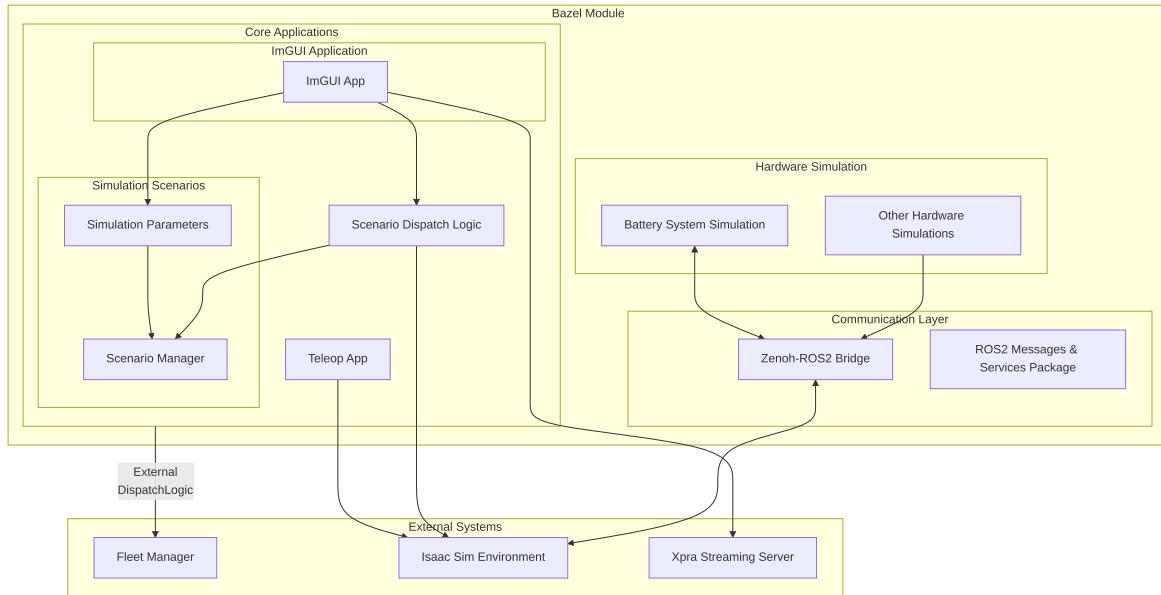


Development Workflow

⌚ Our simulation runs in a **Kubernetes** cluster, allowing us to develop and test scenarios locally or in the cloud.

❖ **Bazel** is used to manage dependencies and build the simulation environment, ensuring a consistent and reproducible development workflow.

Structure in Bazel



Deployment

Our simulation runs in Kubernetes, both locally for engineering, and in a cloud environment for executing long-running scenarios.

The cloud deployment comes with external systems that allow remote access, tracking KPIs of the scenarios, and tracing simulation execution.

Application at Bosch Rexroth

Digital twin technology and virtual commissioning are transforming how Bosch Rexroth's customers deploy automation solutions:



Virtual Commissioning Benefits

- Test drive systems before hardware arrival** - Validate motion profiles, acceleration curves, and control algorithms in simulation, reducing on-site commissioning time by 60-80%
- ctrlX AUTOMATION integration** - Simulate complete automation cells with Bosch Rexroth's control platform, testing PLC logic and drive coordination virtually
- Safety validation** - Test safety functions (Safe Torque Off, safe motion) in virtual environments before exposing personnel to risk
- Optimize factory layouts** - Evaluate different automation scenarios to determine the right number and placement of drive systems before installation

For Bosch Rexroth's Business

Digital twins enable:

- **Earlier customer engagement** - Demonstrate automation concepts to customers before committing to hardware
- **Reduced project risk** - Identify integration issues in simulation rather than on-site
- **Faster time-to-market** - Parallel development of mechanical and control systems
- **Training environments** - Safe space for operators to learn ctrlX platform without physical equipment
- **IT/OT convergence showcase** - Demonstrate Industry 4.0 capabilities with virtual twins connected to real data systems

Motius can rapidly build digital twins of Bosch Rexroth's drive systems and automation solutions, providing a powerful sales and validation tool for complex projects.