NODE

CI/CD Tools for Scaling of AMR Software Rollouts

NODE Robotics GmbH

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We make mobile robots easy to use.

Fraunhofer IPA spin-off, established in 2020 and headquartered in **Stuttgart**, boasts a dynamic team of **30 dedicated employees**. Our remarkable journey has already seen us deploy our cutting-edge software to power **more than 750 Autonomous Mobile Robots (AMRs)**, revolutionizing various industries with their productive applications.

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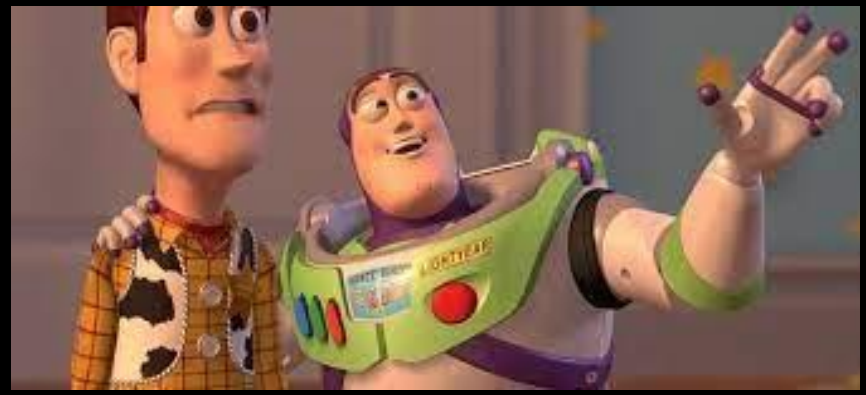
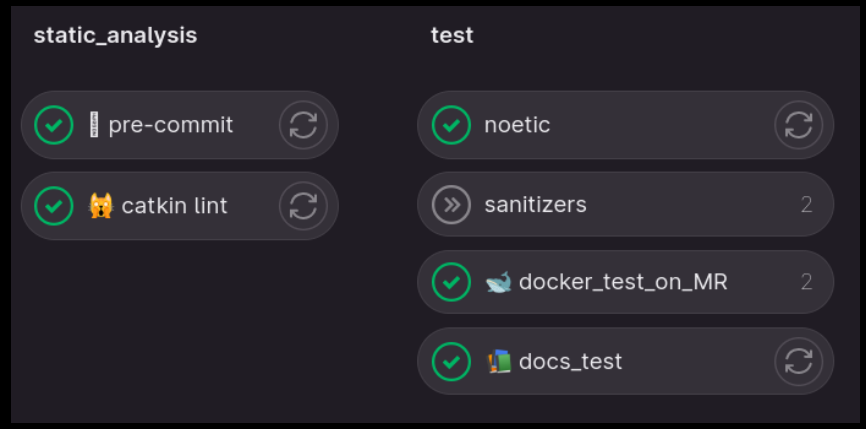
Situation

- ✓ You've built your awesome Robotics software stack
  - ✓ running on 1000s of robots
  - ✓ everything is going great
- ✓ Edge cases where the behavior can be better
  - ✓ implement some improvement
  - ✓ run unit tests
  - ✓ test in simulation
- ✓ All looks good
  - ✓ click merge and ship?





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Real World

? Are you sure you won't be breaking production on the customer sites?

? Will this improve the experience of all your customers?

? Will this work for all parameter sets that are deployed?

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Multidimensional Matrix From Hell

Robot types

Release v1.0

Release v2.0

Modules

Localization

Navigation

Fleet Management

Environments

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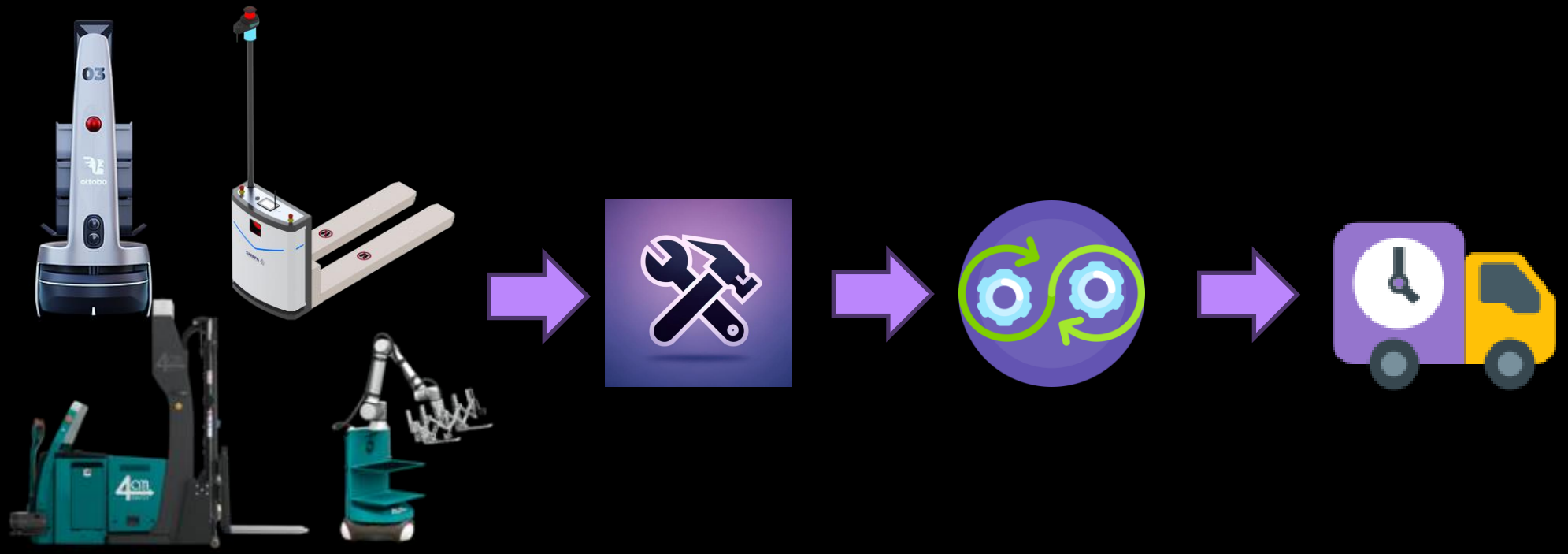
What do we want to achieve?



Robots Tools CI/CD Safe Delivery

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How to tackle this problem?

- ✓ Automated Checks
  - check configs for consistency
  - check for missing parameters
- ✓ Automated Testing
  - simulation
  - functional and multi robot tests
- ✓ Real World Data
  - Bagfiles are key
  - automated bag tests

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What are the requirements to the tools?

- ✓ Flexible
  - works on a variety of customer setups
  - independent from the hardware
- ✓ Extensible
  - easy to add more component tests in the future
- ✓ Scalable
  - with the # of customers
- ✓ Repeatable and Reproducible
  - reduce the amount of manual work

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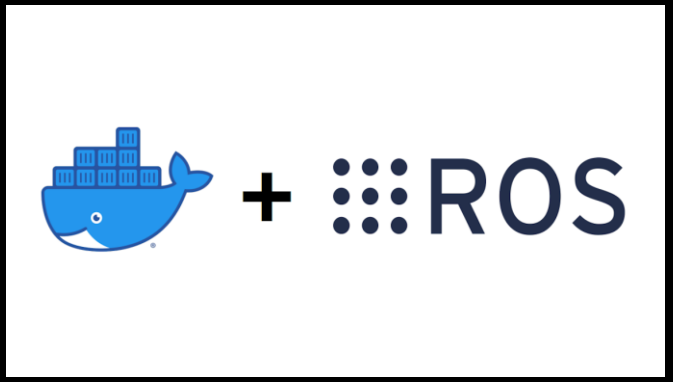
How do we deploy software?

- ✓ Robot integrators have a wide variety of setups.
  - different ROS installations
  - different launch structures
  - different architectures
- ✓ Docker based releases
  - reproducible
  - repeatable
  - easier dependency management
  - ROS1, ROS2 compatibility



no more

“works on my machine”

The right setup and tools

- ✓ docker-compose
  - writing and maintaining them was not easy
- ✓ Python tooling
  - autogenerate docker-compose files
  - spin up containers and simulation
  - check config files
  - API control functionality
- ✓ Light weight simulation and bagfiles
  - laser scan generation
  - individual map support

```
node-tool
Usage: node-tool [OPTIONS] COMMAND [ARGS]...

Options:
    --version                     Show the version and exit.
    -r, --release-file FILENAME   The release file to use
    --latest                      Use the latest release instead of providing a file
    --latest-stable               Use the latest release candidate from the global release repo
    -c, --robot-config FILENAME   [DEPRECATED] The robot config to load
    --help                        Show this message and exit.

Commands:
    config-checker  Run config checker tool
    config-specs    Dumps the configuration specification for a given...
    dump-docs       Dumps all API specs from all components for the current...
    dump-release    Dumps the release with all components filled in from...
    env-server      Environment server tooling
    fleet-server    Fleet server tooling
    generate        Generate docker-compose files
    get-image       Prints the image that is used for this component
    simulate        Generate and run simulation
```

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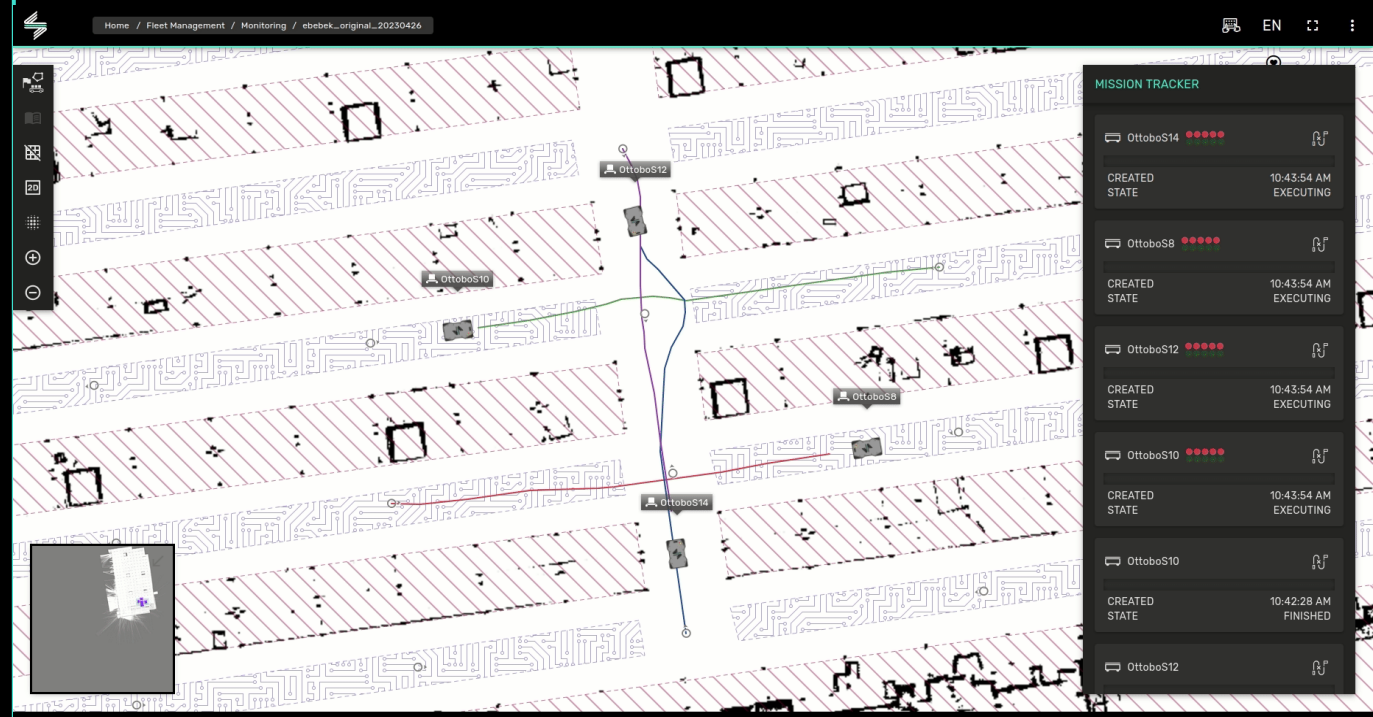
The right setup and tools

- ✓ Navigation tests
  - generalized tests for navigation
  - module specific tests for docking
  - API based testing
- ✓ Multi-Robot tests
  - test whole stack with custom setup
- ✓ Customer specific tests
  - test individual behavior and interfaces
  - custom bagfile testing



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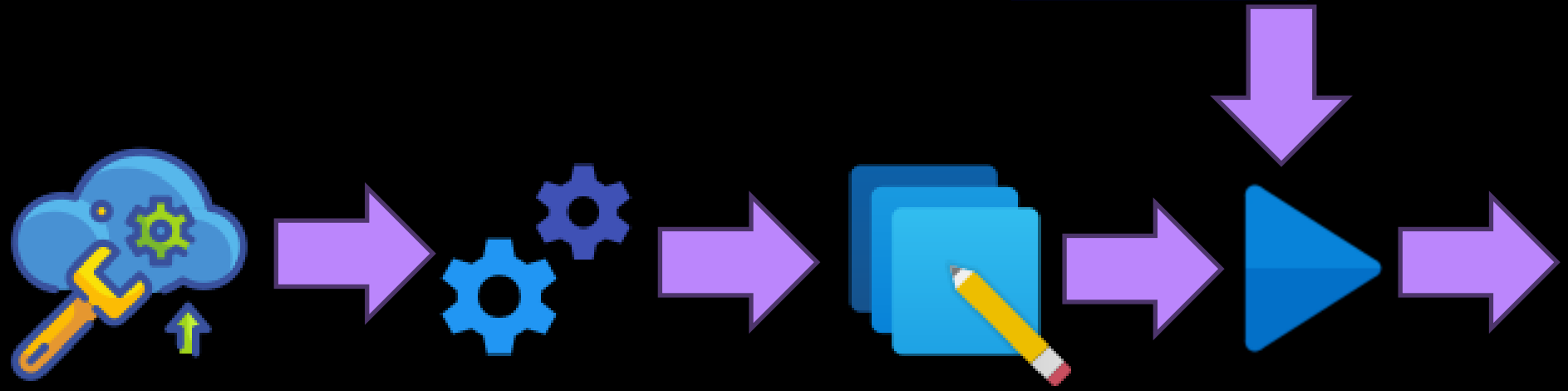
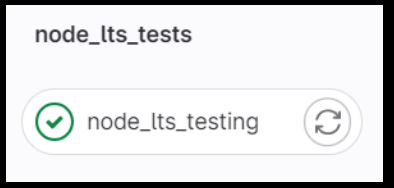
NODE Tool Pipeline



NODE Tool Config set Docker compose Spin up stack



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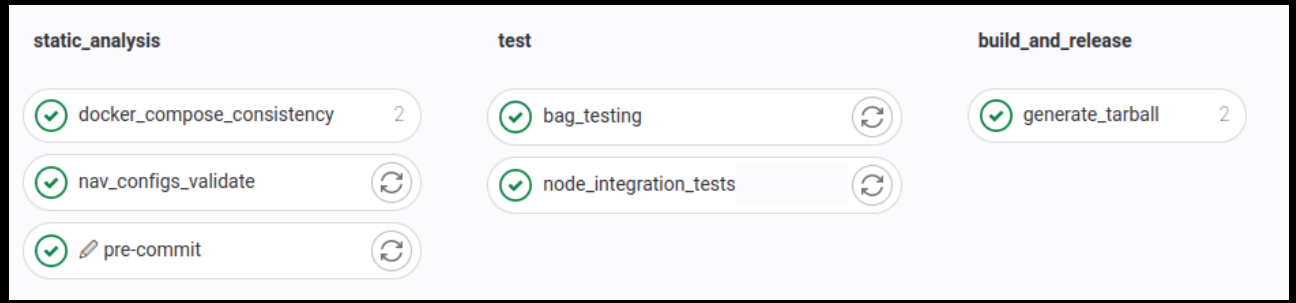
Implementation in CI

- ✓ CI Templates that can be included across repos
  - include the testing job
  - Inherit from base ci job
  - specify config paths in the repo
  - run any ROS bag-based or simulation test
  - test customer setup directly




```yaml
bag_testing:
  extends: .node_lts_tests
  variables:
    PROVISIONING_RELEASE_FILE: "${CI_PROJECT_DIR}/provisioning/release.yaml"
    PROVISIONING_NAV_CONFIG_FILE: "${CI_PROJECT_DIR}/configs/robot_config.yaml"
    PROVISIONING_BAG_CONFIG_FILE: "${CI_PROJECT_DIR}/configs/bag_test.yaml"
    TOX_OPTIONS: "-e py311"
  tags:
    - BAG_TESTING
```

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Summary and next steps

- ✓ Infrastructure in place
- ✓ Add further testing of new modules
- ✓ Empower tooling even further for new deployments and use cases
- ✓ Build also tooling for deployment of different robots of the same type

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