Enabling Next-Gen Smart Manufacturing with ROS-Industrial

toward Factories of the Future (FoF)

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Solutions Architect Advanced Robotic Platform Group, HIM 2017.09.27

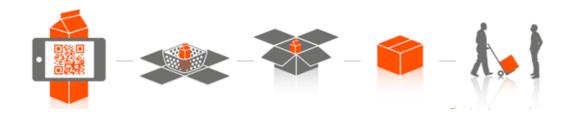


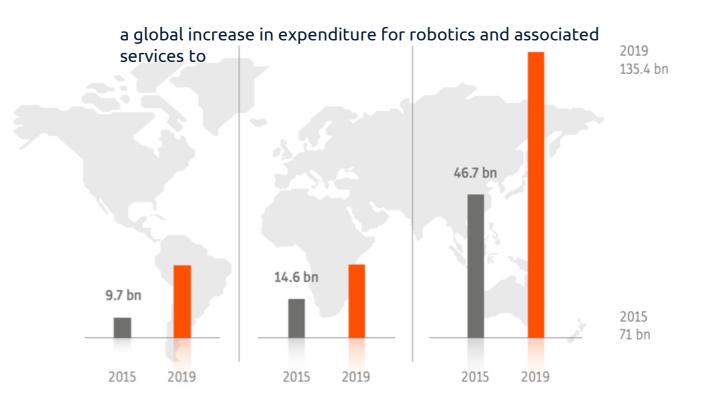
Building Forward Together



Industry 4.0







Source: IDC Forecast Worldwide

- Industry 4.0 Trend
 - Customization
 - Individualization



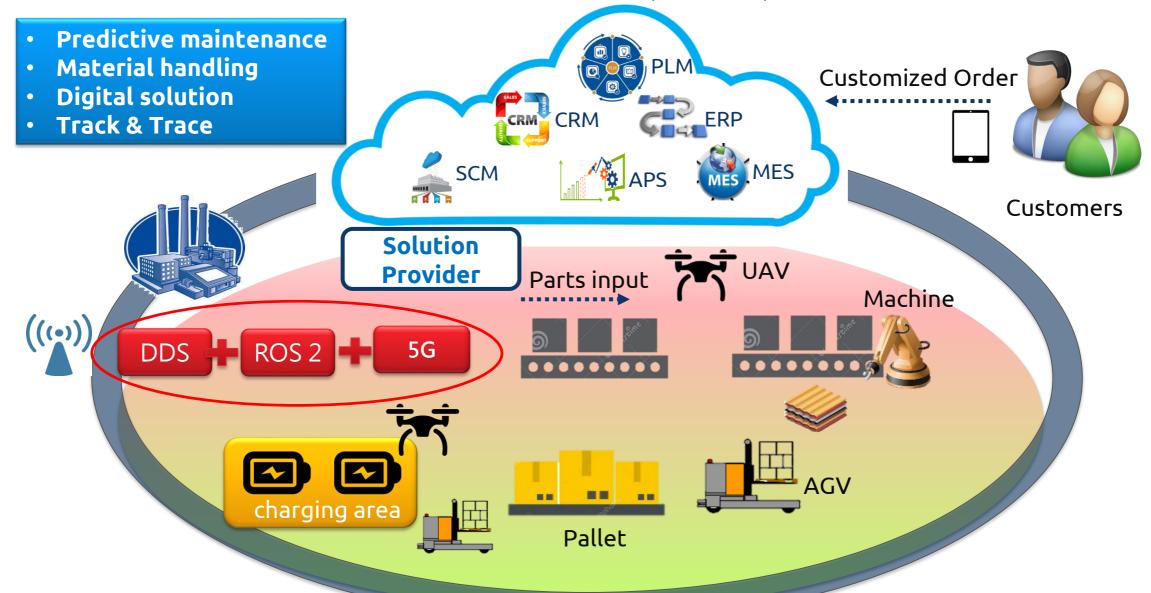
• Smart Factory of the Future

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

(customer relationship)

Factories of the Future (FoF)

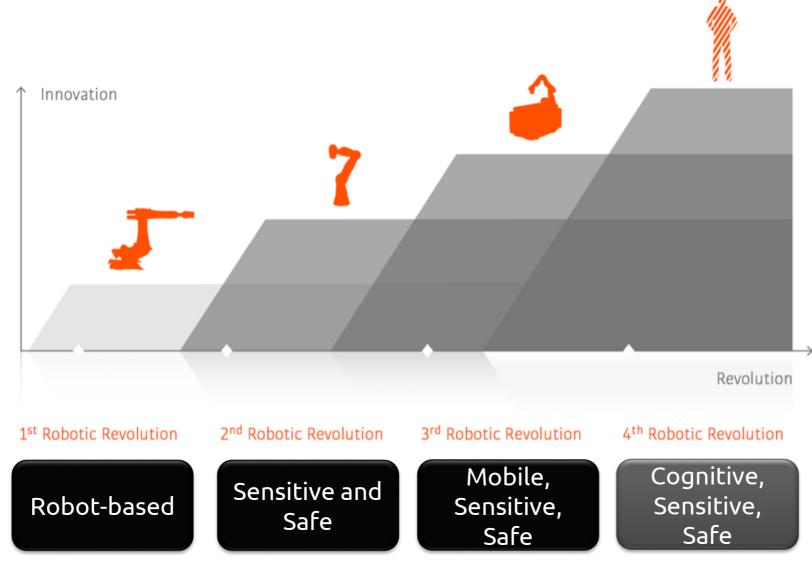




Source: FFG / ADLINK

Building Forward Together

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.

Source: KUKA, 2017

Megatrend 1: Real-time Edge Computing

► Interoperable/ environment (DDS over 5G)

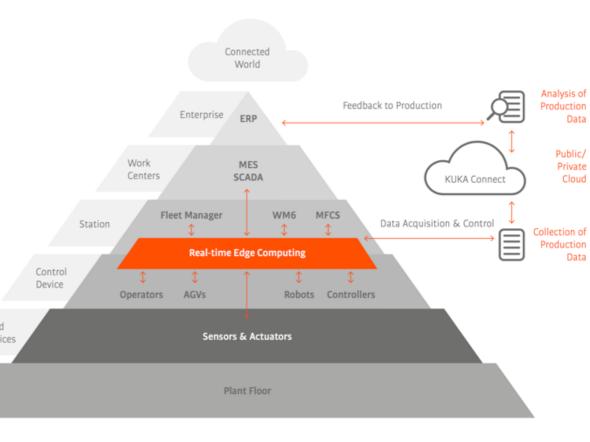
- Barrier-free networking of heterogeneous IT landscape and production environment (wire/wireless)
 - Allow scalable edge computing and virtualization of resources
- non-homogeneous data sources, and compact, streaming data analytics with real-time capability

► 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

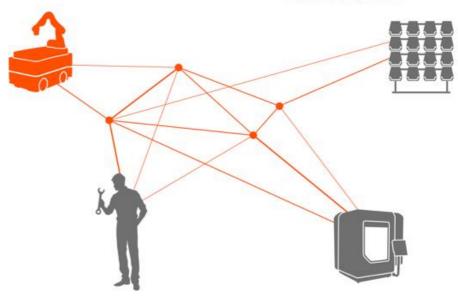
- Share this knowledge with other units in the fleet
- Anything that has been located by one unit in the swarm is instantly available to every other unit
- ► This results in a universally networked, shared "motion and route plan" that allows the coordinated execution of all robot motions

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 liwa 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

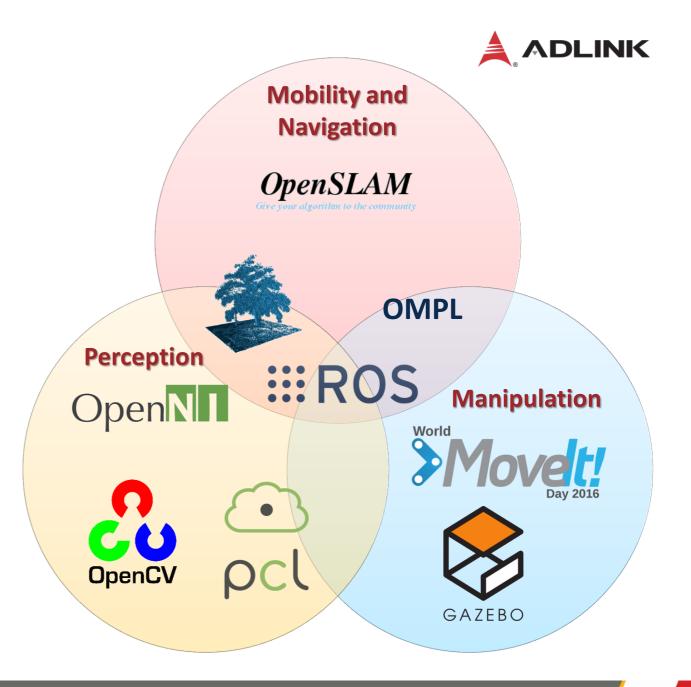
- OpenCV, TensorFlow, etc.
- CUDA, CPU, ARM, X86
- Lidar, Infrared sensors, depth sensor, camera



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



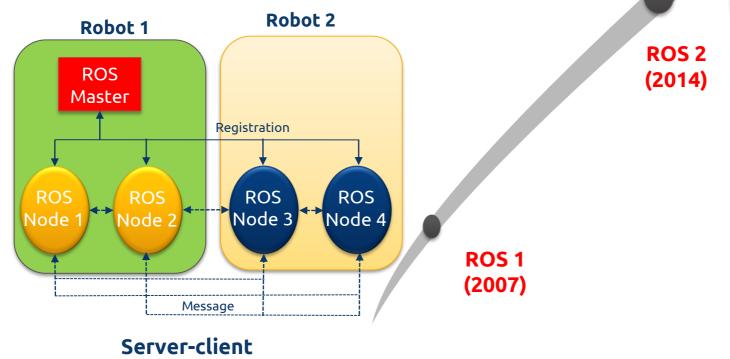
Toward Distributed, Autonomous Way!

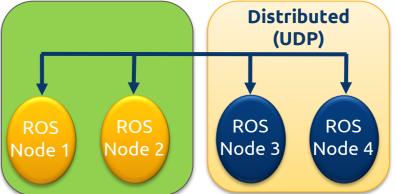
• ROS 1 Standalone

ROS 2 coordination among machines,

adopt **DDS (pub-sub)**

(TCP)





ROS 2 removes the Master Node

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

ROS 2 Merit

Industry Adoption of ROS



















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)



todesco srl & IT+Robotics srl (Italy)

Source: ROS-Industry

Using ROS to design AMR in FoF





ROS packages

Fleet Management client

Data Collection

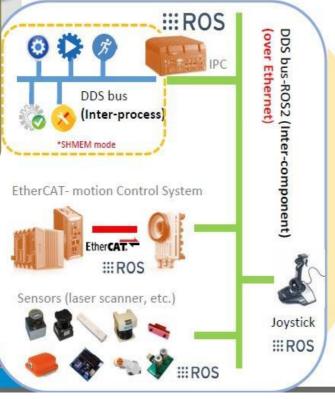
Navigati on

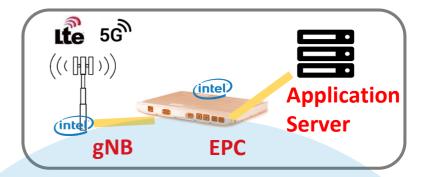
Pick & Place

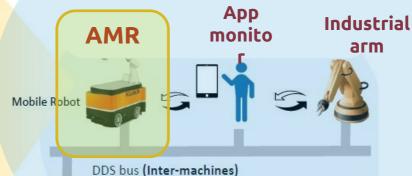
Electrical Control Syste m

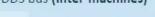
Smart Devices

Conveyo r Barcode scanner Lidar





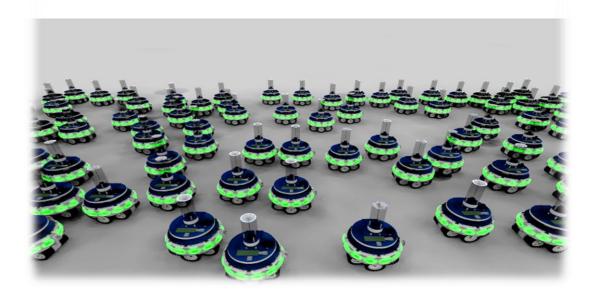




- Low latency (< 10ms)
- High bandwidth
- Reliability
- Low power consumption
- Scalability

Enterprise Wireless environment (licensed/unlicensed)





ADLINK DDSBOT DEMO



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*.



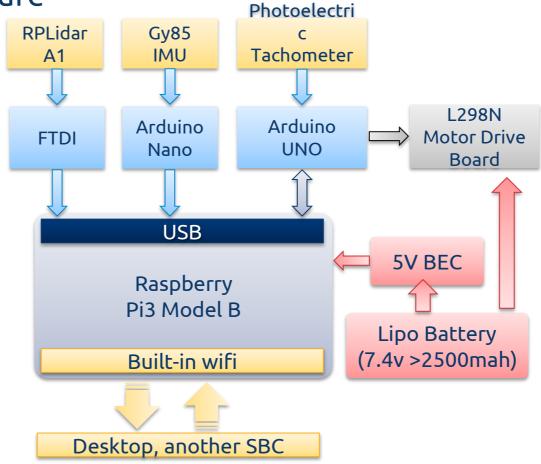


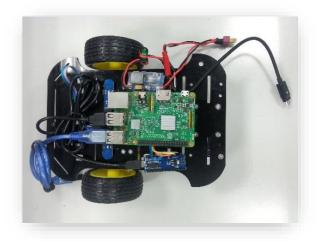


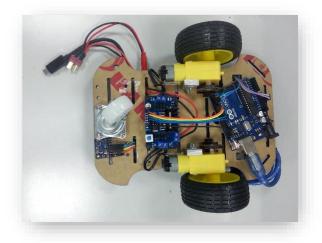
ROS 1.0/2.0 based swarm robots architecture

■ 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	











ROS 1.0/2.0 based swarm robots architecture

■ Software architecture

ROS 2.0

ROS 2.0 ddsbot_manager **ROS 2.0** ROS 2 parameter bridge /swarm poses ROS 1 /swarm_goals I/swarm_poses robot goal tf to filter transfor filter move_base

parameter bridge /swarm poses /swarm_goals I/swarm poses robot goal tf to filter transfor filter move base /multi_robots simple/goal Swarm costmap layer ROS 1 (Kinetic) **Navigation Stack**

Robot 1

ROS 2.0 (OpenSplice DDS) Topics ROS 2.0 parameter bridge /swarm poses /swarm_goals /swarm poses robot goal tf to id filter transfor filter move base /multi_robots simple/goal Swarm costmap layer ROS 1 (Kinetic) **Navigation Stack**

ROS 1 (Kinetic)
Navigation Stack

Swarm costmap layer

/multi_robots

/tf

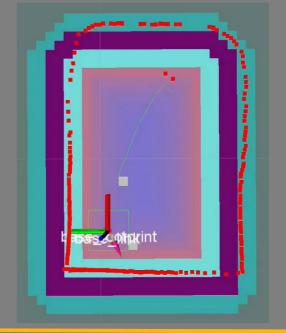
Robot 2

simple/goal

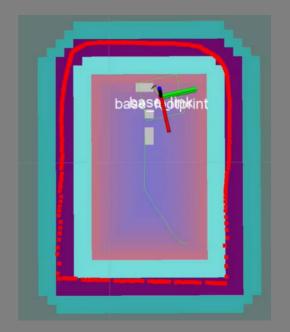
Real Space (ROS 1.0)



Robot 2



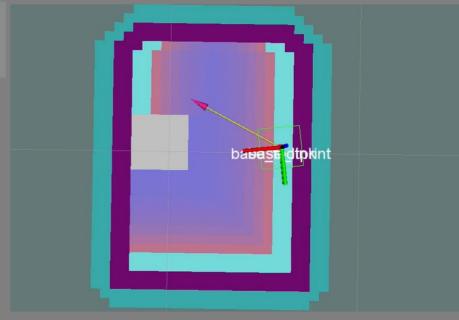
Robot 1



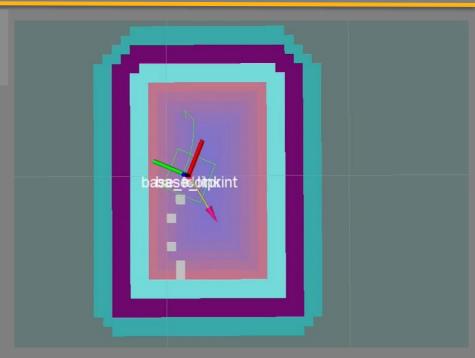
Real Space (ROS2.0)



Robot 2



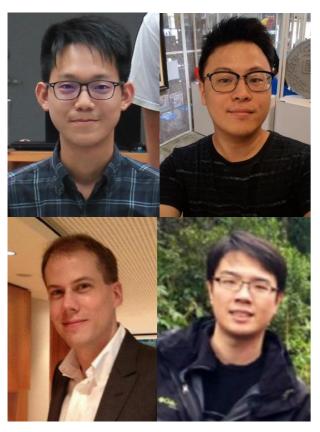
Robot 1





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

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. 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 hardware

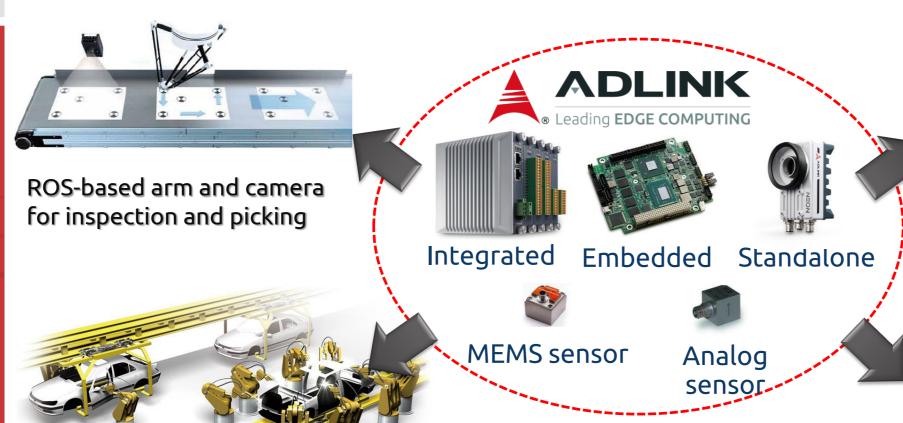


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ADlink ROS-2 Industry-Grade Products in



20:108, Vision, Measurement





Machine condition monitoring robots



Embedded ROS-based PC for industrial arms

ADLINK ROS-based PC for AMR

