

# Enabling Next-Gen Smart Manufacturing with ROS-Industrial

**toward Factories of the Future (FoF)**

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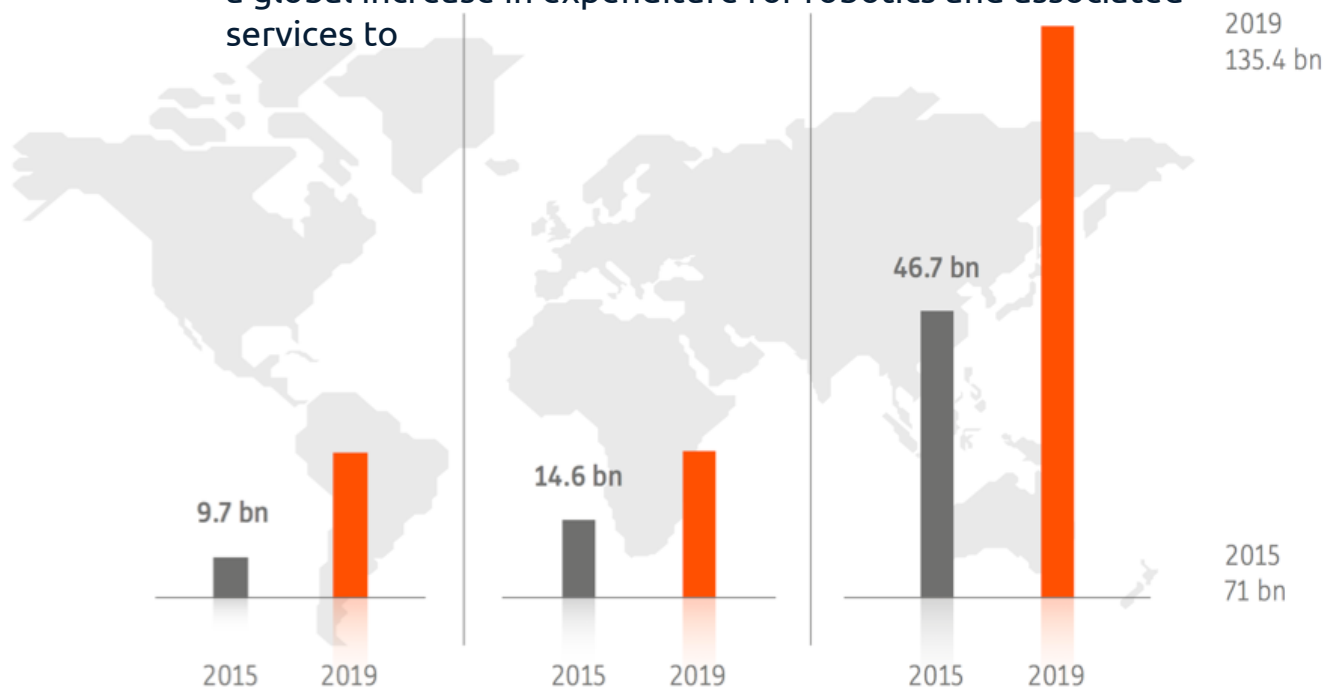
**Building Forward Together**



# Industry 4.0



a global increase in expenditure for robotics and associated services to



Source: IDC Forecast Worldwide

## • Industry 4.0 Trend

- Customization
- Individualization



## • Shorter Time-to-Market (Customer orientation)



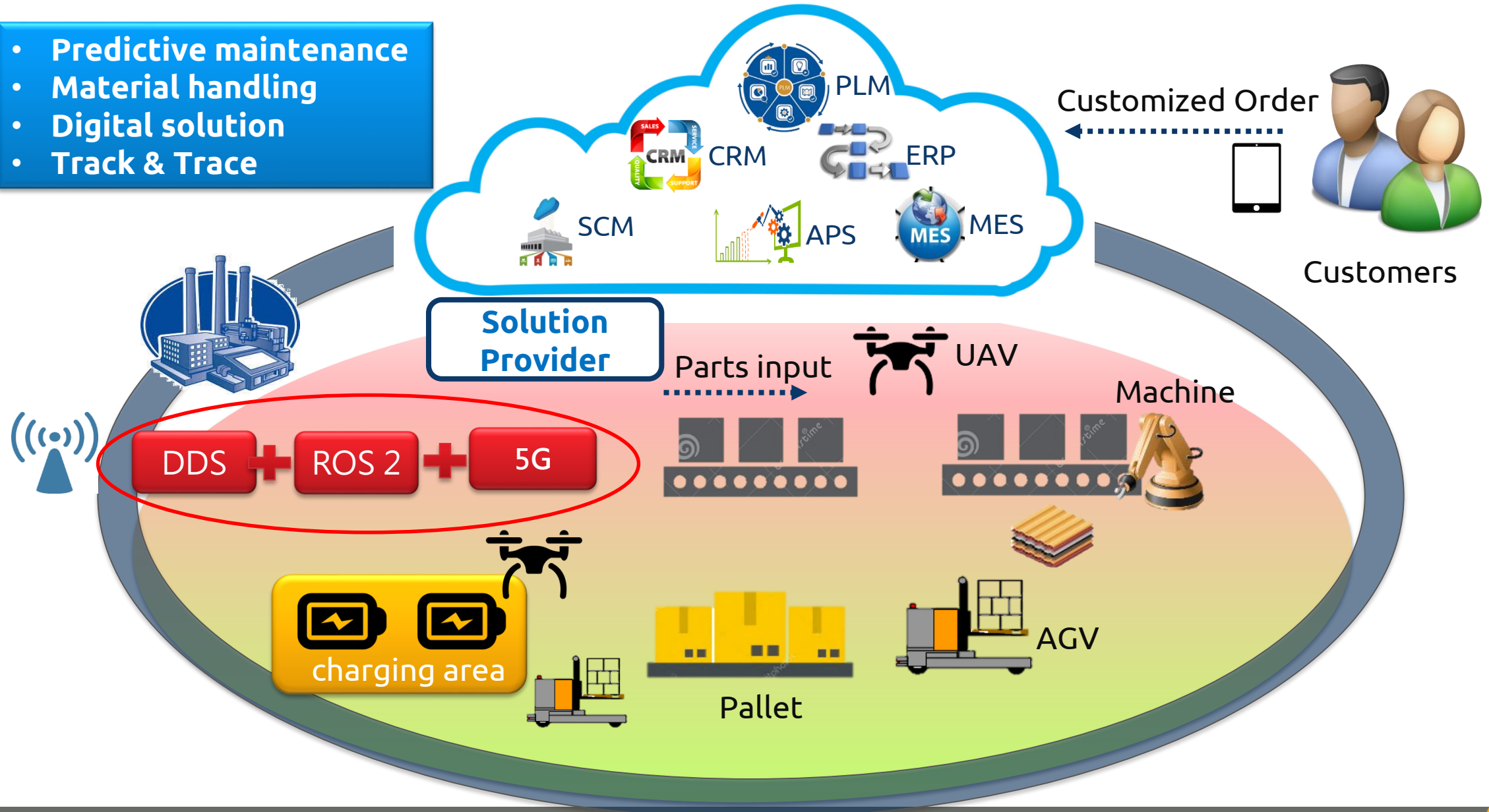
## • Smart Factory of the Future

- Flexibilization of production
- Intelligent, fast and reliable logistics services

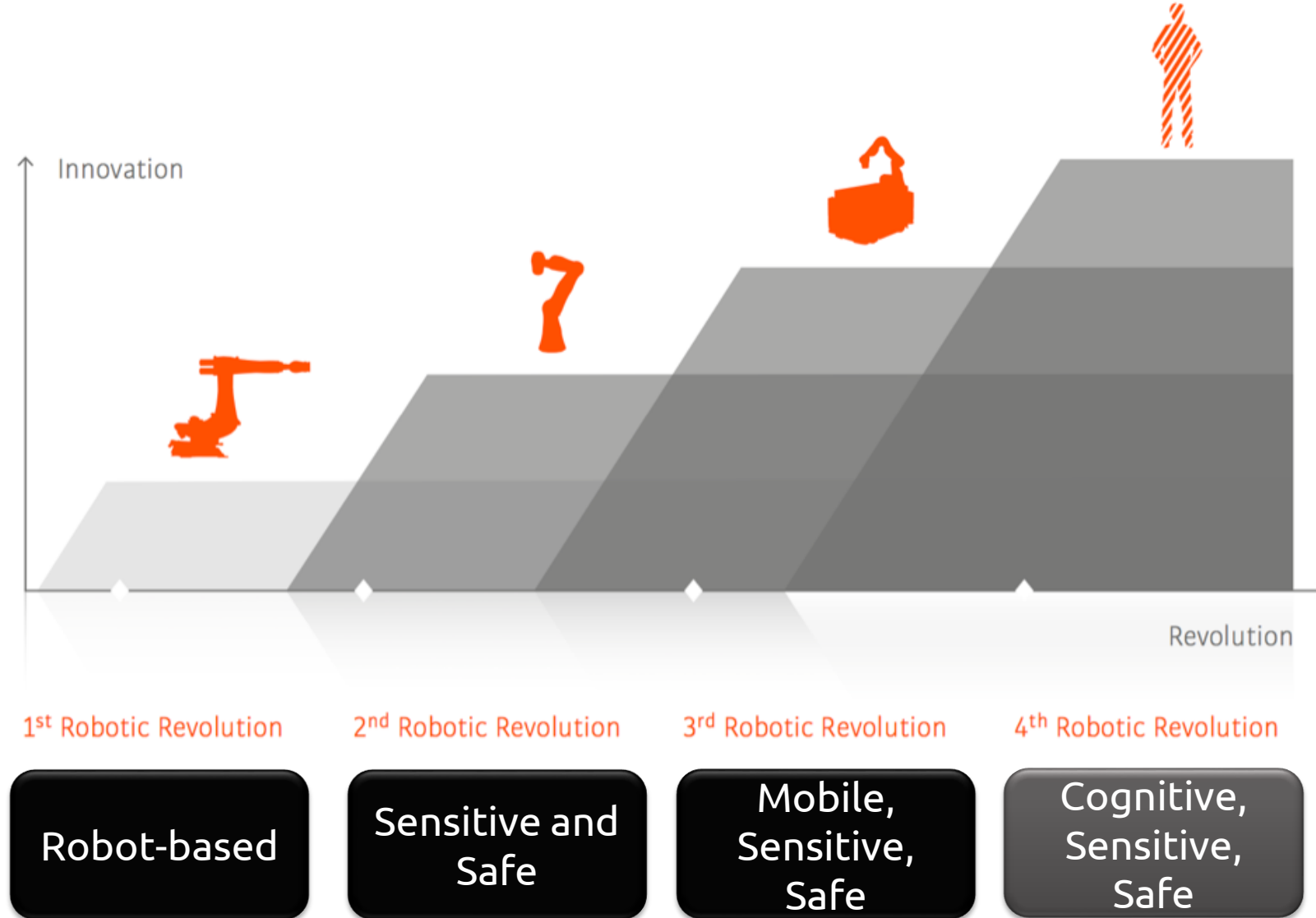
(customer relationship)

# Factories of the Future (FoF)

- Predictive maintenance
- Material handling
- Digital solution
- Track & Trace



# Four Revolutions in Automation Technology



Source: KUKA, 2017

## Robot of Future

- constantly **improving** **their ability** to work directly with **humans**,
- master communication such as **gesture** or **voice** control,
- **intuitively integrate** into variable processes,
- operate in a **mobile** and **autonomous** manner, for example as **AGVs** or mobile robots,
- capable of **learning**, **share** **knowledge** and act in swarms,
- become **perceptive** and are **aware** of their **environment**.

# Megatrend 1: Real-time Edge Computing

## ► *Interoperable/ environment (DDS over 5G)*

- Barrier-free networking of heterogeneous IT landscape and production environment (wire/wireless)

- ❖ Allow **scalable edge computing** and **virtualization of resources**

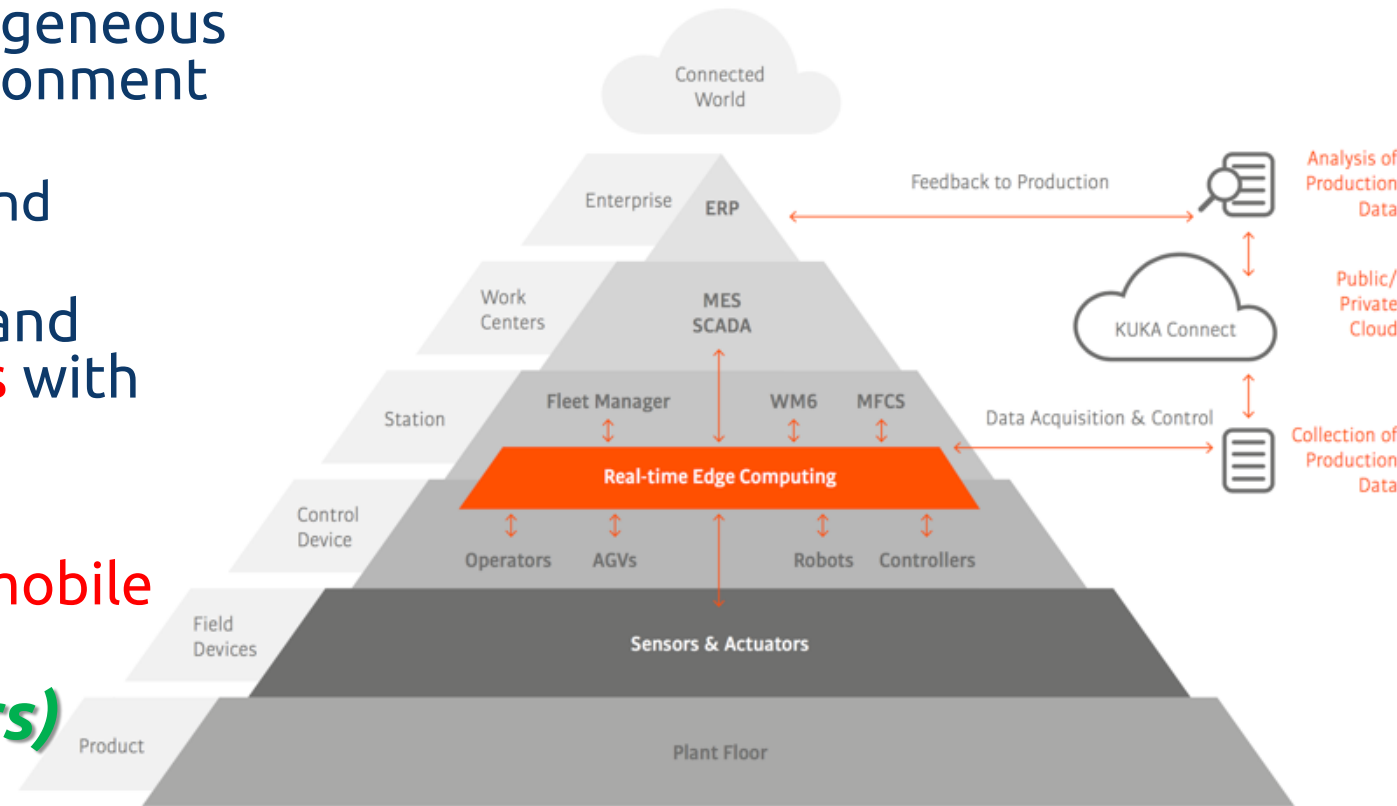
- non-homogeneous **data sources**, and **compact, streaming data analytics** with real-time capability

## ► *Autonomous (ROS 2)*

- Collaborative robots (cobot) are **mobile** and **collaborate** with **human**

## ► *Sensitive (hw platform + sensors)*

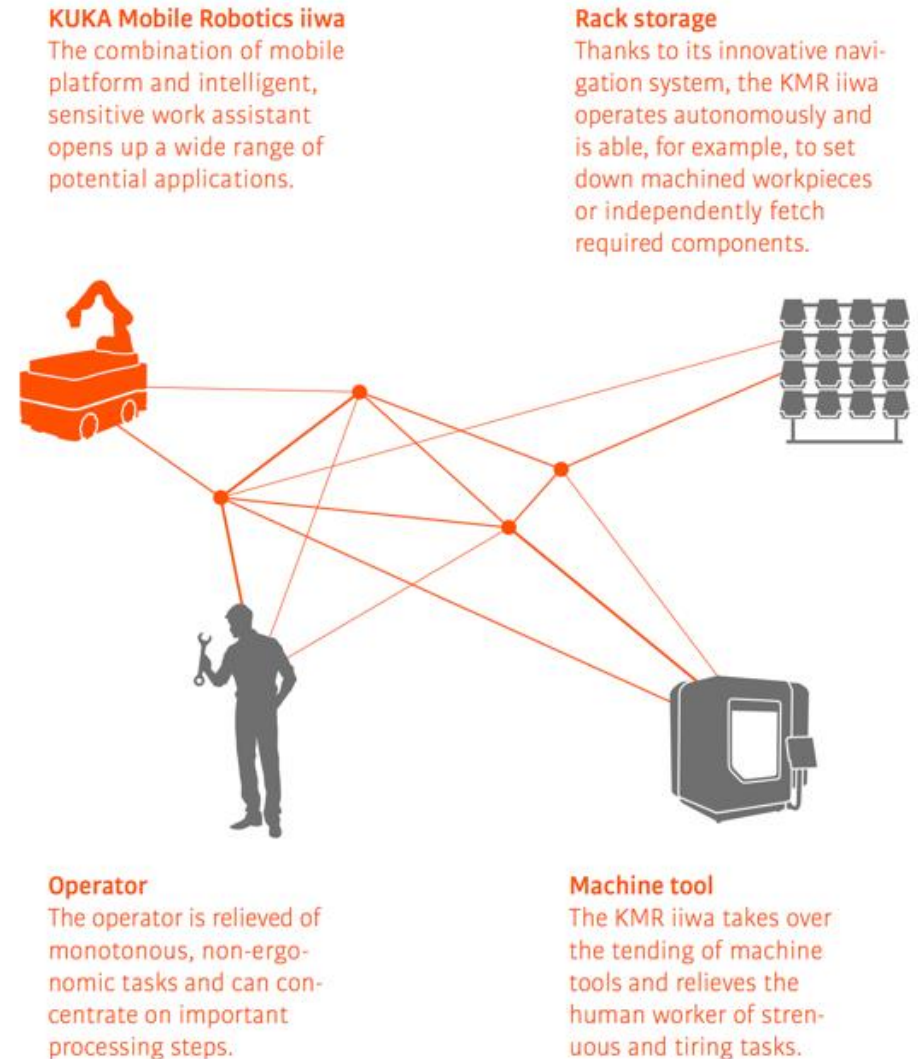
- Identification (Who am I?)
- Location (Where am I?)
- Data storage (What do I know?)
- Computing power (What can I do?)
- Connectivity (Who can I communicate with?)





# Megatrend 2: Learning/Sharing in Swarms

- ▶ Share this knowledge with other units in the fleet
- ▶ Anything that has been located by one unit in the swarm is instantly available to every other unit
- ▶ This results in a universally networked, shared “**motion and route plan**” that allows the **coordinated execution** of all robot motions



# Megatrend 3: Cloud-based Platform

- ▶ seamlessly **bridge** the gap between proprietary OT in production and standardized data formats and new protocols in business and cloud IT.
- ▶ “**on-click**” options through **cloud-based software applications** and services that allow them to leverage the existing infrastructure, i.e. logistics and production, to the next level of flexibility, efficiency and effectiveness.
- ▶ autonomously **check, optimize** and **document** the results of its work



# Community's power! Why ROS ?



- **Largest open-source community in the robotics world**

- 3M, ABB, BMW, Ford, BOSCH, Boeing, Siemens, MIT, Stanford > 250 members
- 3000+ developers
- 100,000+ download (July'15 ~July'16)
- 180,000+ commits
- 140+ kinds of robots
- Reusable modular components

- **Fruitful HW/SW supported**

- OpenCV, TensorFlow, etc.
- CUDA, CPU, ARM, X86
- Lidar, Infrared sensors, depth sensor, camera

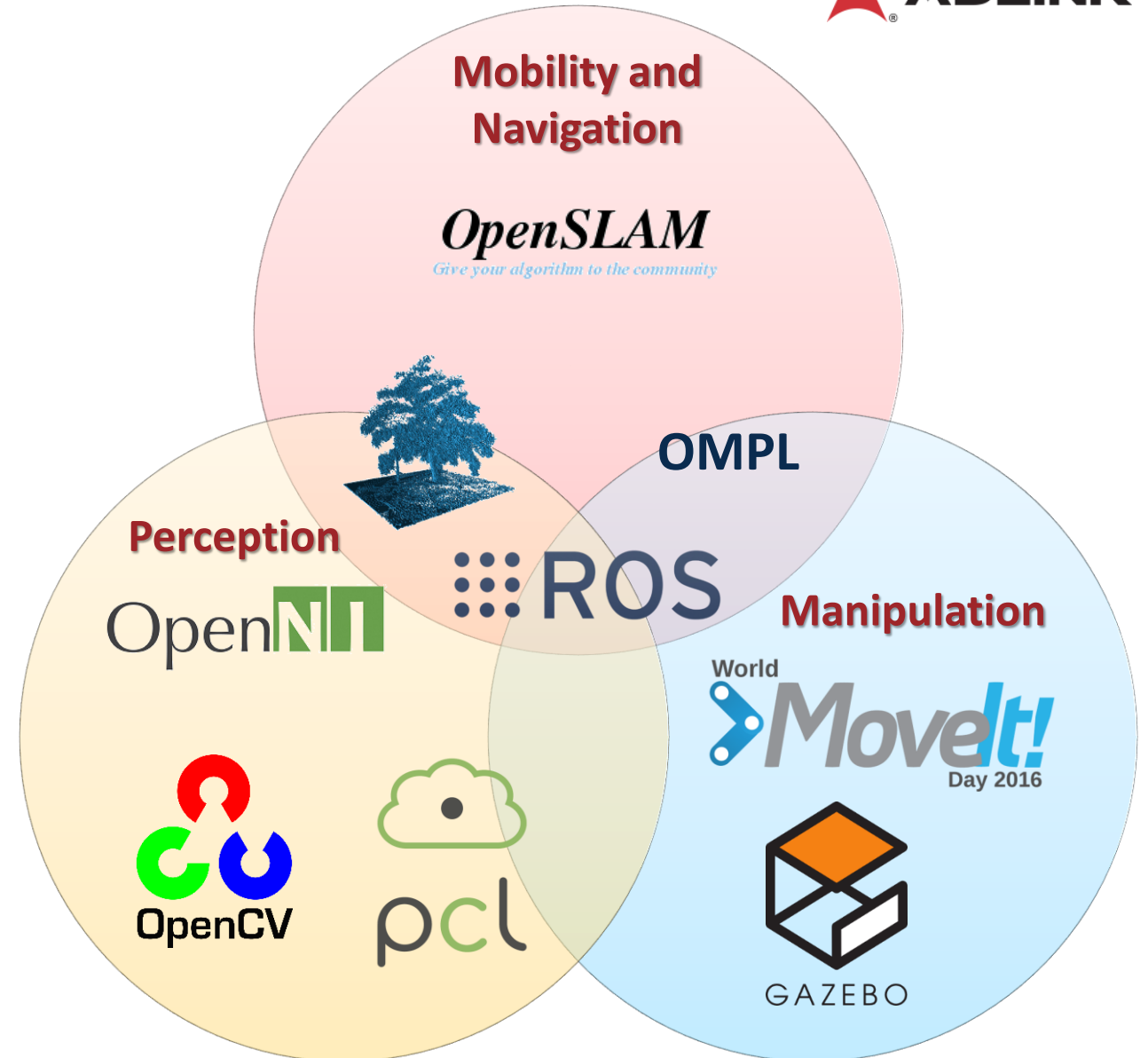


ROS-INDUSTRIAL CONSORTIUM WORLDWIDE MEMBERSHIP, FEBRUARY 2017



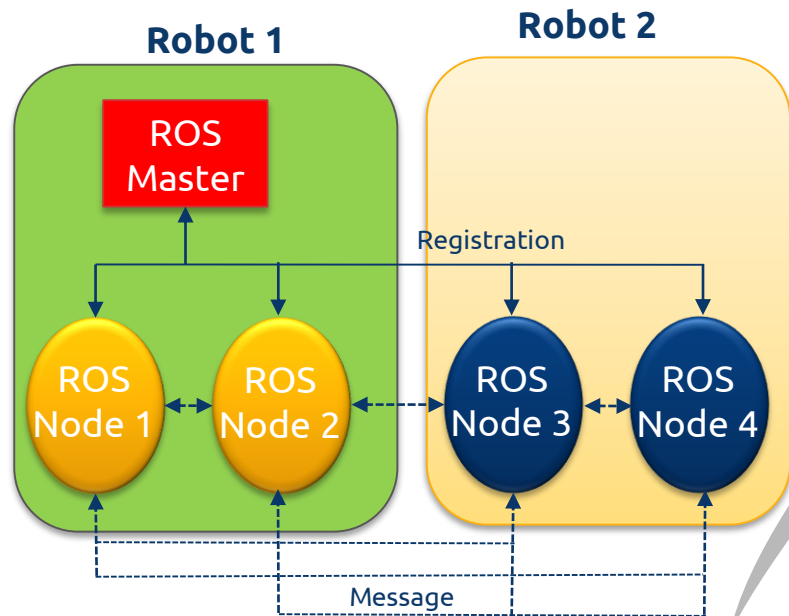
# What is ROS?

- State-of-the-art algorithms
- Rapid development from research community
- Broader capabilities than current industrial solutions



# Toward Distributed, Autonomous Way !

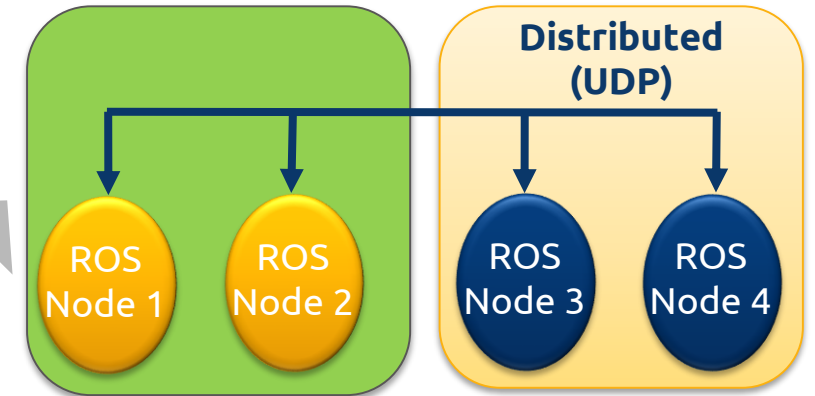
- ROS 1 Standalone
- ROS 2 coordination among machines, adopt **DDS (pub-sub)**



Server-client  
(TCP)

ROS 1  
(2007)

ROS 2  
(2014)



ROS 2 removes the  
Master Node

- Real-time
- Powerful QoS
- Standard tech.
- Dynamic discovery)

ROS 2  
Merit

# Industry Adoption of ROS



**Military**



**Disaster Mgt**



**Robonaut**



**Valkyrie**

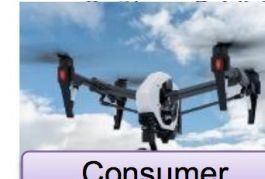
**Space**



**Manufacturing**



**Logistic**



**Consumer**



**Agriculture**



**Savioke**

**360° collision avoidance (2015).**



**BMW**



**Rethink Robotics**  
VCs include GE Ventures, Goldman Sachs & Bezos Expeditions



**Fetch Robotics**  
VCs include Oreilly AlphaTech Ventures, Shasta Ventures & SoftBank



**YuJin Robotics (Korea)**



**Kawada Robotics (Japan)**



**Magazino GmbH**  
VCs include Siemens



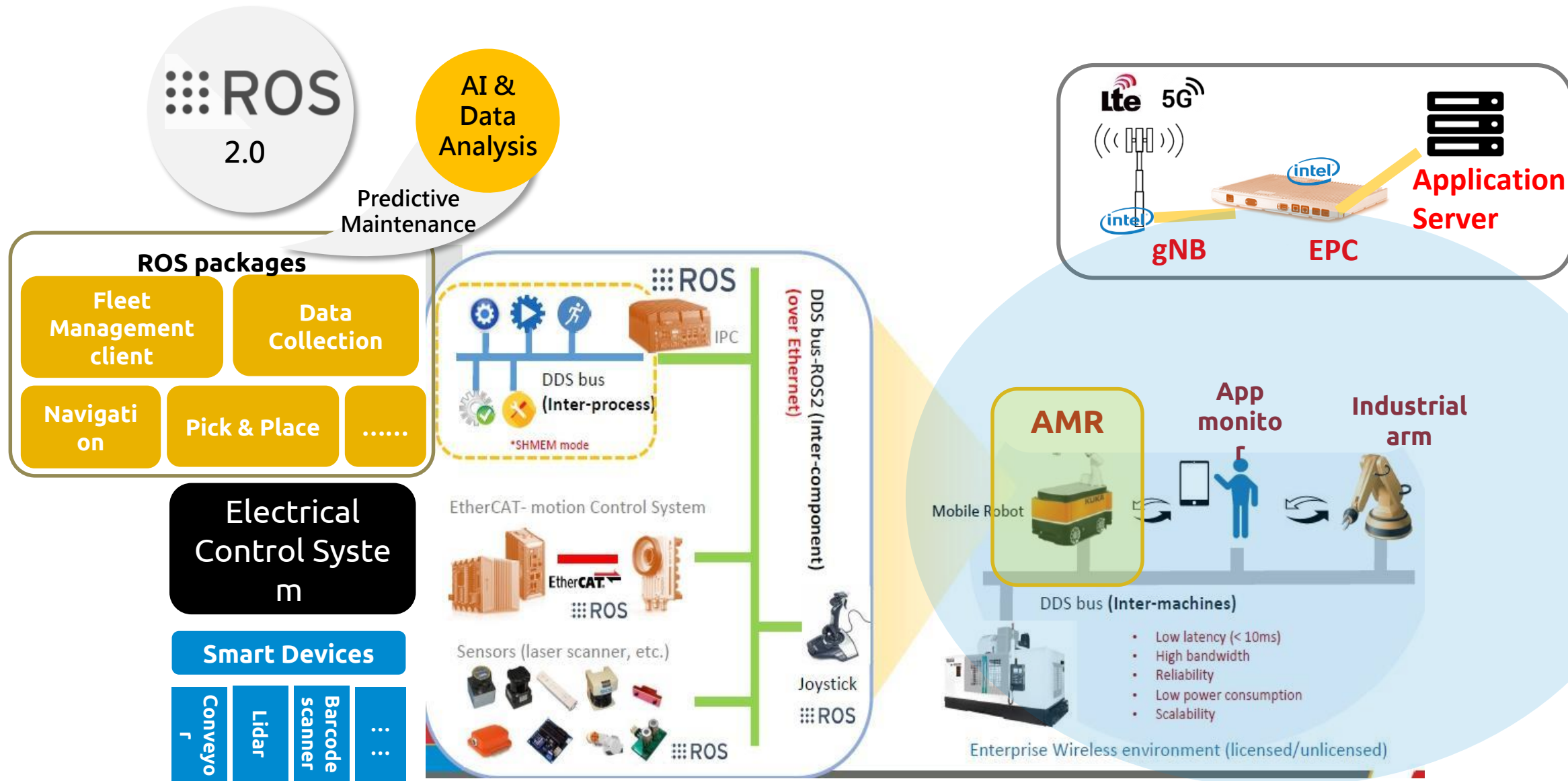
**CSIRO – Bobcat (Australia)**



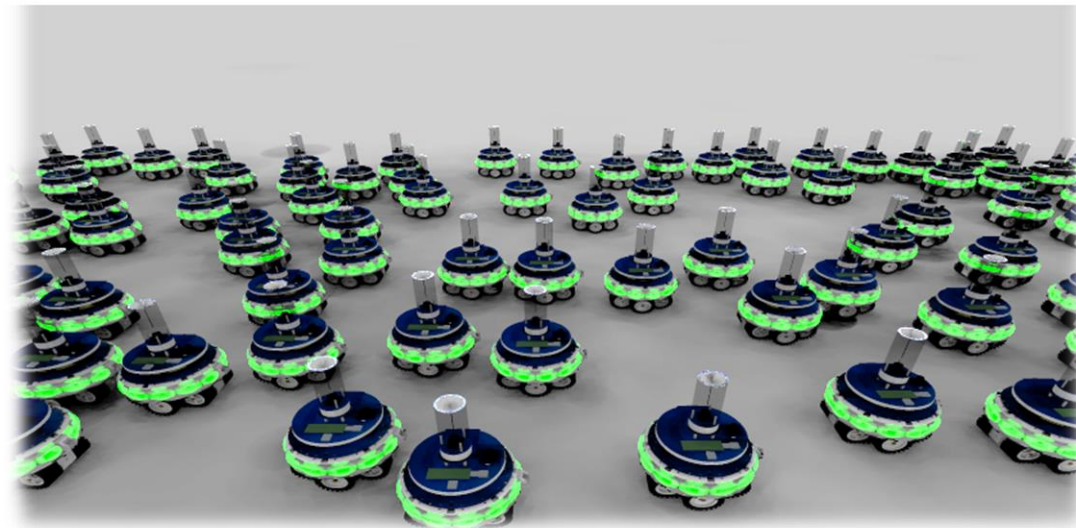
**Three ROS Powered Stations**

**Control System by U+Robotics**  
todesco srl & IT+Robotics srl (Italy)

# Using ROS to design AMR in FoF







# ADLINK DDSBOT DEMO



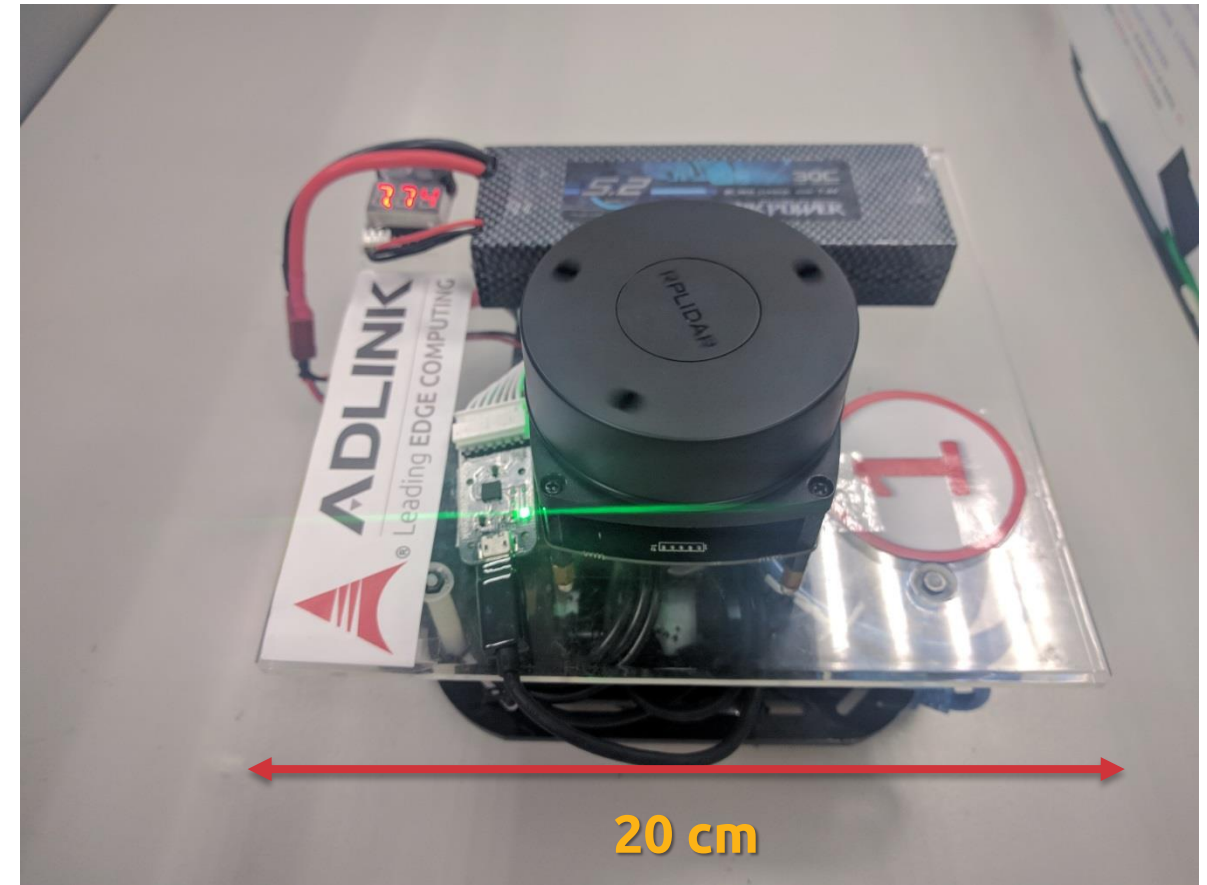
# ADLink DDSBot



## ROS 1.0/2.0 based swarm robots architecture

### □ Features:

- ROS2-based swarm system.
- Self-awareness and autonomous.
- **PrismTech DDS (Opensplice CE).**
- Compatible with ROS 1 applications.
- Fast and Easy Implementation.
- Low-cost robot. (total cost < **USD250**)
- Open source with **Apache 2.0 license.**



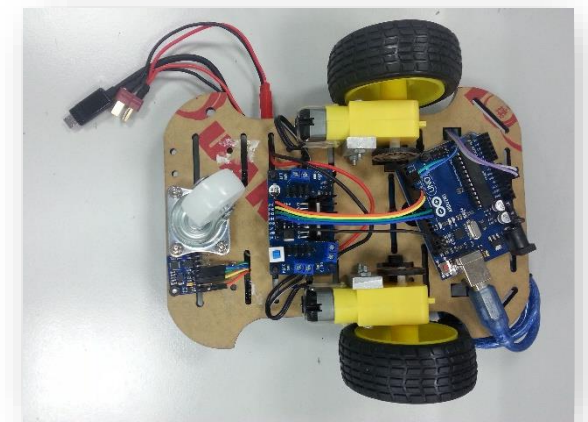
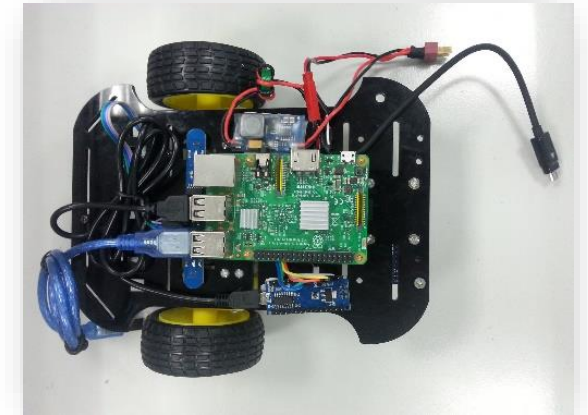
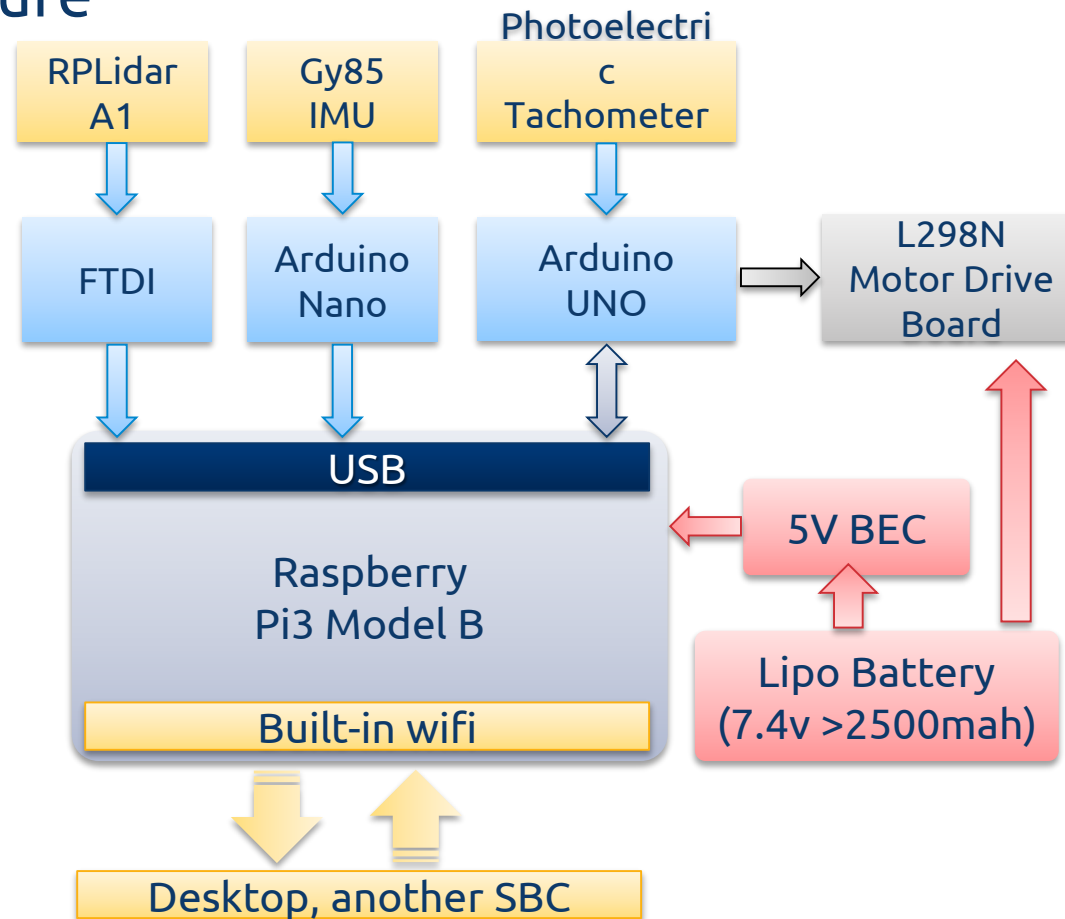
ROS

# ADLink DDSBot

ROS 1.0/2.0 based swarm robots architecture

## Hardware architecture

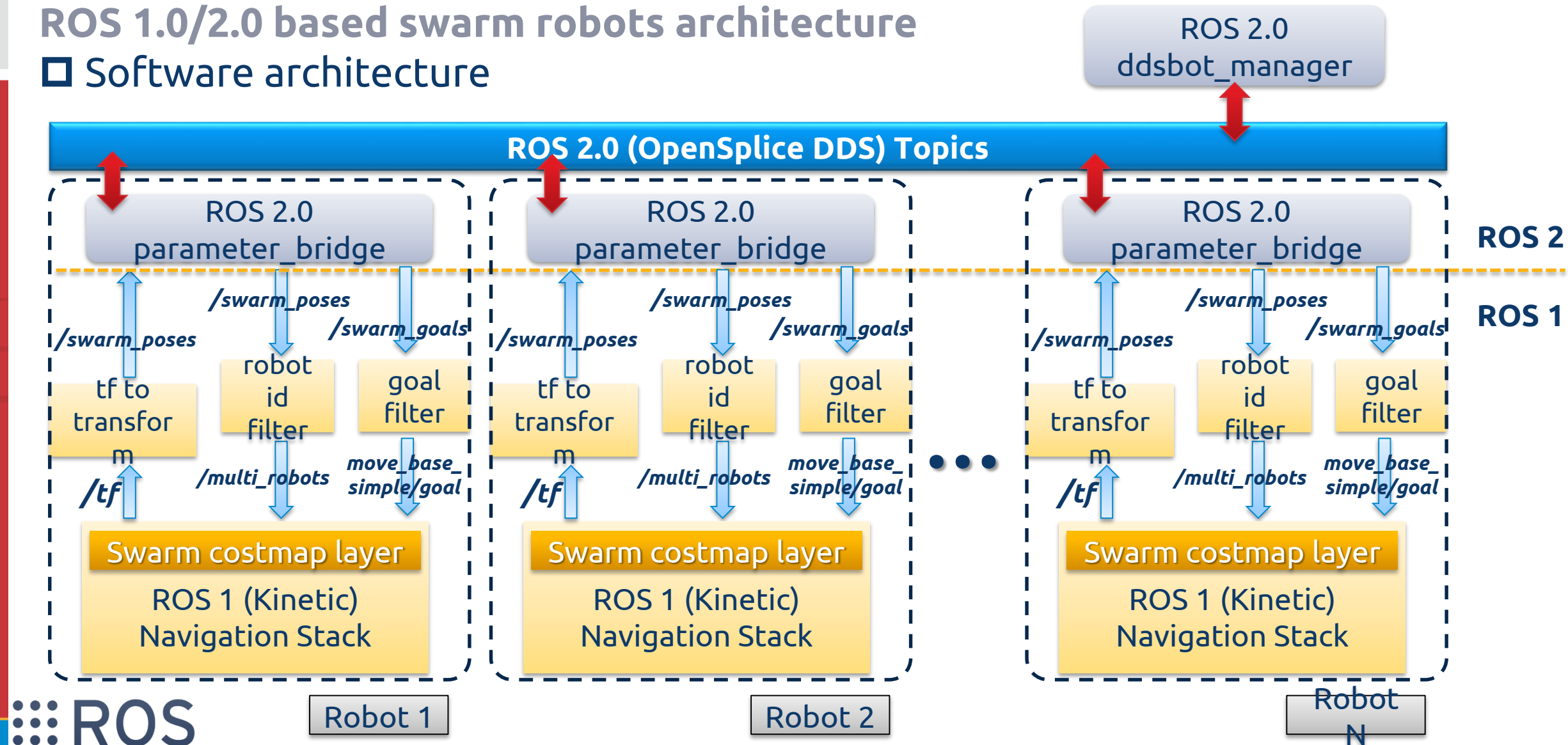
Item & quantity	
Raspberry Pi 3 Model B	1
RPLidar A1	1
Arduino UNO	1
Arduino Nano	1
Gy85 IMU	1
Arduino Car Chassis Kit	1
Photoelectric Tachometers	1
L298N Motor Drive Board	1
5V BEC (dc to dc)	1
Lipo Battery	1
Total cost: < 250USD	



# ADLink DDSBot

## ROS 1.0/2.0 based swarm robots architecture

### ❑ Software architecture



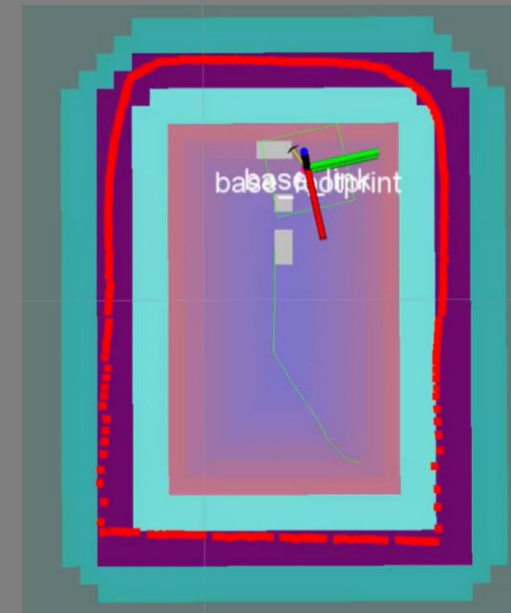
# Real Space (ROS 1.0)



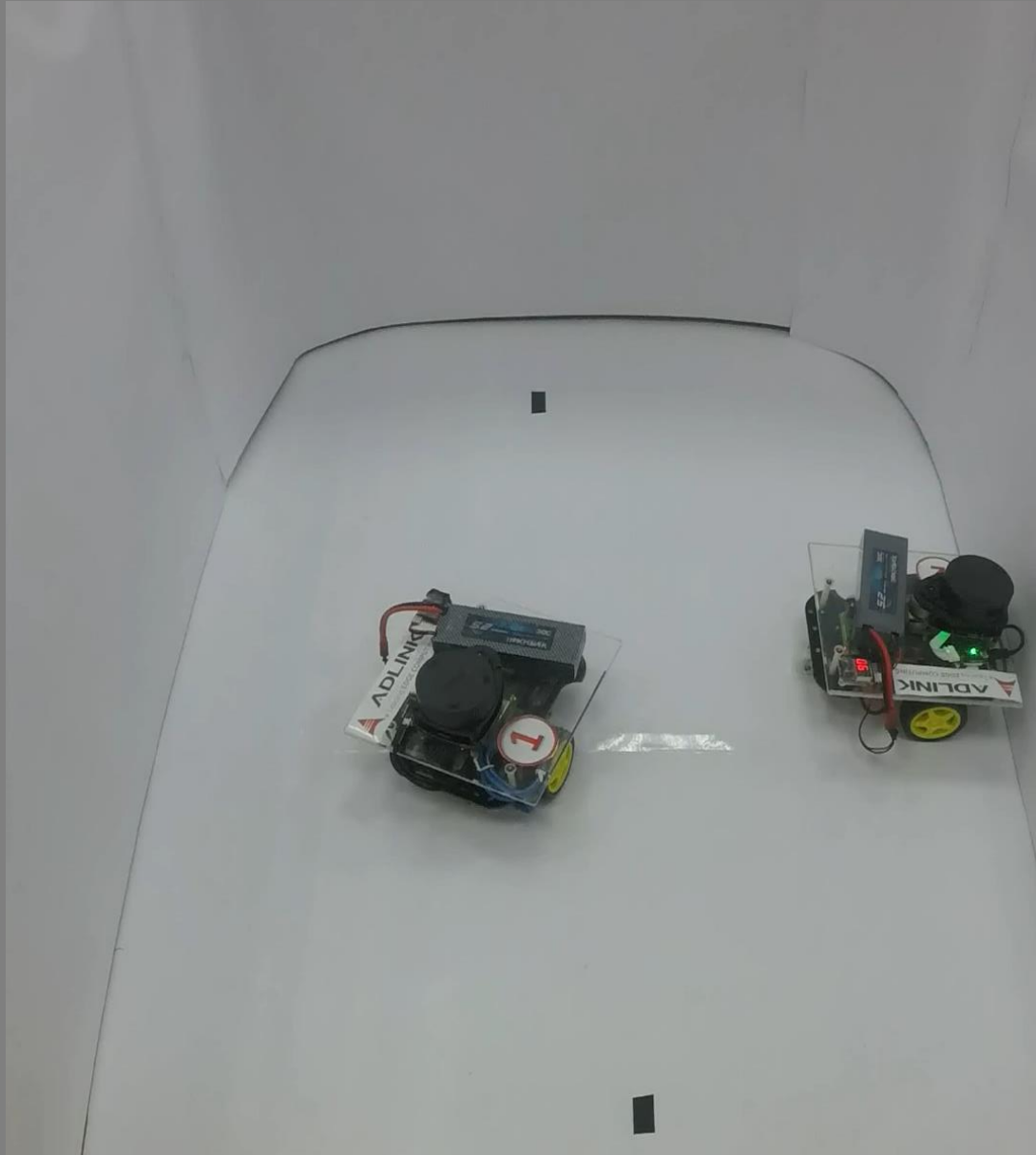
Robot 2



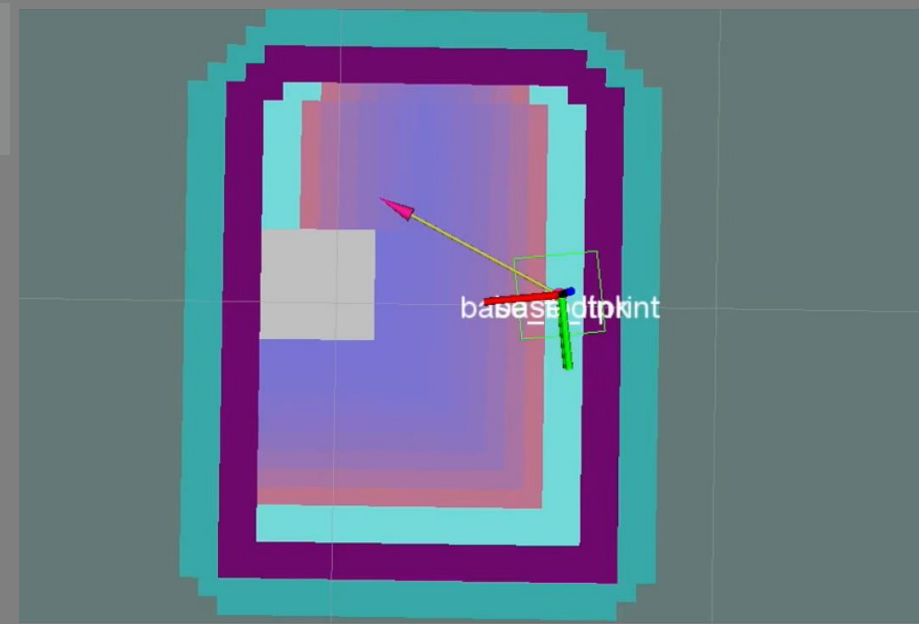
Robot 1



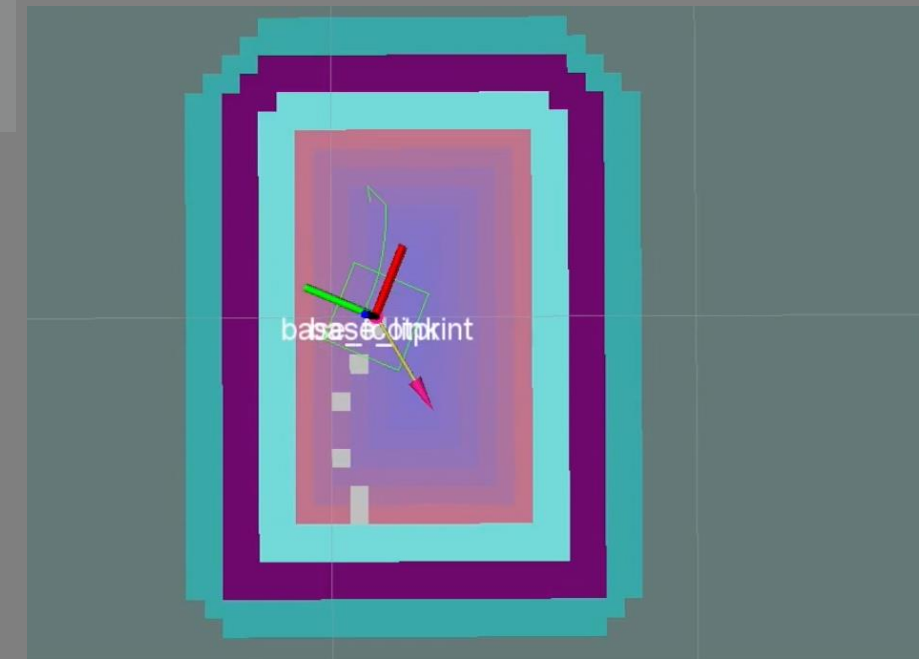
# Real Space (ROS2.0)



Robot 2



Robot



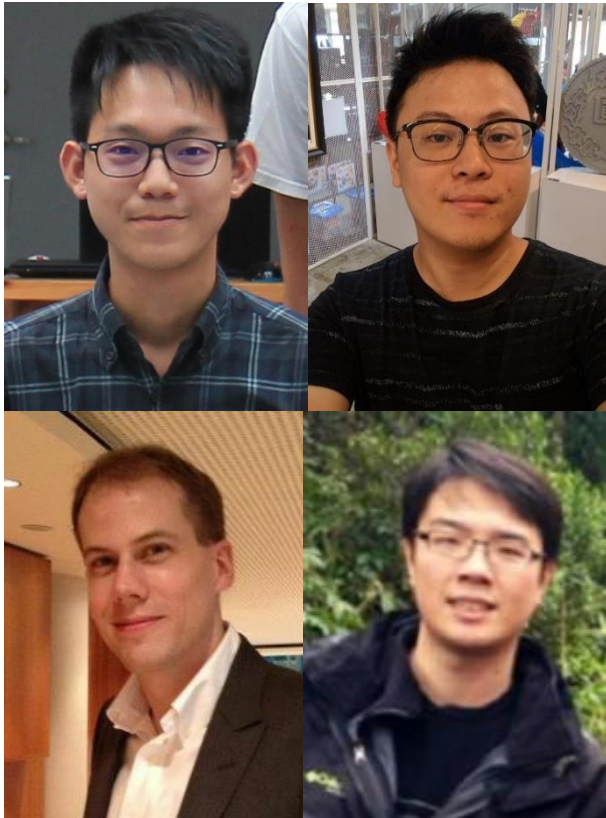


# ADLink DDSBot



ROS 1.0/2.0 based swarm robots architecture

□ Team & Source code



## Team members:

HaoChih, Lin; Chester, Tseng; Erik, Boasson; Ryan, Chen

## Source code (github, Apache 2.0):

[https://github.com/Adlink-ROS/adlink\\_ddsbot](https://github.com/Adlink-ROS/adlink_ddsbot)

## Roadmap:

- Released version: by the end of Sept.
- Ready to go Pi3 image file will be released.
- Documents & Tutorials.



# Conclusion

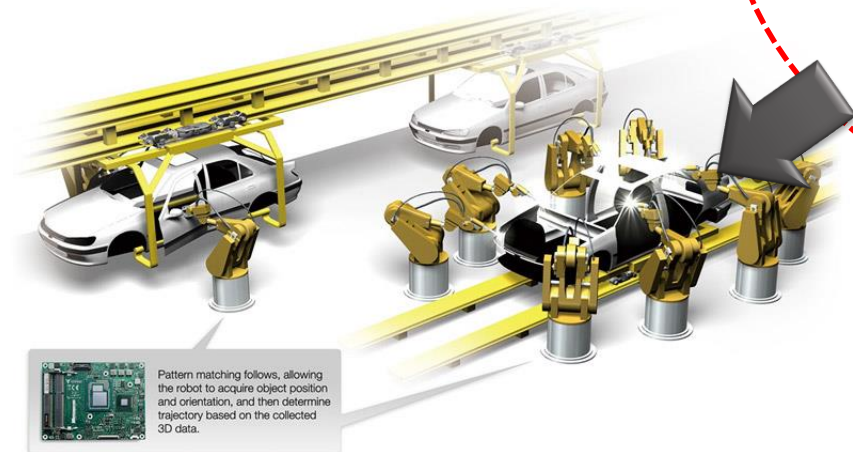
- ROS2 Version 1.0 will be release on Dec. 13<sup>th</sup>, 2017.
  - <https://github.com/ros2/ros2>
- Currently, you can try Beta 3 with OpenSplice Community Edition (open source)
  - <https://github.com/PrismTech/opensplice>
- Standing on the shoulder of giant of ROS, toward intelligent connected FoF
  - Easy, abstract, reliable, rea-time ROS platform (DDS-based)
  - Work with huge community of ROS
- ADLINK ROS-Industry solutions will ensure ... re and hardware



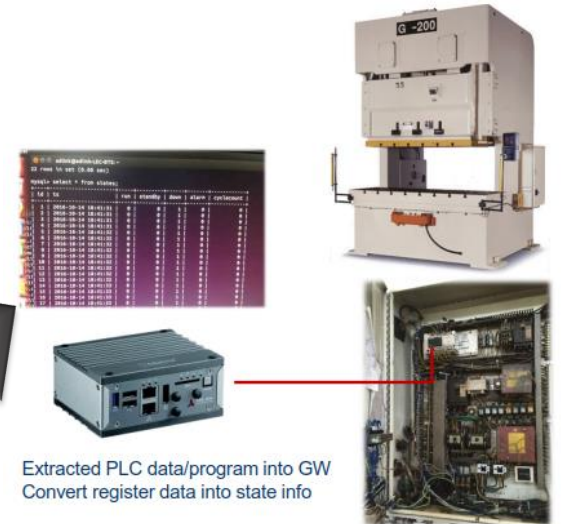
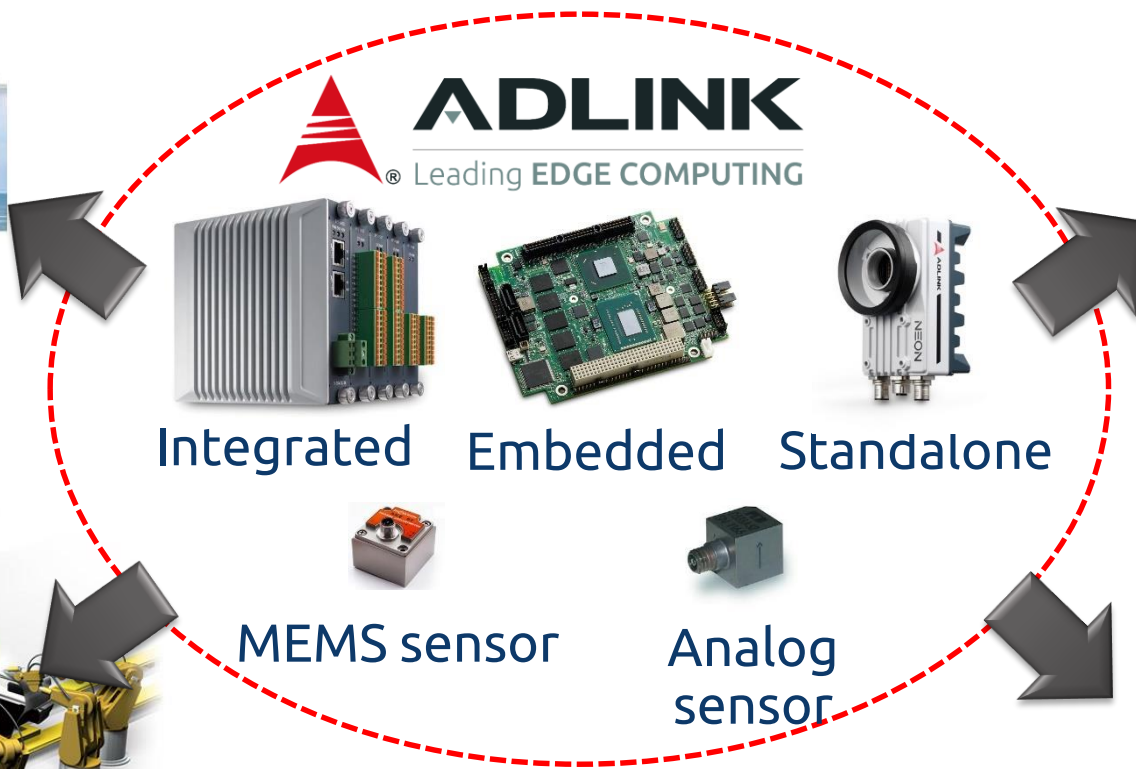
# ADlink ROS-2 Industry-Grade Products in 2018, Vision, Measurement



ROS-based arm and camera for inspection and picking



Embedded ROS-based PC for industrial arms



Machine condition monitoring robots



ADLINK ROS-based PC for AMR

