

Enabling Next-Gen Smart Manufacturing with ROS-Industrial

toward Factories of the Future (FoF)

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2017.09.27



Building Forward Together





Every product is the same!

NIKEiD.

MEN'S

WOMEN'S

COLLECTIONS

STUDIOS

VIEW ALL

Customize Your Ride

NIKE LUNARGLIDE+ 2 iD.

[CUSTOMIZE
YOURS >>](#)

Every product is different!



CHOOSE YOUR COLOR

WHAT'S NEW
NIKE SUPER SPEED 3/4 iD

- > CREATE YOUR OWN
- > VIEW THIS DESIGN

BY NIKECTR720



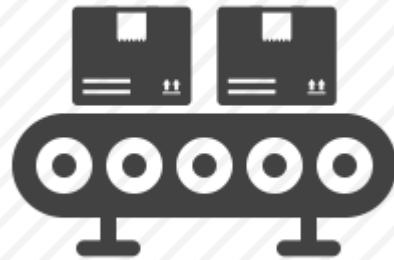
WHAT'S HOT
NIKE SHOX NZ iD

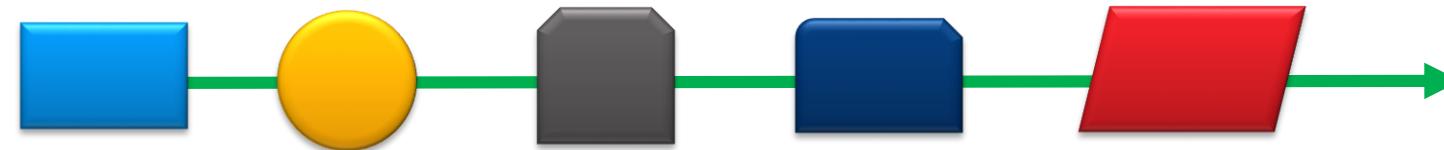
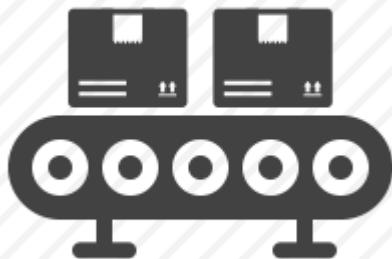
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BY ZJ5118



Massive Production



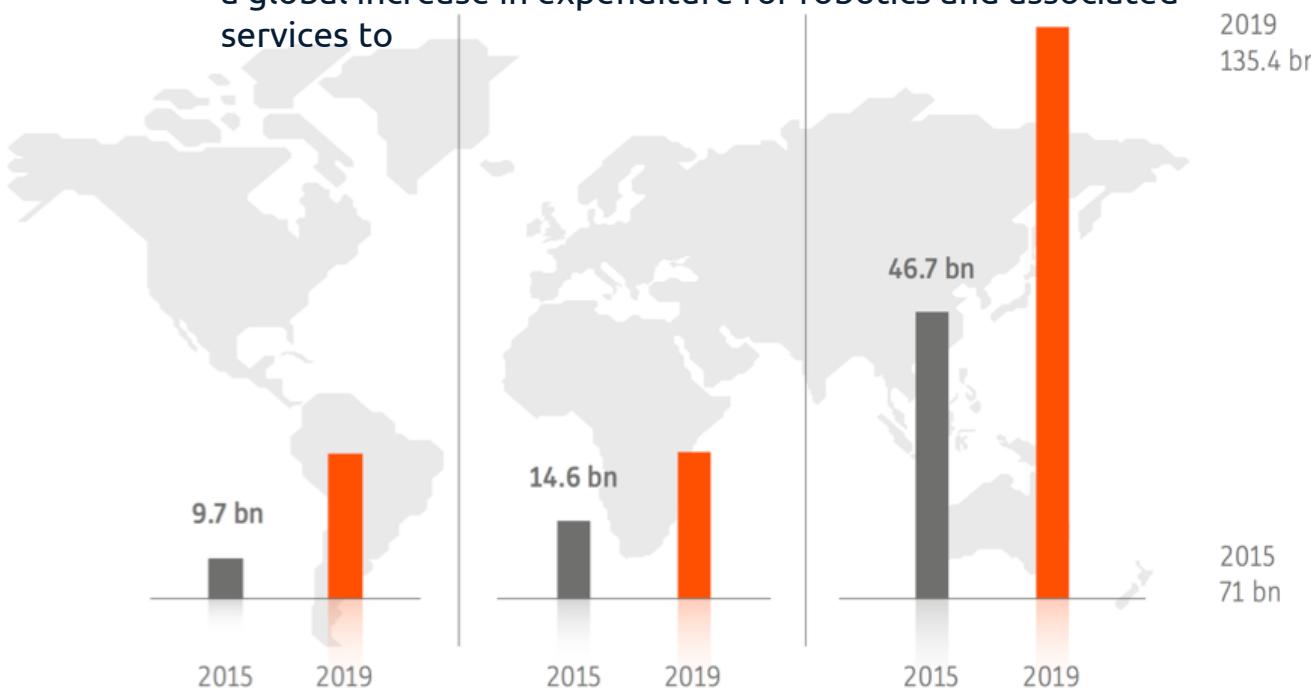


Individual Production

Industry 4.0



a global increase in expenditure for robotics and associated services to



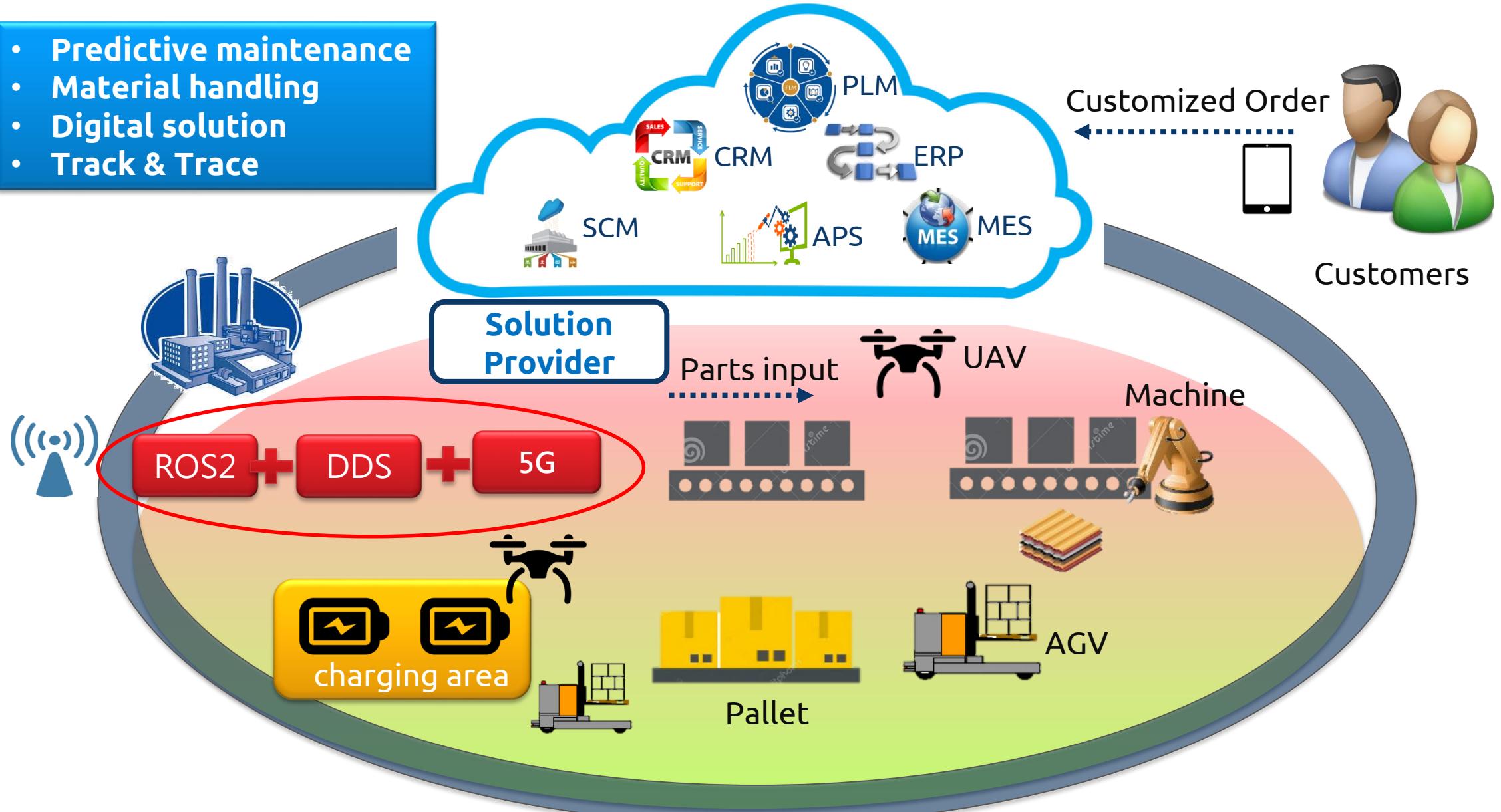
Source: IDC Forecast Worldwide

- **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)

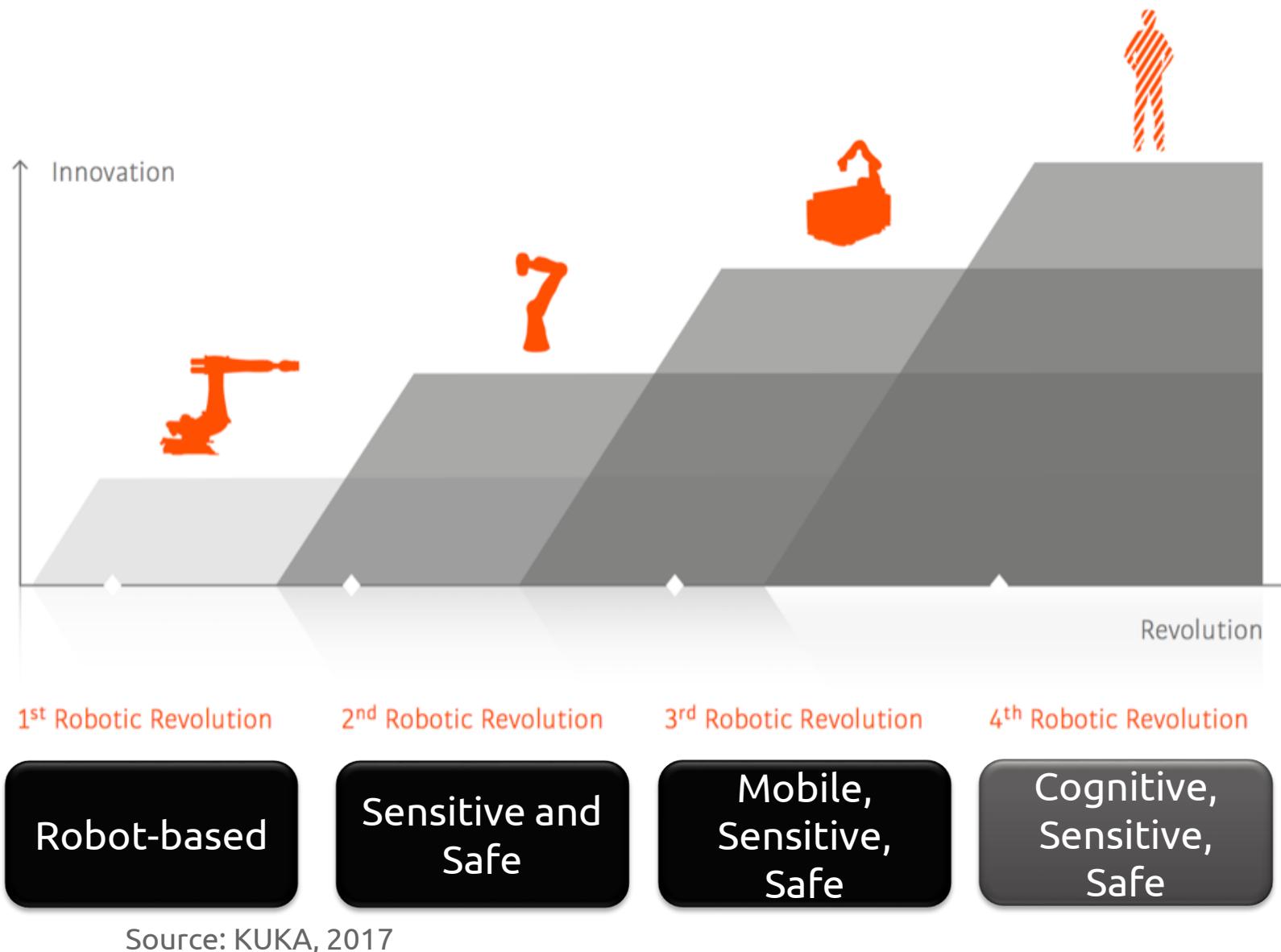
Factories of the Future (FoF)



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



Four Revolutions in Automation Technology



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)*

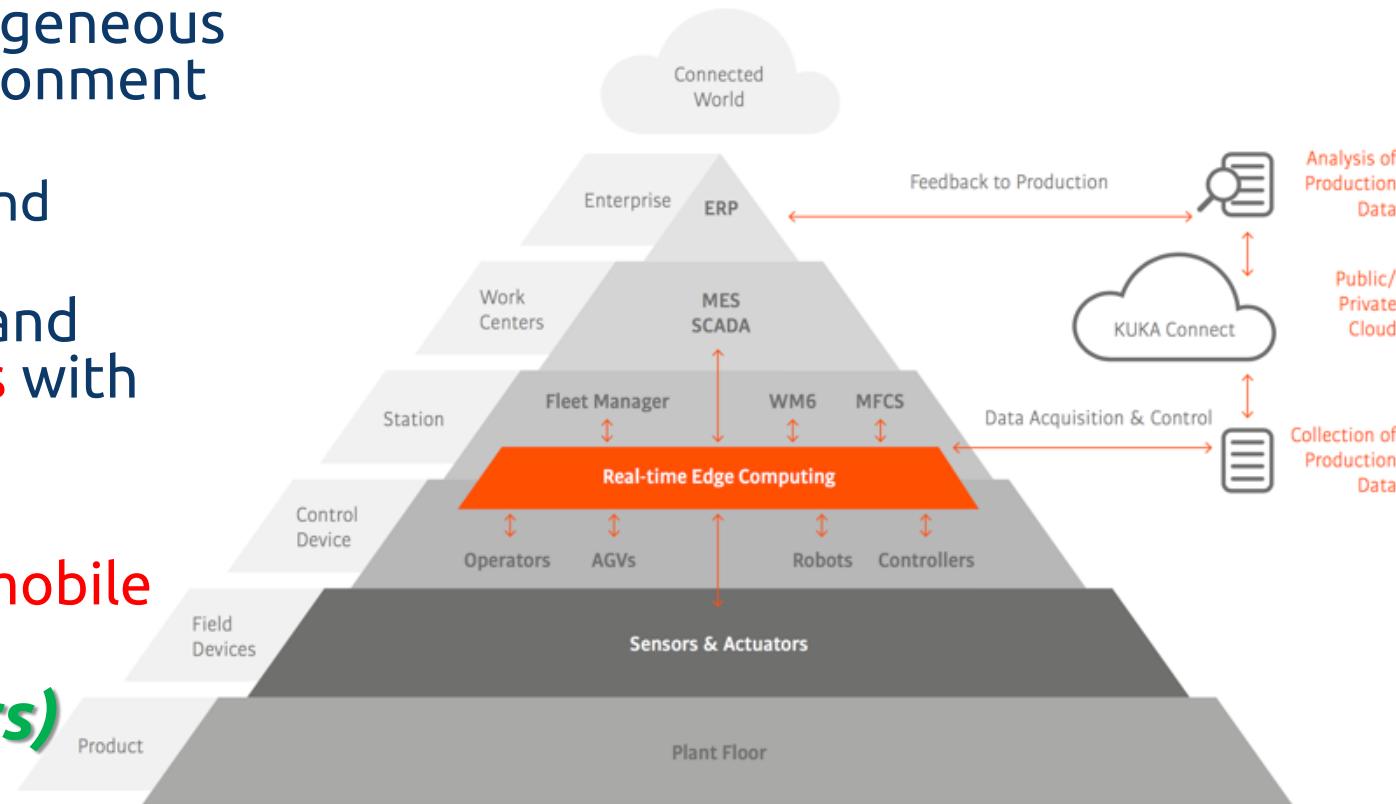
- Barrier-free networking of heterogeneous IT landscape and production environment (wire/wireless)
 - ❖ Allow **scalable edge computing** and **virtualization of resources**
- non-homogeneous **data sources**, and **compact, streaming data analytics** with real-time capability

► *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?)

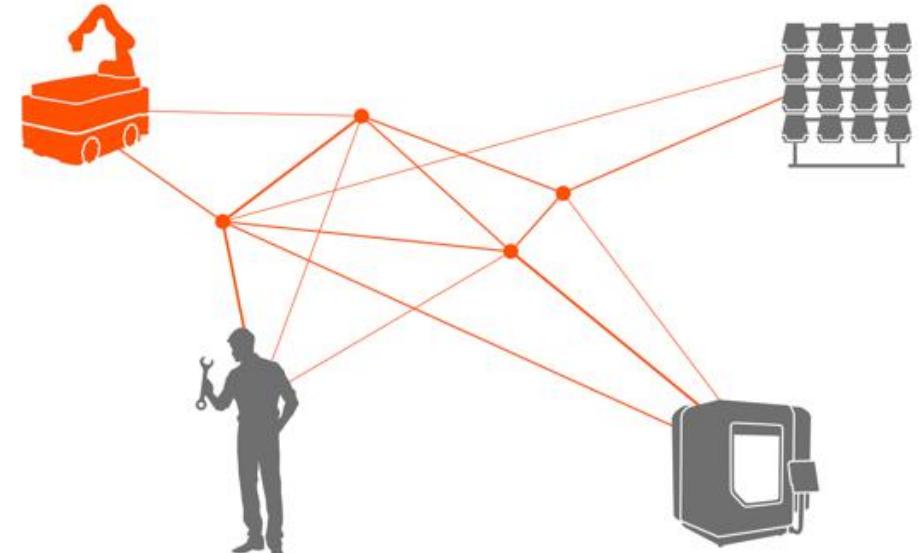


Megatrend 2: Learning/Sharing in Swarms

- ▶ 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

KUKA Mobile Robotics iiwa
The combination of mobile platform and intelligent, sensitive work assistant opens up a wide range of potential applications.

Rack storage
Thanks to its innovative navigation system, the KMR iiwa operates autonomously and is able, for example, to set down machined workpieces or independently fetch required components.

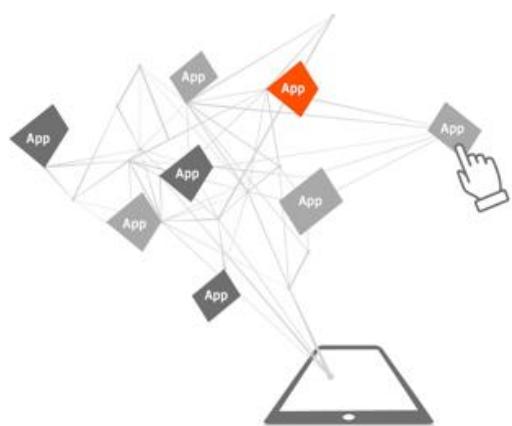


Operator
The operator is relieved of monotonous, non-ergonomic tasks and can concentrate on important processing steps.

Machine tool
The KMR iiwa takes over the tending of machine tools and relieves the human worker of strenuous and tiring tasks.

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

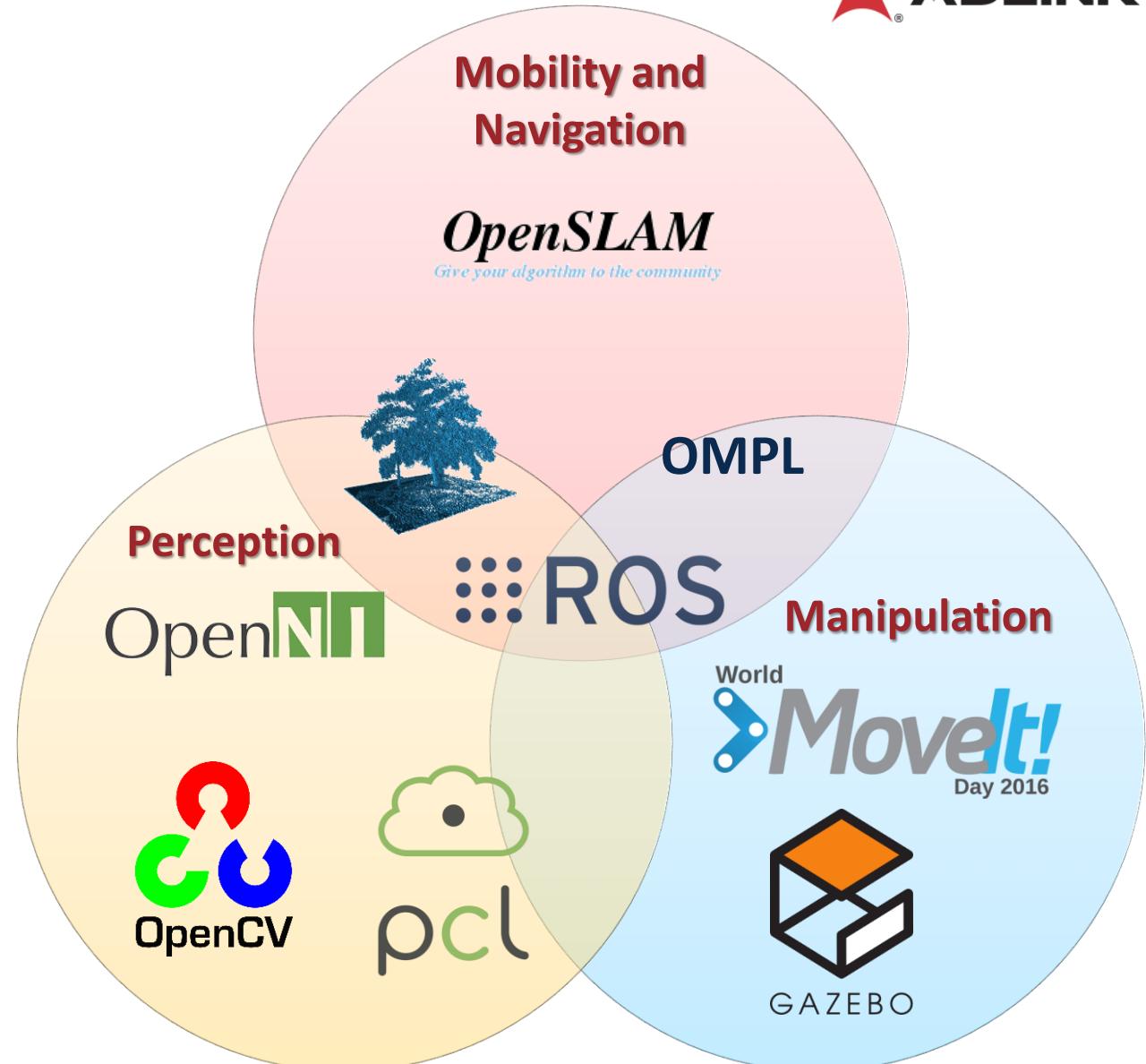


ROS-INDUSTRIAL CONSORTIUM WORLDWIDE MEMBERSHIP, FEBRUARY 2017

What is ROS?



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

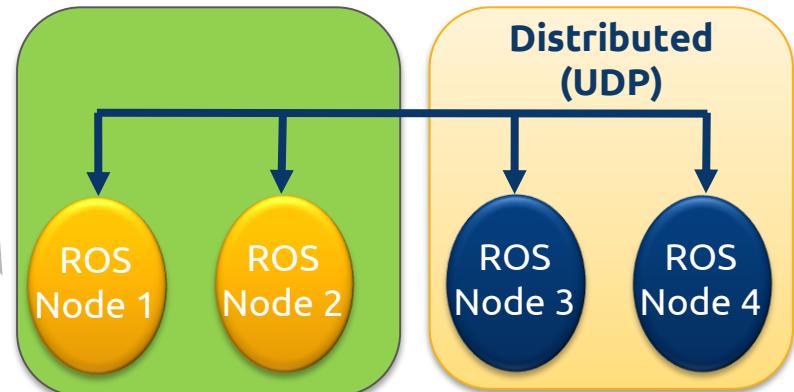
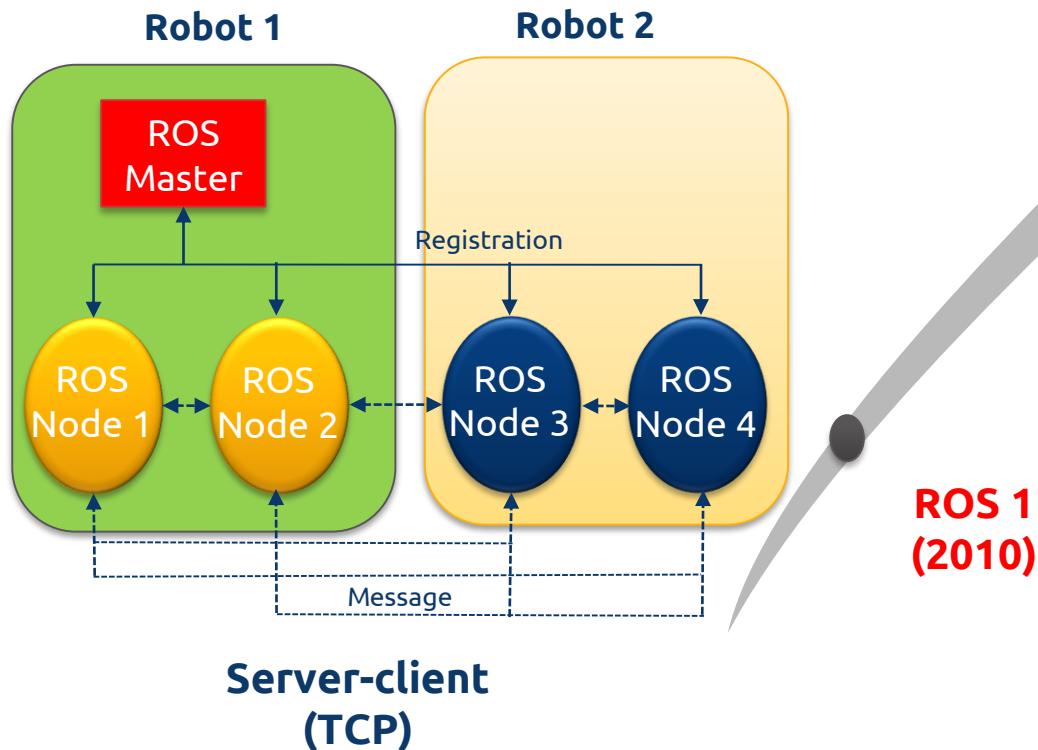


Source: ROS-Industrial Introduction slides 2013, Shaun Edwards

Toward Distributed, Autonomous Way !



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



ROS 2 removes the Master Node

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

ROS 2
Merit

Industry Adoption of ROS



Military



Disaster Mgt



Valkyrie
Space



baxter
Manufacturing



Logistic



Agriculture



Savioke



BMW



Three ROS Powered Stations

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



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



Fetch Robotics
VCs include O'Reilly AlphaTech Ventures, Shasta Ventures & SoftBank



YuJin Robotics
(Korea)



Kawada Robotics
(Japan)



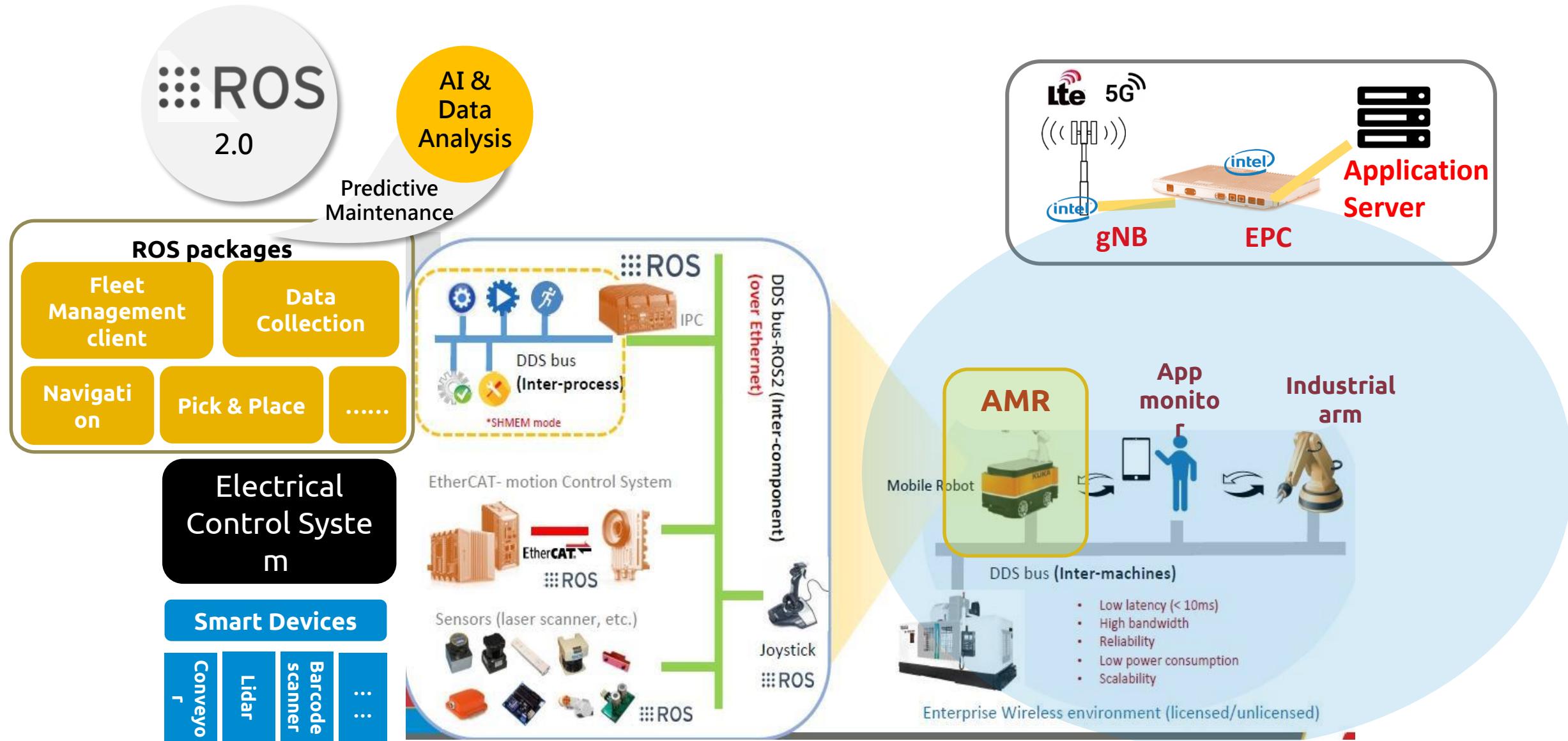
Magazino GmbH
VCs include Siemens



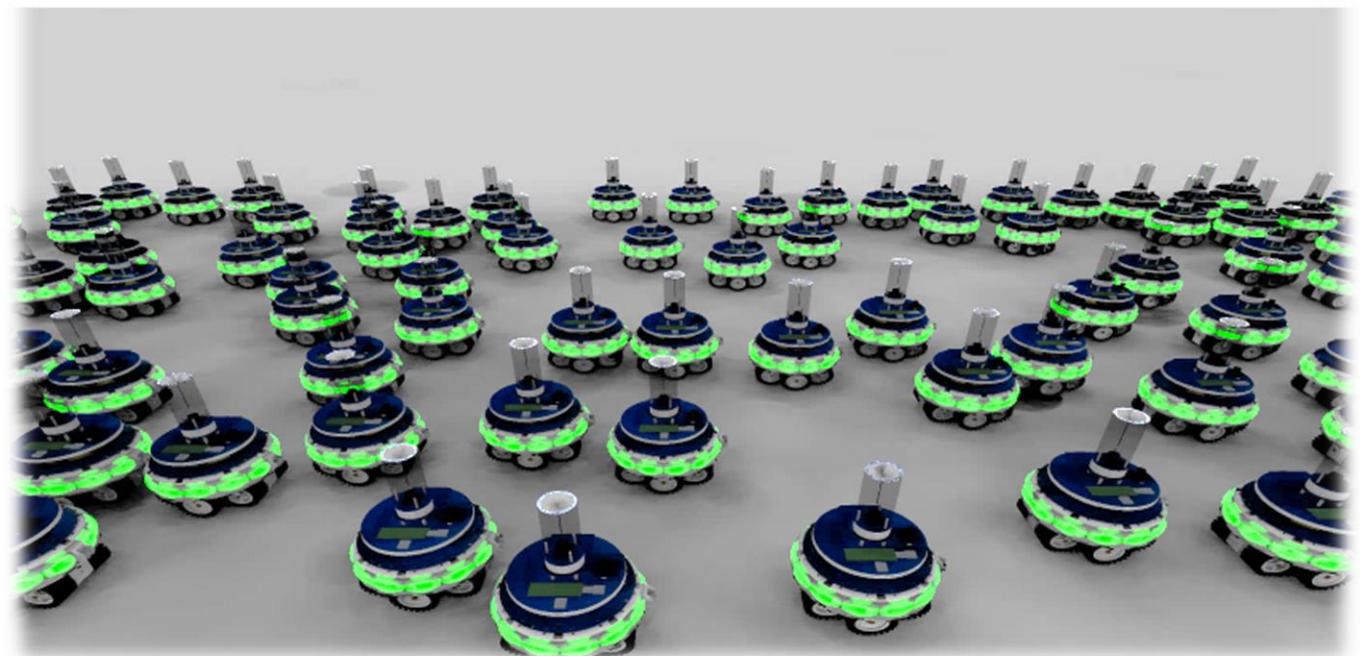
CSIRO – Bobcat
(Australia)

Source: ROS-Industry

Using ROS to design AMR in FoF



Demonstration: Adlink DDSBot



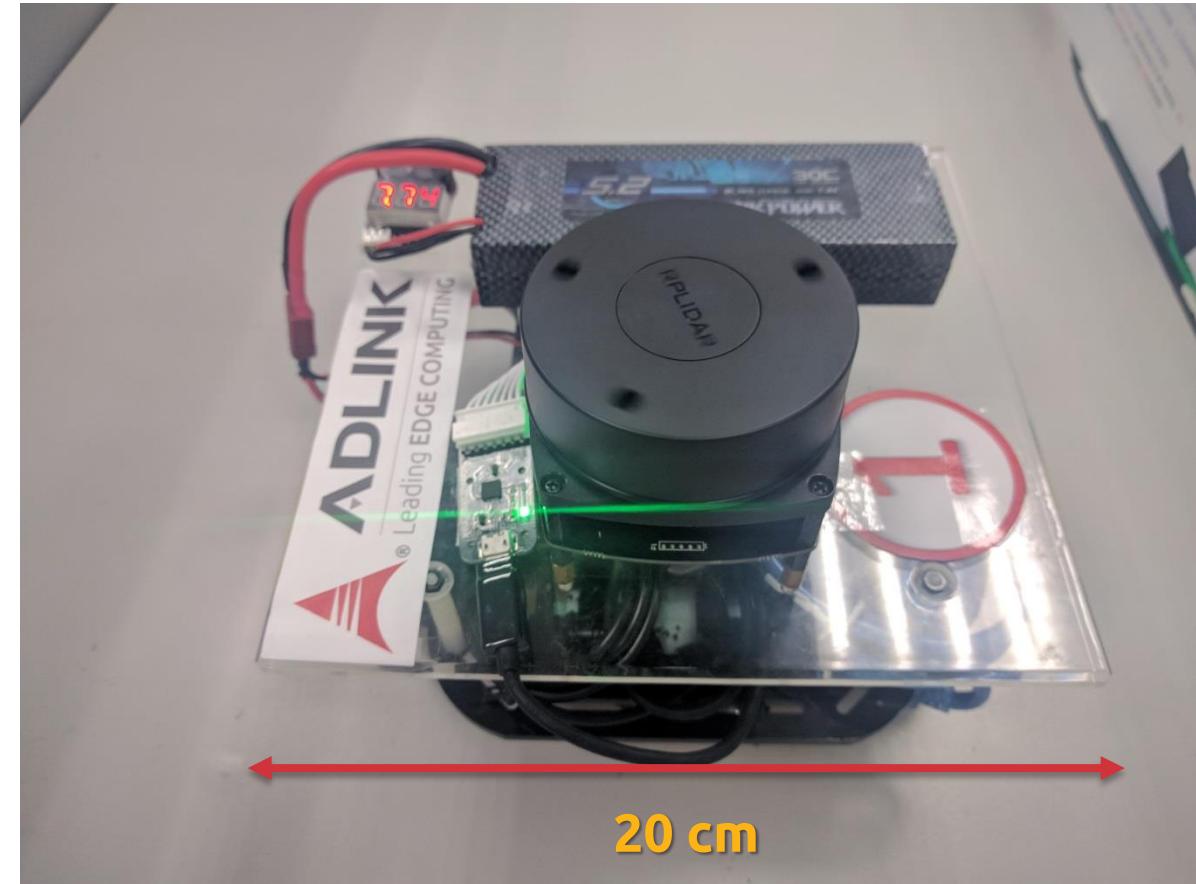
ADLink DDSBot



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*.



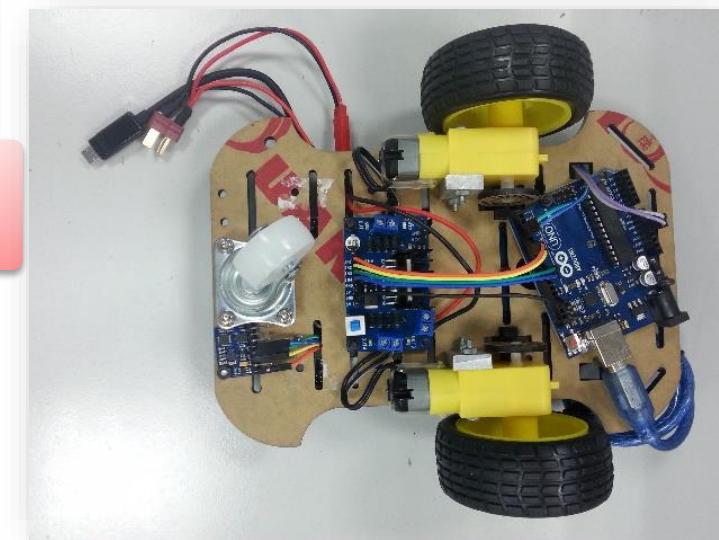
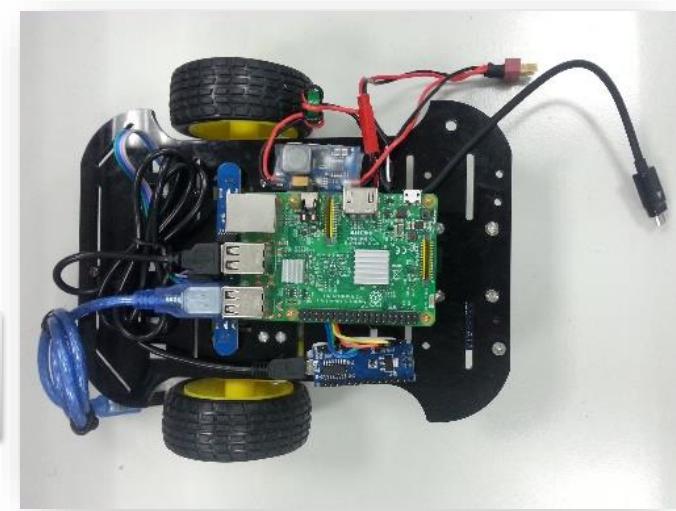
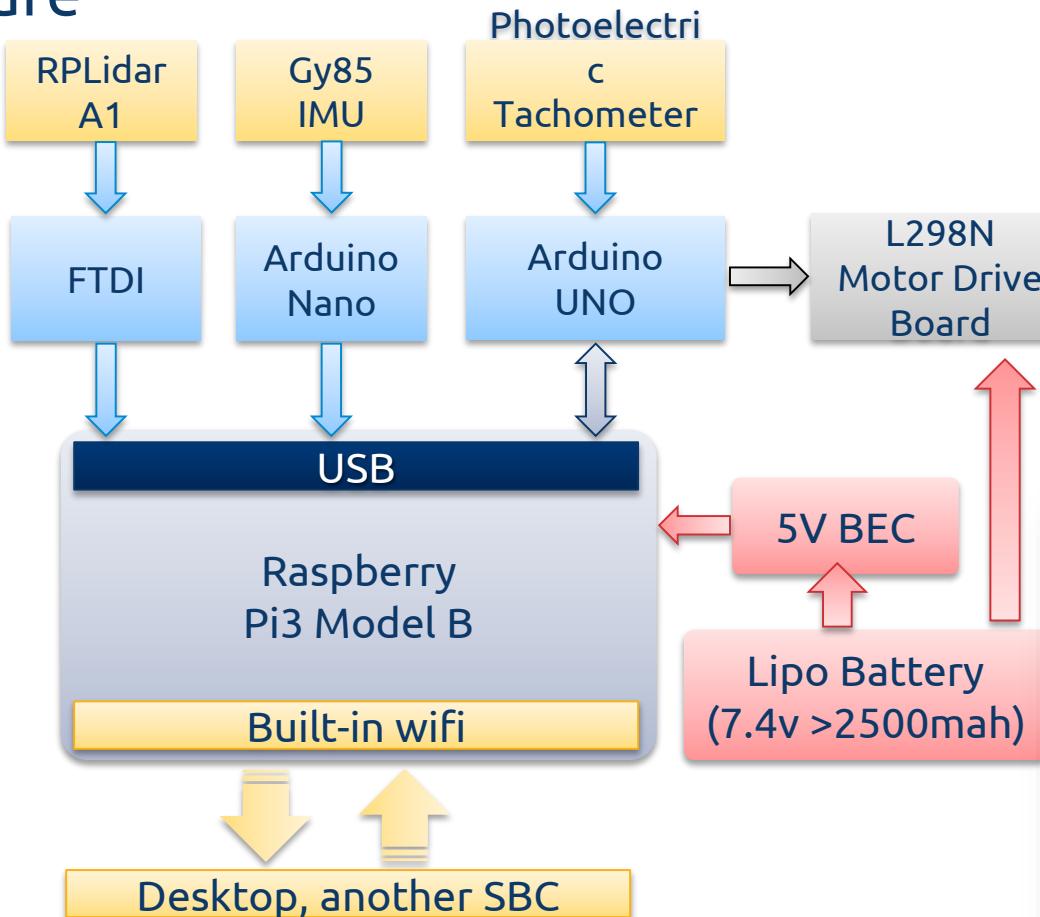
ADLink DDSBot



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	

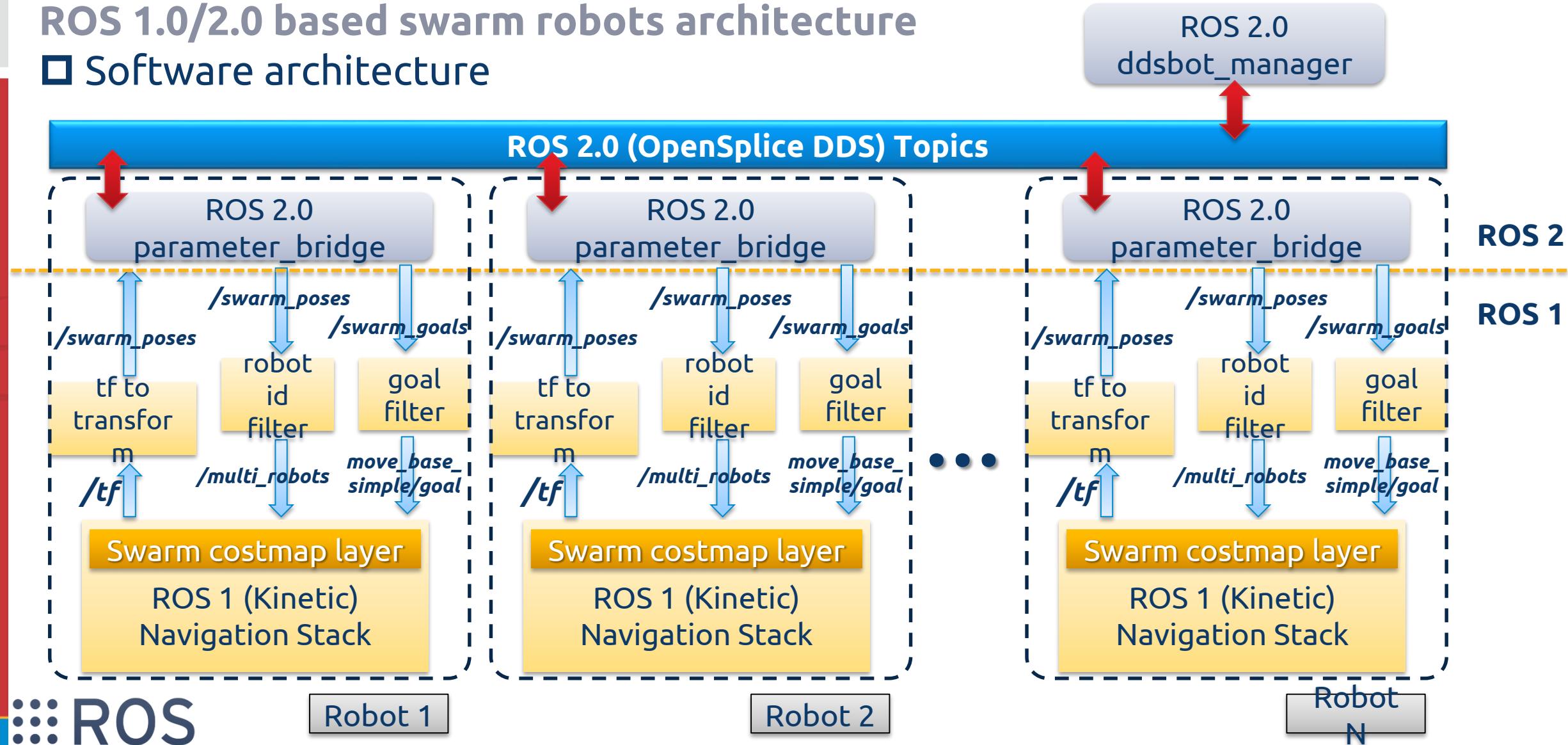


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ROS 1.0/2.0 based swarm robots architecture

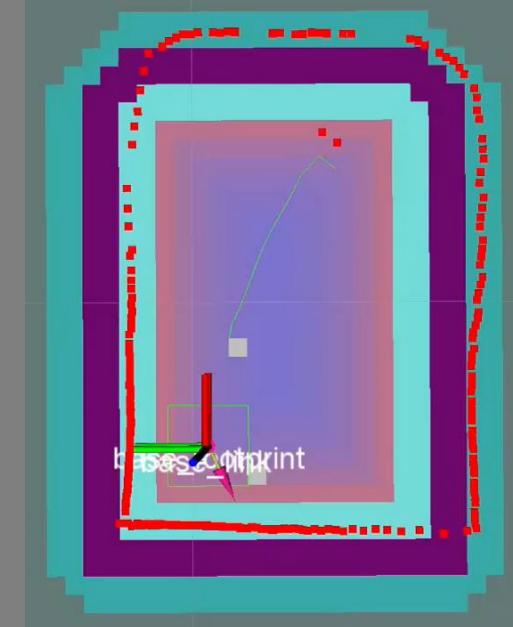
Software architecture



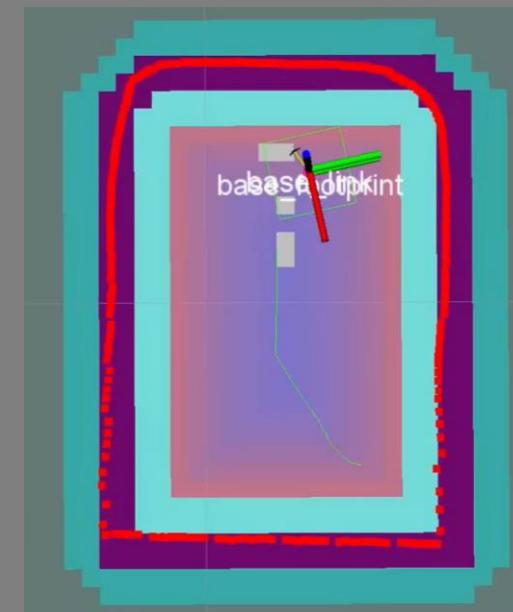
Real Space (ROS 1.0) with *failed Master*



Robot 2



Robot 1

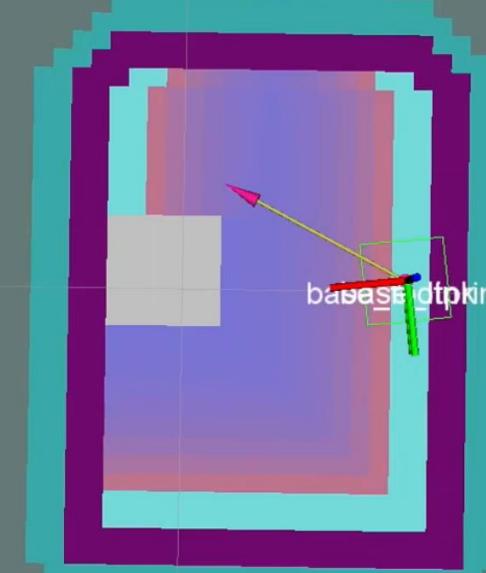


Real Space (ROS2.0)

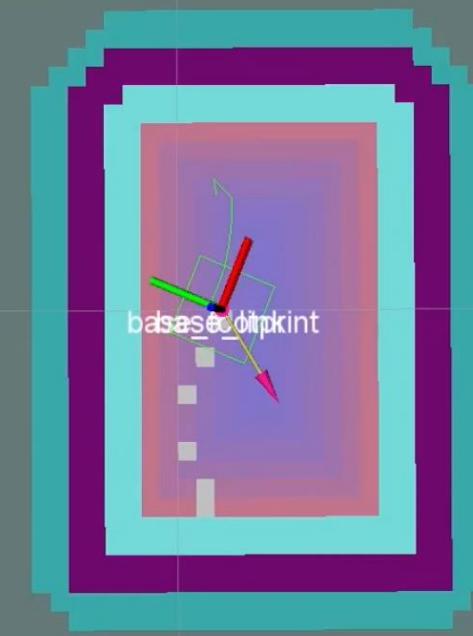
1
2



Robot 2



Robot 1

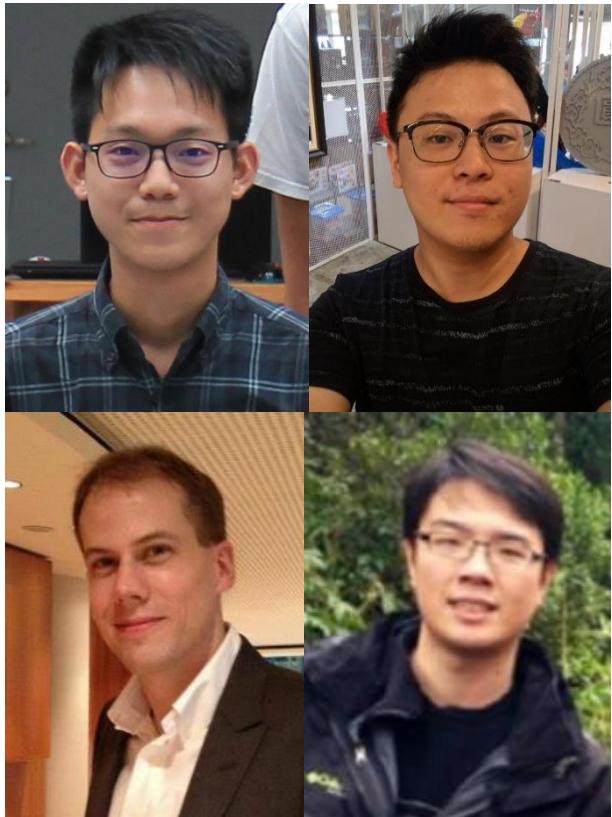


ADLink DDSBot



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_ddsb0t

Roadmap:

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

FREE

Conclusion

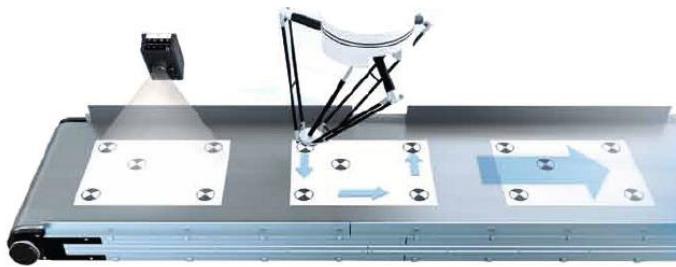


- ROS2 Version 1.0 will be release on Dec. 13th, 2017.
 - <https://github.com/ros2/ros2>
 - Currently, you can try Beta 3 with OpenSplice Community Edition (open source)
 - <https://github.com/PrismTech/opensplice>
 - Standing on the shoulder of giant of ROS, toward intelligent connected FoF
 - Easy,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

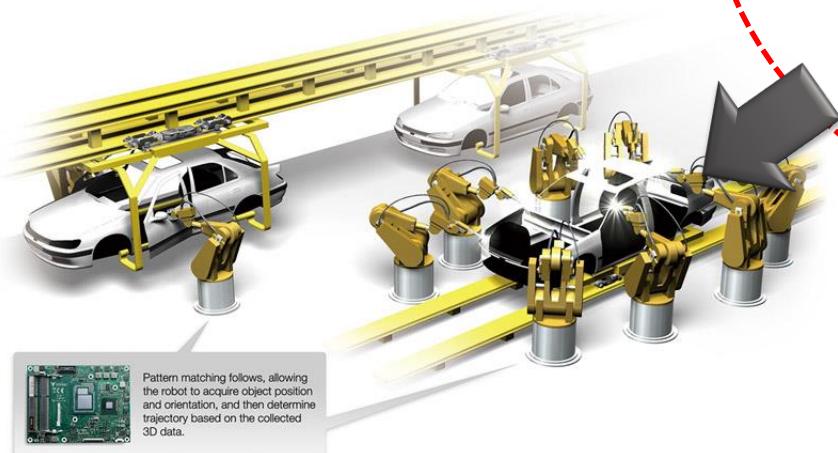
FREE

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



Integrated



Embedded



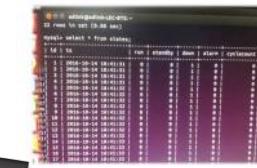
Standalone



MEMS sensor



Analog
sensor



Extracted PLC data/program into GW
Convert register data into state info



Machine condition
monitoring robots



ADLINK ROS-based PC for AMR

