Autonomous Mobile Robots

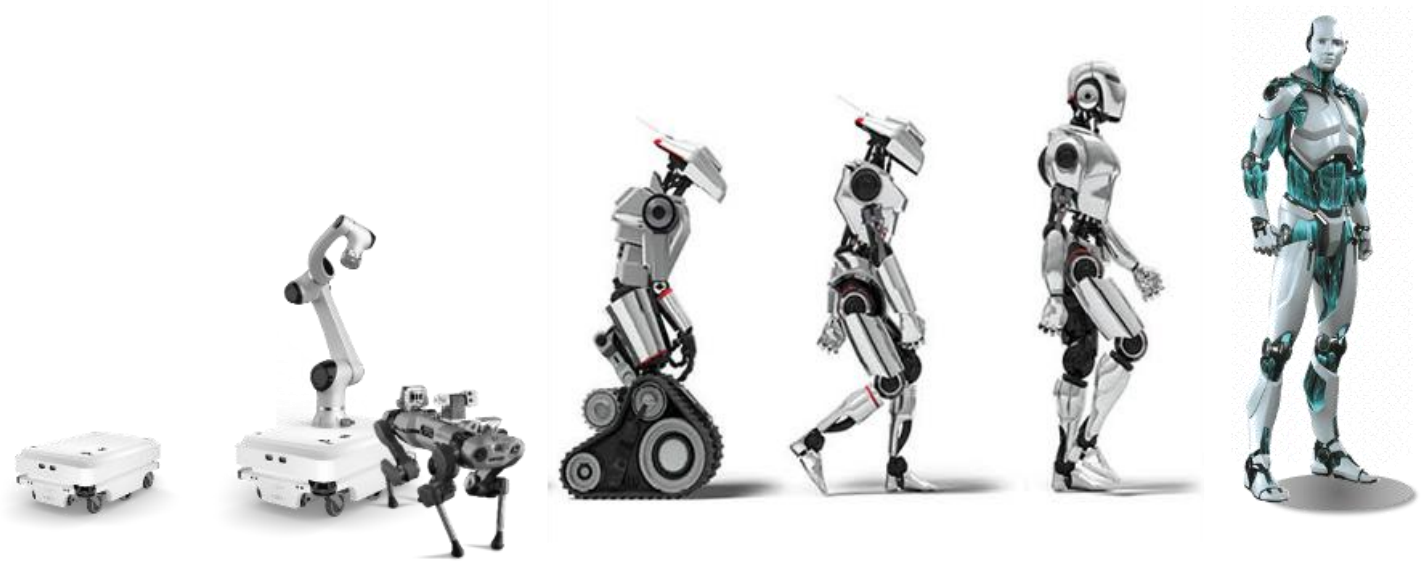
Factory Automation March 2024

Theo Kersjes

Agenda Factory Automation

- Remove Autonomous Mobile Robot from shipping case & setup
- Power up
- Start ROS (Robot Operating System) application

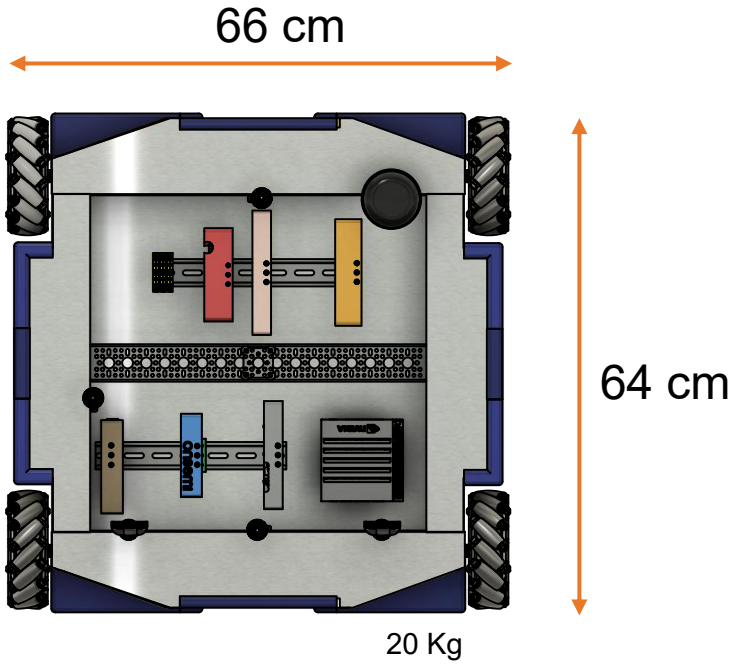
- ROS2 simulation

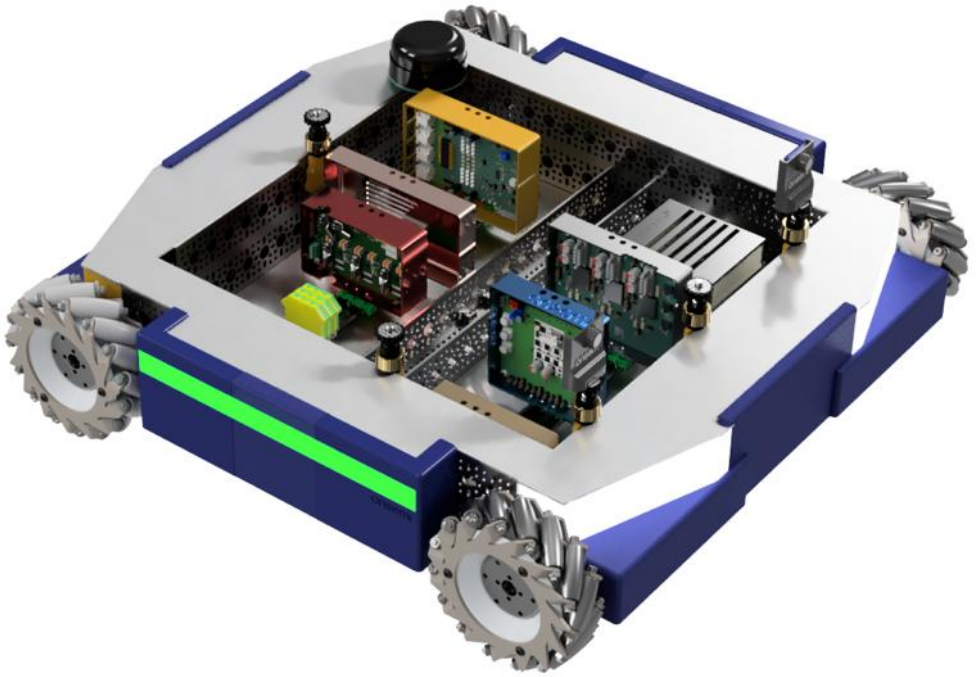


Focus Area for Autonomous mobile Robots

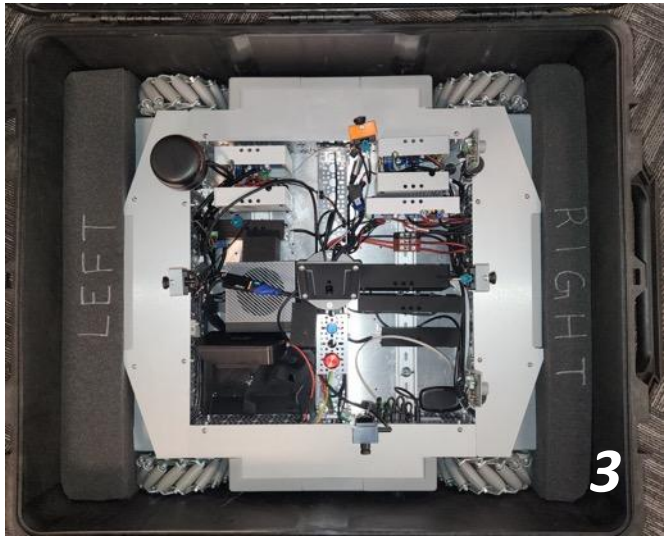
What do they have in common

onsemi Autonomous Mobile Robot





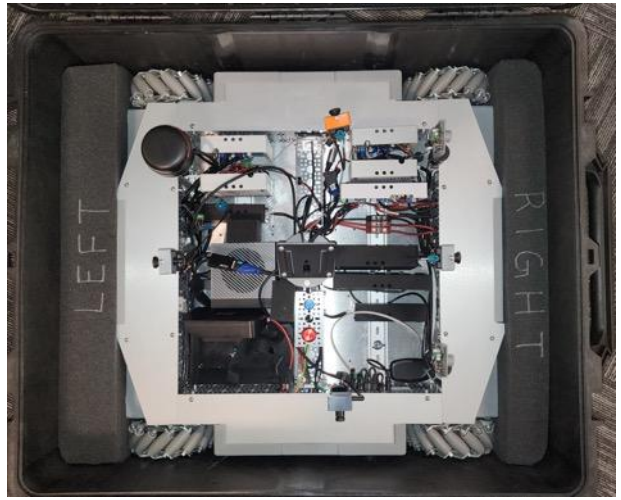
Mobile Robot Case



Mobile Robot setup

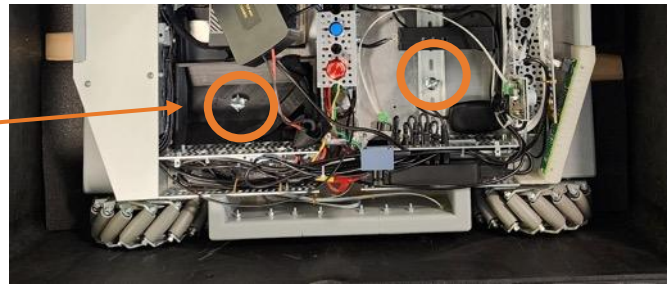
1

- Open Case
- Remove 3 items
  - *Blue Ethernet Cable*
  - *LCD touch screen*
  - *Stand with aruco marker*
- Remove foam layer
  - *Careful foam is precut.*



2

- Remove 2 Wingnuts
  - *See location in orange*
- Lift AMR out of the Case
  - *Warning AMR is 20kg.*



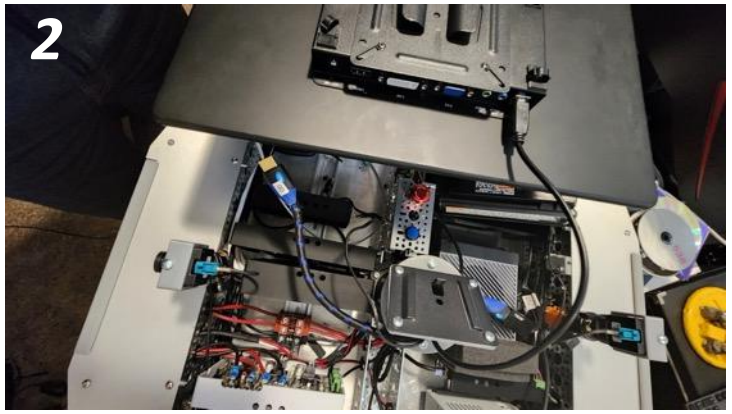
Mobile Robot setup

3

- Under the AMR located items
  - *Remote control Xbox style*
  - *Battery Charger*
  - 2x Batteries
    - *Battery on tradeshow lasts ~ 3 to 4 house depending on amount of driving to reach 1 led on battery*
    - *Battery should be changed @ 1 led for NIVDIA Jetson orin. Else hard shutdown can require re-flashing of the orin (end of show).*
  - Router
    - *Only needed when remotely connecting*

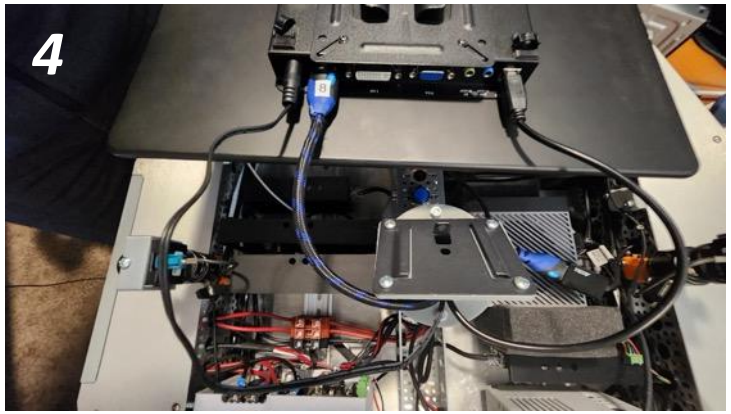
Mobile Robot setup

Hold LCD touch screen upside down above the buttons

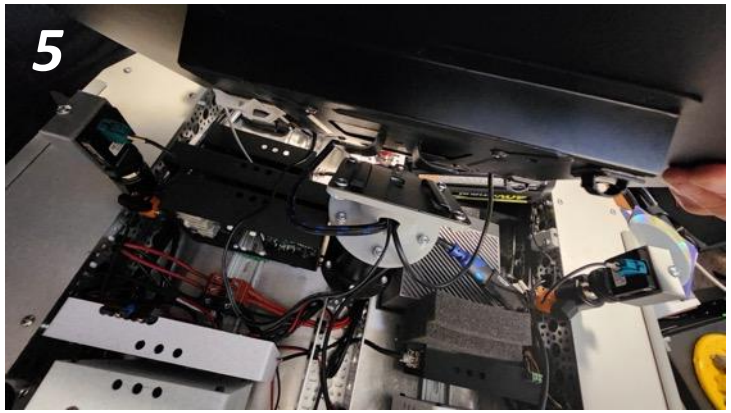


Connect USB to touch screen

Connect HDMI connector



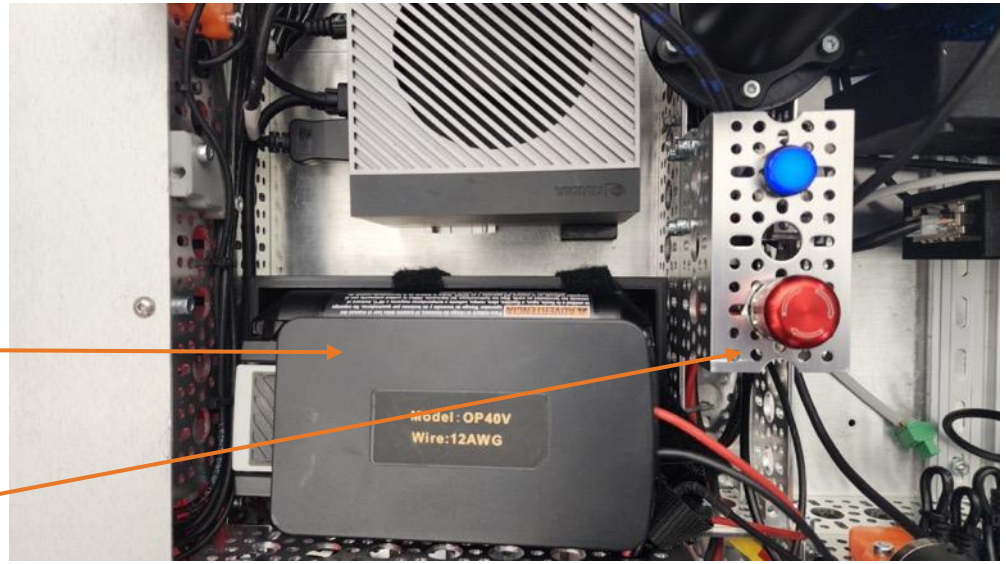
Connect power connector



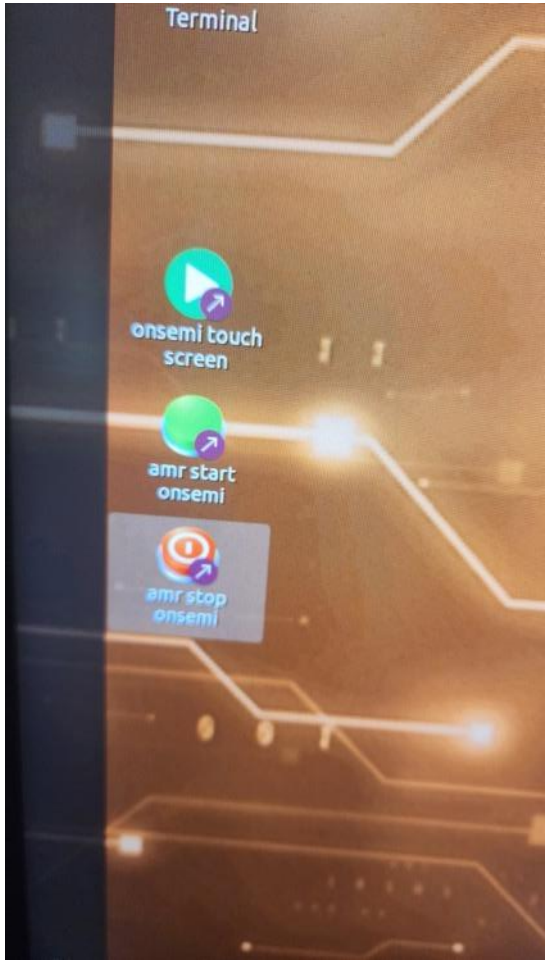
Slide touch screen onto mount

Mobile Robot Power up

- Place battery in battery bay
- Slide battery connector onto battery
- Red Emergency button function
  - *Button disconnects motor power only*
  - *Turn know so button pops up to power motors*
- Blue button reset 10BaseT1S link
  - *Link between NVIDIA Jetson Orin and motor controllers reset*



Mobile Robot start ROS & product information App

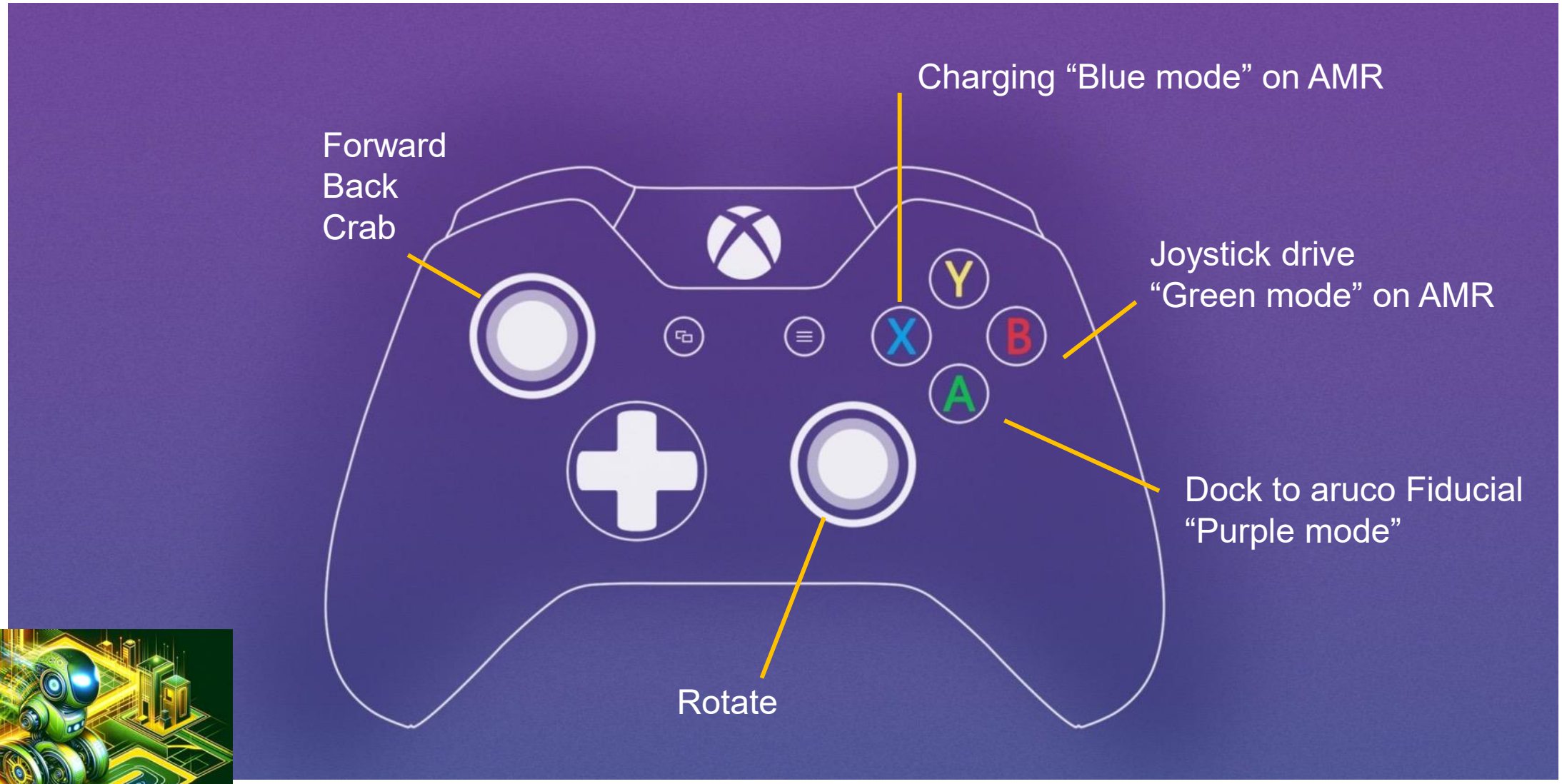


“onsemi touch screen”
Start app with AMR product information

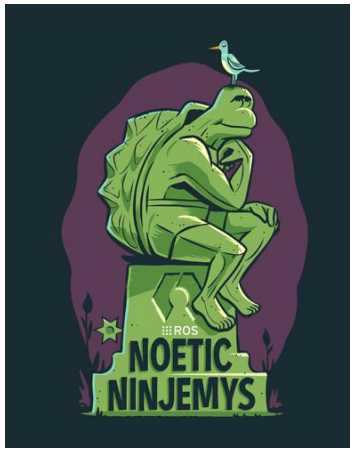
“amr start onsemi”
Start Docker container with ROS

“amr stop onsemi”
Stop Docker container with ROS

ROS1 Noetic



Known Issues ROS1 noetic application



- USB camera needs to be physically unplugged and replunged.
  - After the systems has started, the desktop is visible on the LCD screen. The USB cable to the USB camera should be unplugged and replunged, before running the desktop link “amr start onsemi”
- Drive demo is driving very slowly
  - Driving speed needs to be adjusted for floor friction
- Motor keeps driving when releasing the joystick
  - It is noted that on a slower embedded computer this happens more often. It looks like the motor misses the stop command when releasing the joystick control and keeps driving. Give another motor control (opposite direction …) or use motor emergency stop button.
- ROS1 application is completely in Python
  - Responsiveness issues noted for motor control and aruco image processing

onsemi / Arrow AMR Demo Collaboration (wip)

ROS Robotic Operating System

NCS32100 Inductive Position Sensor

See3CAM_24CUG Global Shutter Camera Module AR0234 (1x)

D3 DesignCore Global Shutter Camera Module AR0234 (4x)

NCV75215 Ultrasonic Sensor 2x

AMR1

CAN FD | BLDC: ecoSpin | Jetson Orin | WiFi | 600W Charger

NVIDIA | ROS 1

AMR Loaner to Steve Shackell @ Arrow ACT (March '24) for World Tour 2024

AMR2

10BASE-T1S | BLDC: NCD83591 | 1x | Jetson Orin | WiFi | >1kW Charger w/ WBG (SiC) | 2x | LiDAR

NVIDIA | ROS 2

Periodic Upgrade Swaps Throughout World Tour 2024

AMR3

10BASE-T1S | BLDC NCD83591 | 4x | D3 Jetson Xavier | >1kW Charger w/ WBG (iGaN) | onsemi RSL15 BLE: AoA/AoD | WiFi | HESAI LiDAR

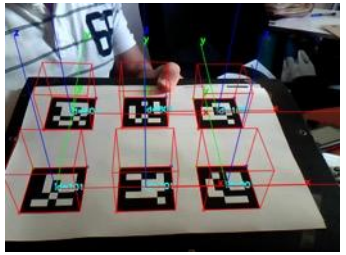
NVIDIA ISAAC | Isaac Sim | ROS 2

Collaborate w/ Nvidia???

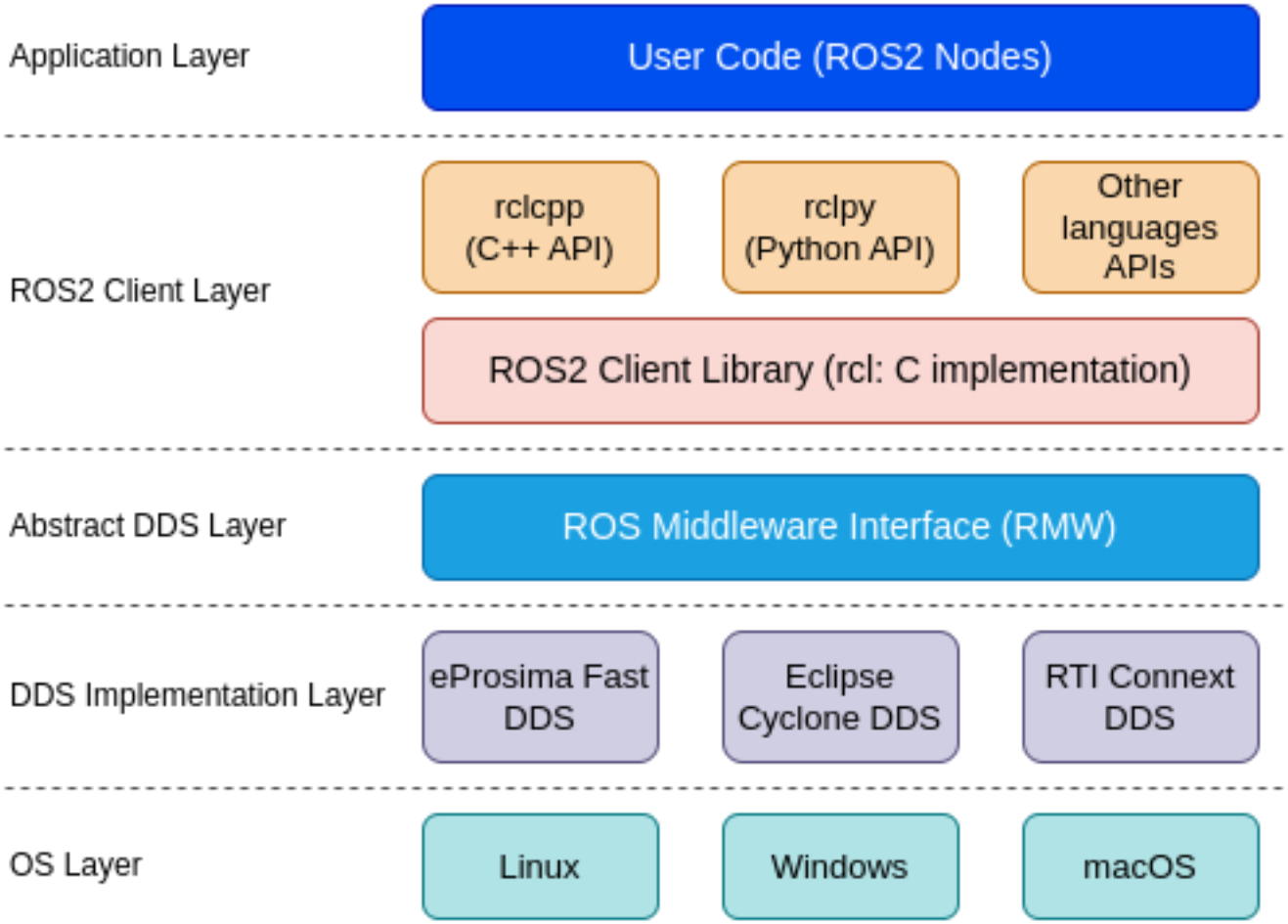
ROS2 Humble application

- Motor control in C++
- Motors have soft start and stop
- New Joystick package that uses dead man switch and turbo mode

- Q1 update:
  - Release system solution guide mobile robotics
- Q2 update:
  - Demo drive to an aruco marker and park next to it, with this demo the ROS1 and ROS2 demos are the same
  - Lidar cones fence demo, set cones on ground or table. The Navigation stack will ‘see’ these as a wall between the cones and not drive outside the area.
- Q3 update:
  - Add onsemi iTOF sensor, onsemi ultrasonic sensor, onsemi LiDAR.

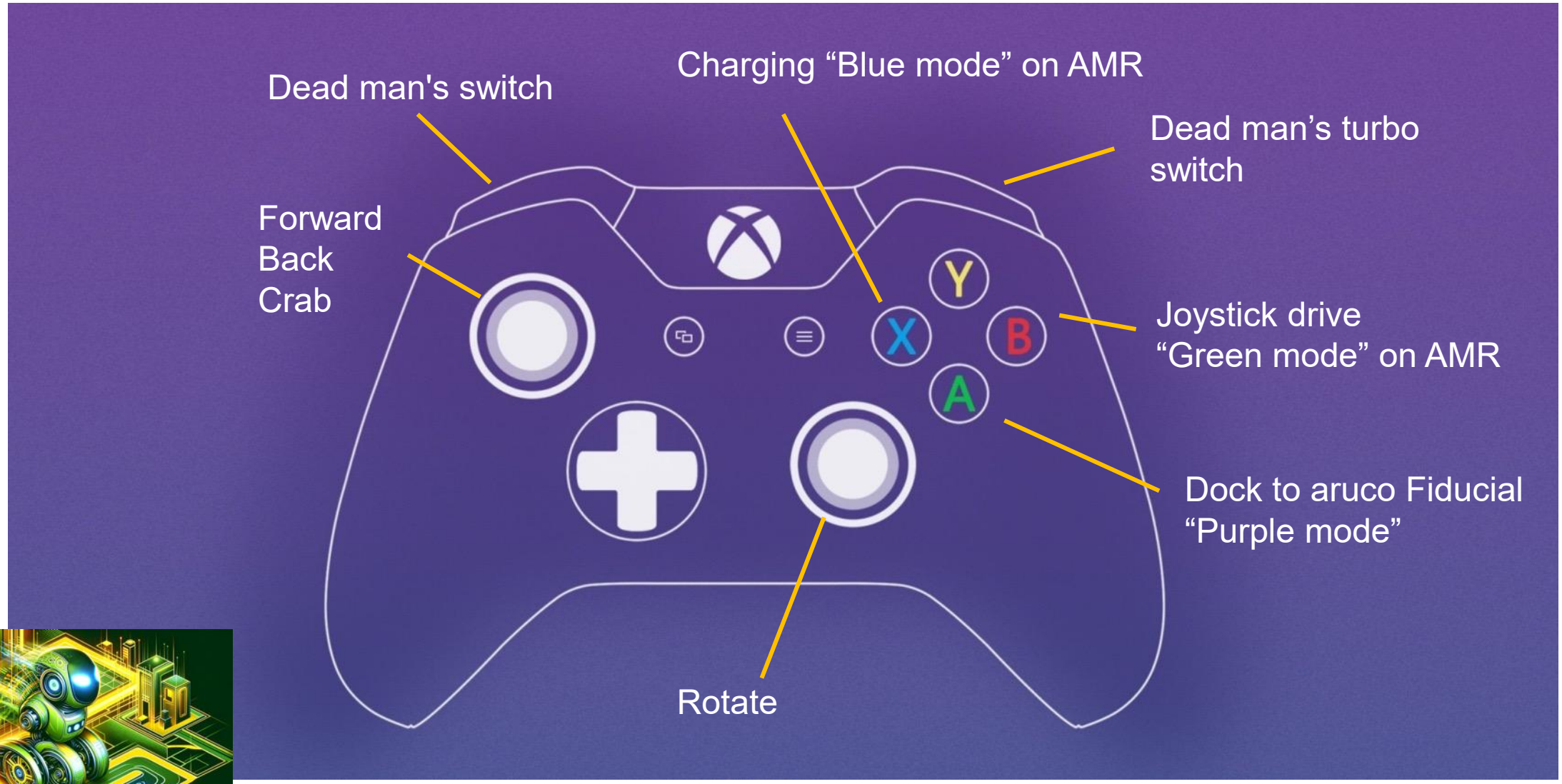


ROS2 Humble

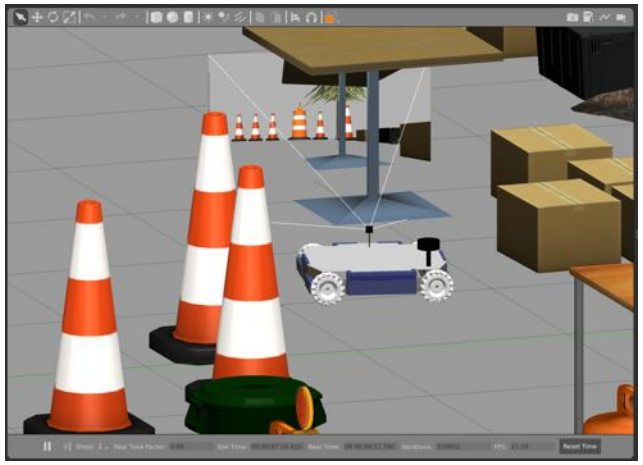


Data **D**istribution **S**ervice provides a publish-subscribe transport

ROS2 Humble

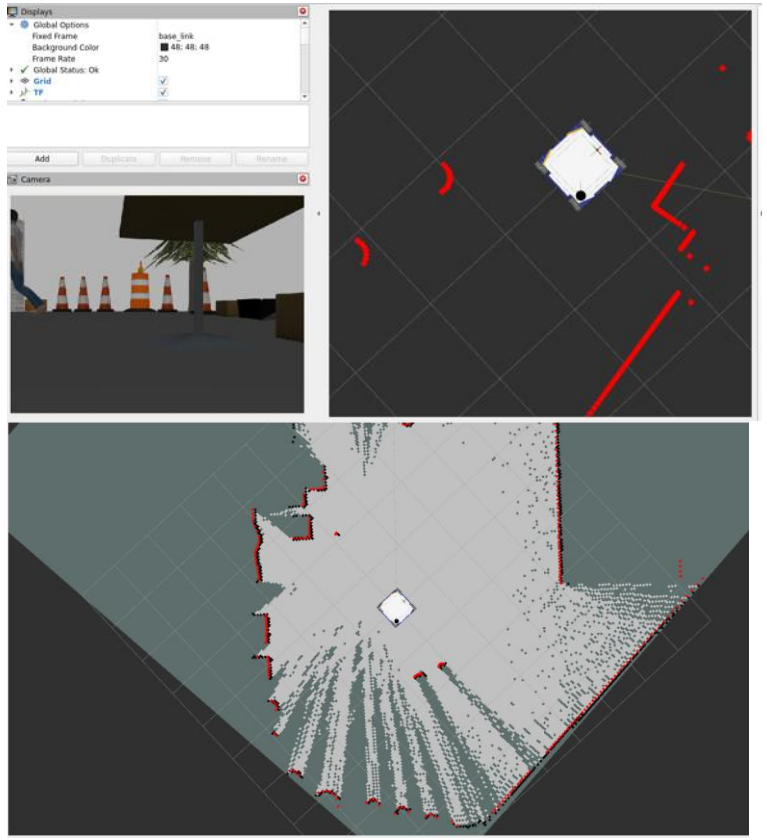


ROS2 gazebo simulator and rviz mapping



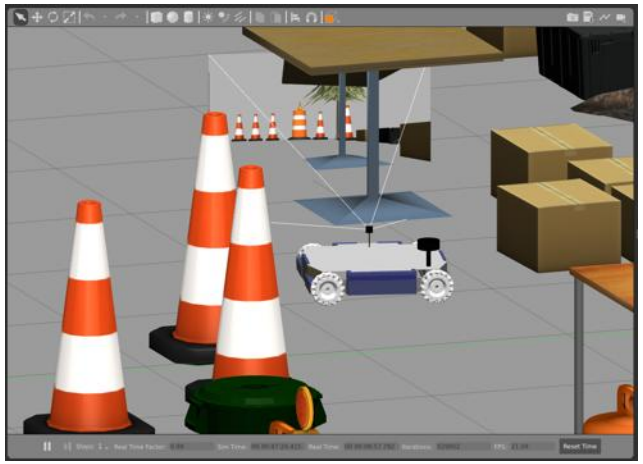
Electronics simulations

- *Project energy usage per motor and or sub-system to full unit battery requirements*
- *Add navigation to charge station and energy optimized navigation.*
- *System impact on electronics*



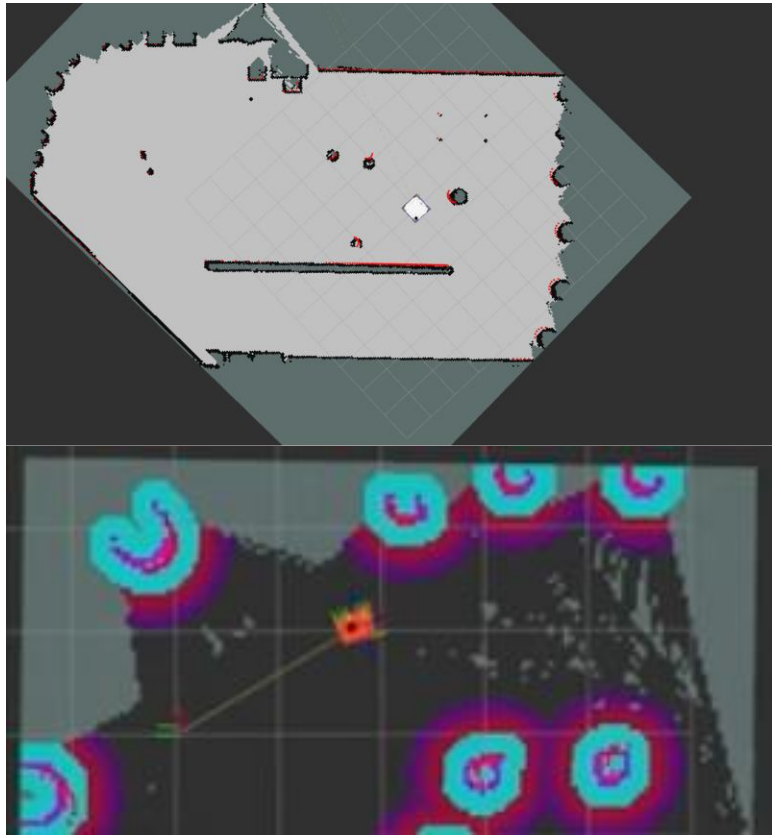
rviz shows amr and mapping

ROS2 gazebo simulator and rviz mapping



Start

- Gazebo simulation environment
- Mapping SLAM
- Navigation set pose



rviz shows robot, mapping and cost map for navigation

ROS2 Humble

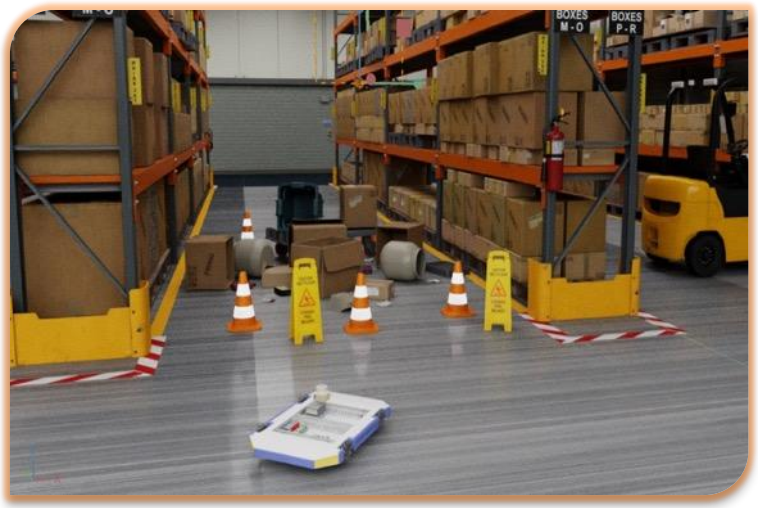
- create docker image.
  - $ docker build -t onsemi_humble ./docker_amr/.
- Start a container form the docker image with GUI support.
  - $ ./docker_amr/run_ximage.bash
- Container will start in /home/onsemi/amr_ros2/ros2_ws, run colcon to build the project
  - $ colcon build --symlink-install
- Setup hardware devices using udev rules. It is needed to restart udev rules and usb hub to make see3cam, onsemi_rgb, onsemi_motor, onsemi_leds, show up in ls /dev runs script
  - $ ./src/onsemi_amr/startup.sh
- **start onsemi AMR app from CLI**
  - $ ros2 launch onsemi_amr launch_sim.launch.py world:=src/onsemi_amr/worlds/obstacles.world

NVIDIA Omniverse

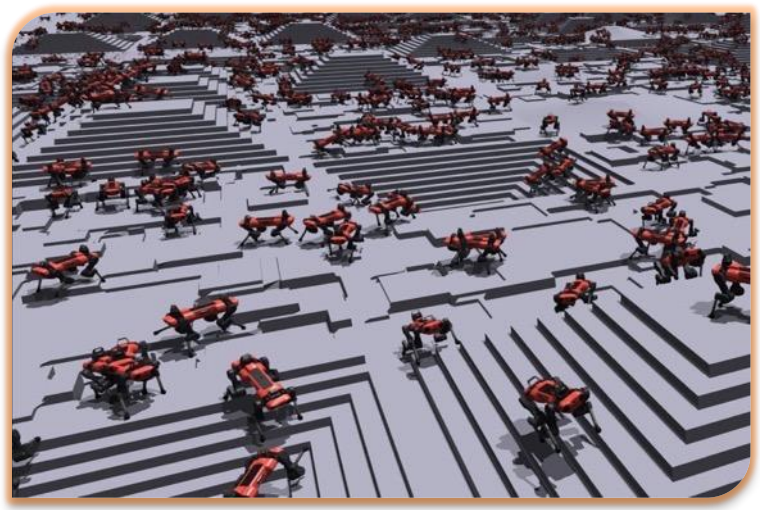
NVIDIA Isaac Simulation

NVIDIA Drive Simulation

Digital Twin and synthetic data



Synthetic data



Accelerated AI Training

Today Best AI is an AI and Human together

Collaborative next is Adaptive robots

- Intrinsic safety and performance without compromise
- Learn and accomplish new tasks just like an apprentice, but faster
- Capable of performing tasks that traditional robots are not capable of – Increasing demands to automate such tasks due to labor shortages and harmful work environments.

Boston Dynamics

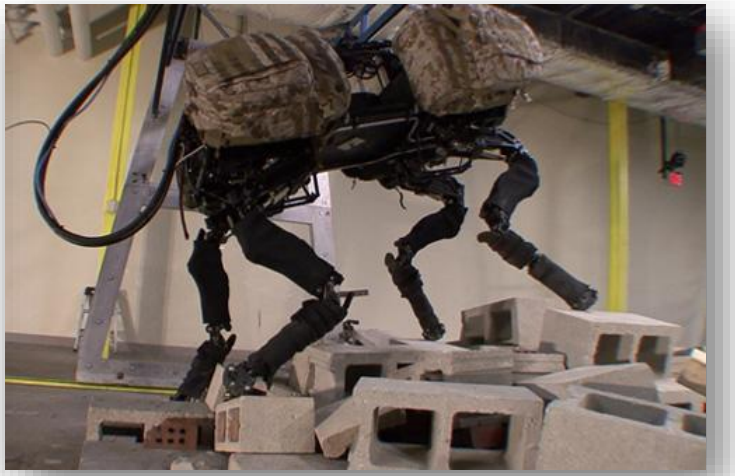
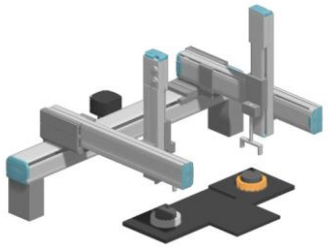


ABB Dual Arm

Industrial Robots



Cartesian Robot

Optimized

SCARA Robot

Economic

Parallel Robot

Fast

6-axis Robot

Flexible

AMR Robot

Mobile

Focus Area for Autonomous mobile Robots

D3 Engineering

- DESIGNCORE® NVIDIA® JETSON XAVIER™ NX 12-CAMERA CARRIER BOARD
  - DP to HDMI needed for touchscreen on mobile robot not working with DP-to-HDMI dongle. This is listed in the documentation but need to find solution.
  - Only 1 USB3.0 port. Use HUB to connect all subsystems
  - Docker container for Noetic works, however some critical code needs to be rewritten in python due to speed issues.
  - Docker container for Humble problems with installing some of the packages. Issue not clear yet

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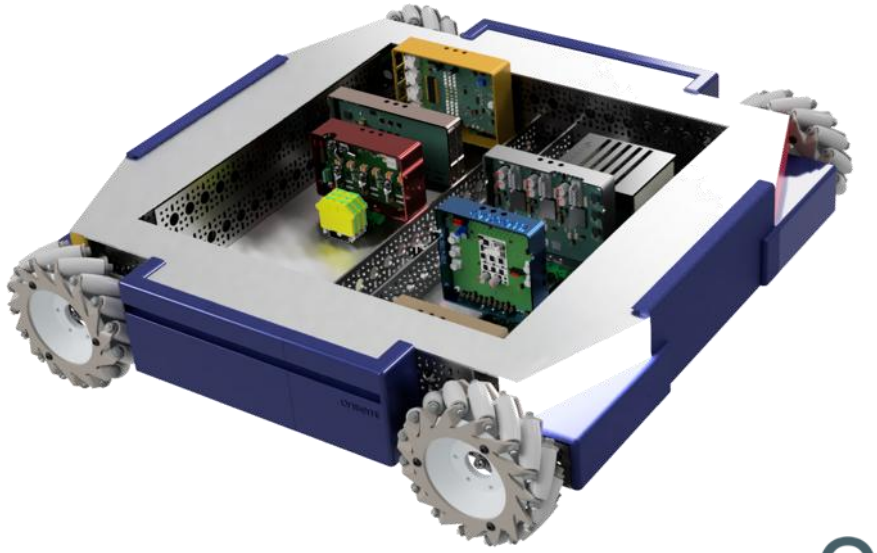
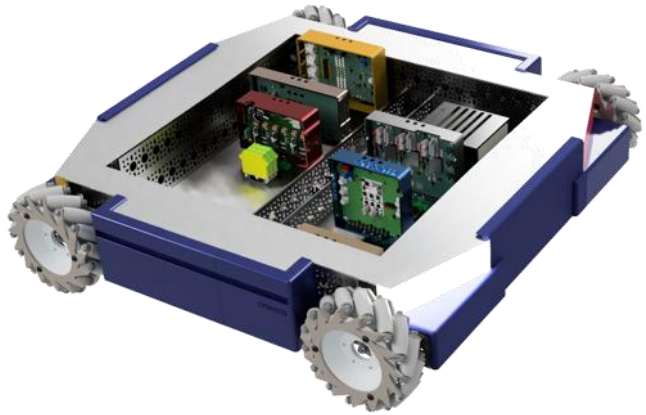
onsemi Autonomous Mobile Robot concept

- With capabilities similar to self-driving cars, autonomous mobile robots are complex designs made up of sub-systems that allow the robot to move, see and operate safely with minimal or no human interaction.
- **onsemi** minimizes this complexity with reliable intelligent power and sensing solutions that provide the essential building blocks of your design. Our sub-system solutions, ranging from rugged, high-resolution imaging systems to high-power motor control to highly efficient and compact battery charging solutions, are all built using decades of experience serving the automotive industry

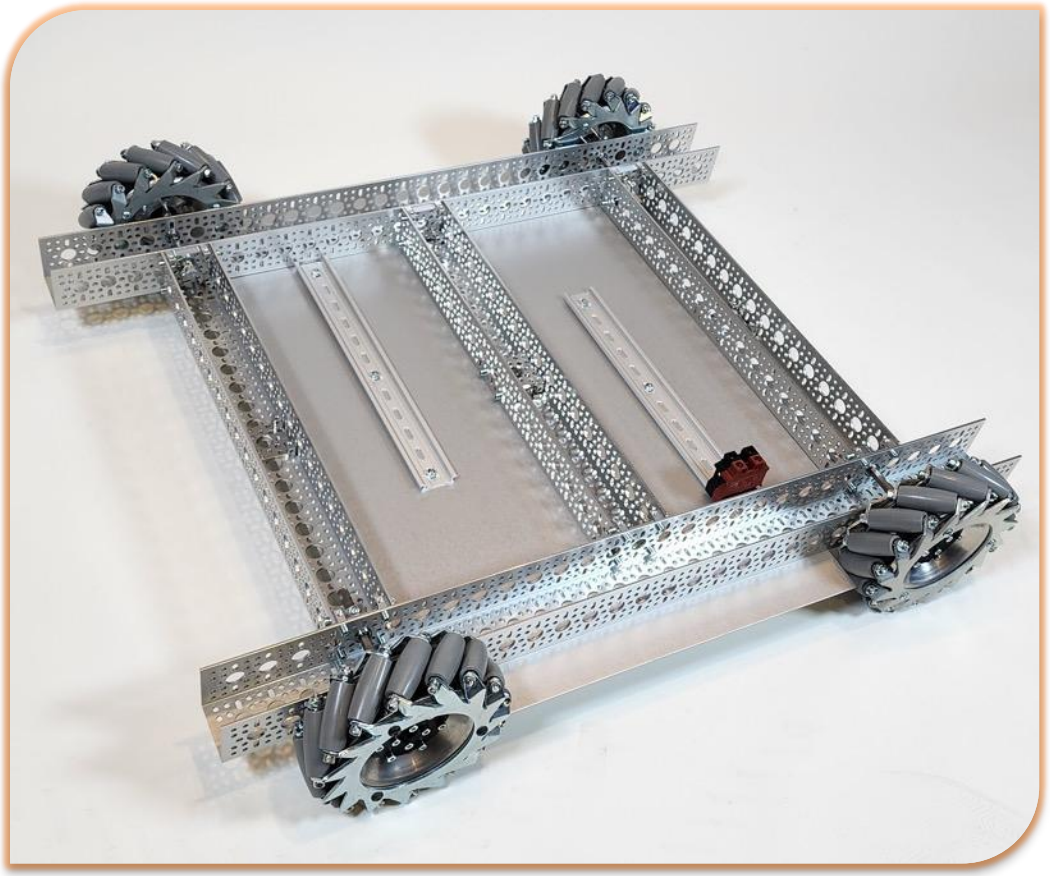


Available AMR collateral

- BOM
- Mechanical
- 3D printed parts
- Sheet metal
- Assembly
- ROS2 appication
- Notes



Starting the AMR build



goBILDA
Strafer™ Chassis Kit V5

D3 Designcore
Carrier board

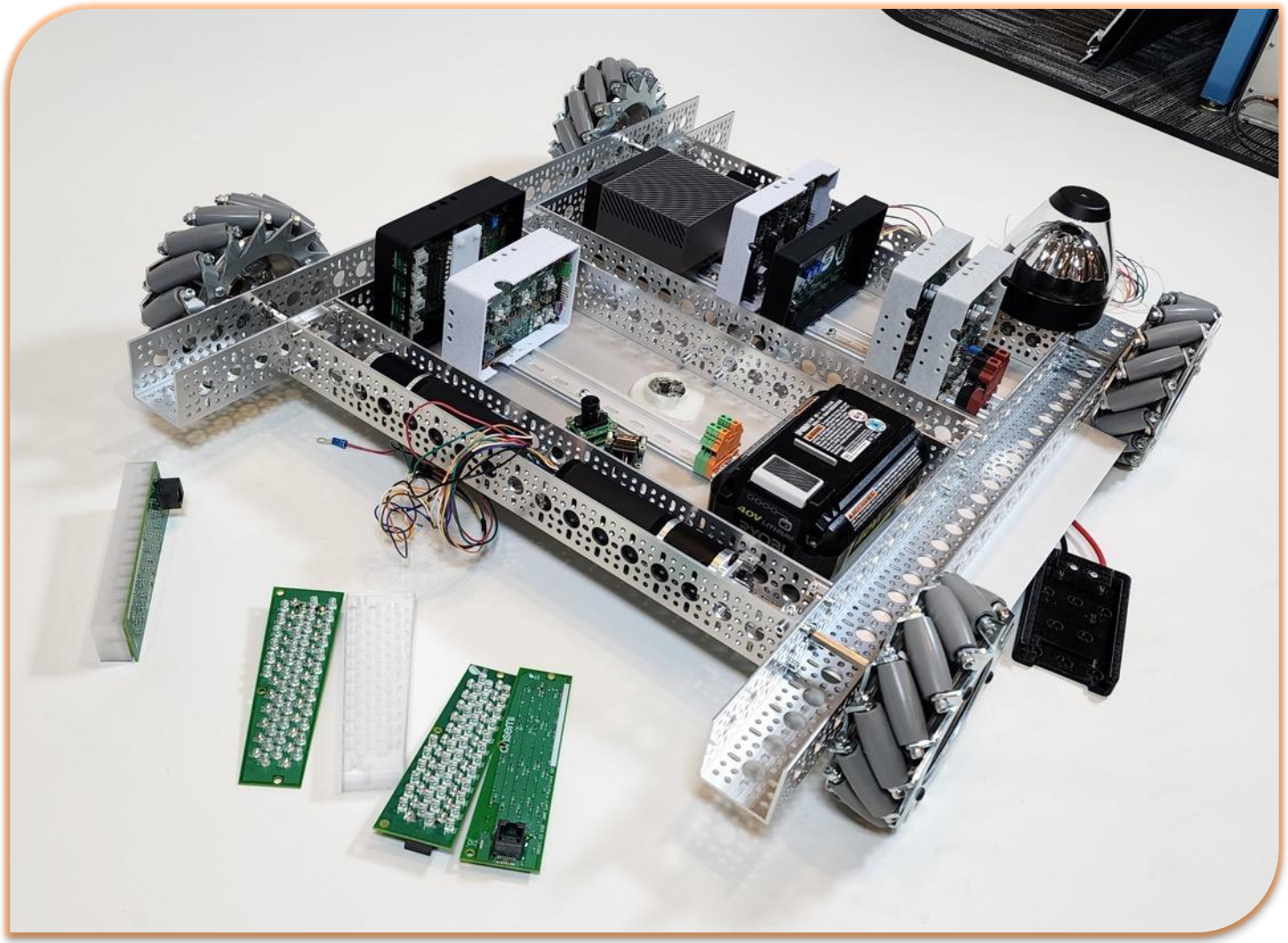
Nvidia Jetson Orin

Ryobi 6.0Ah OP4050A 40 Volt
Lithium-Ion Battery OP406A

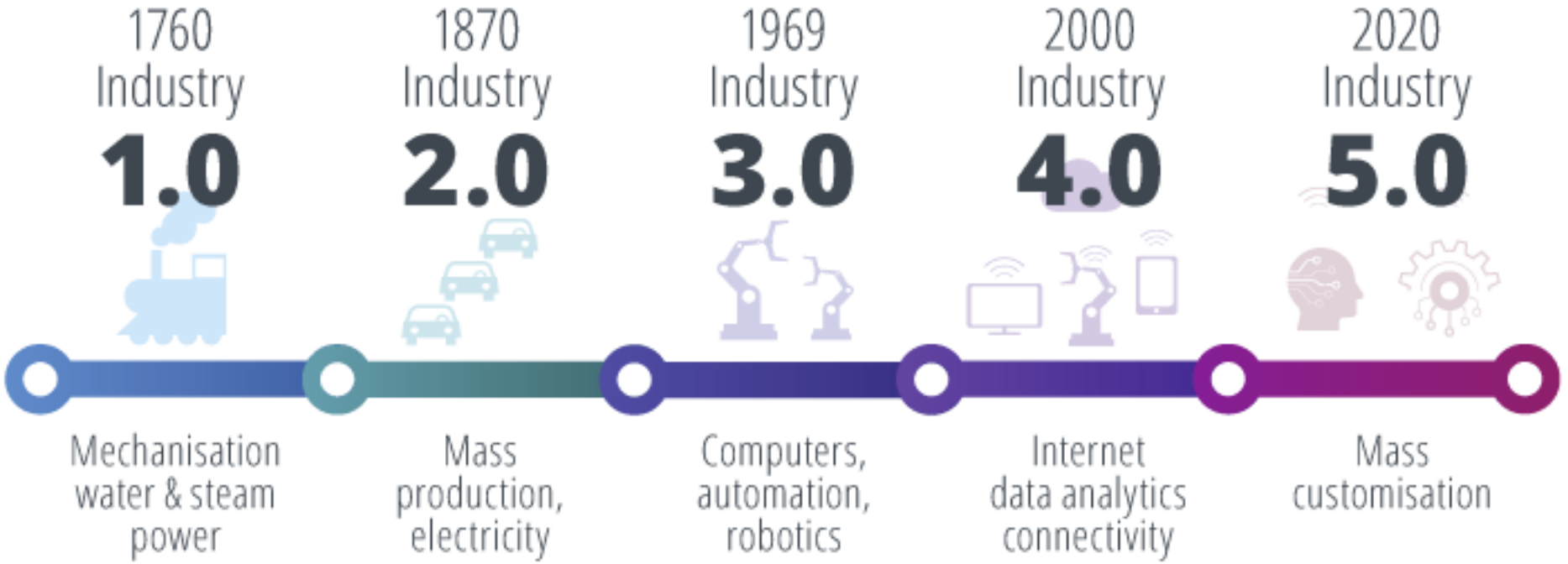
DIN Rail Slotted Aluminum RoHS 12"
Long 35 mm Wide 7.5 mm High

Anaheim Automation, BLDC
with Planetary Gearboxes
BLWRPG17

onsemi solutions for Autonomous Mobile Robots



- Almost half of manufacturers facing significant cost rises due to investment in people
- Technology training lacking for over half of manufacturers
- Economic climate holding back sustainability strategy for seven-in-ten manufacturers



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