The Journey of building ROS-Industrial initiatives in Asia Pacific

ROS-Industrial Consortium
Asia Pacific

Present by: Nicholas Yeo
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• Who we are
• ROS-Industrial Consortium
• Today challenges
• What we are trying to achieve
Who are we?

Advanced Remanufacturing and Technology Centre (ARTC) under Agency for Science, Technology and Research (A*STAR)

- Focused in Advanced Manufacturing and Remanufacturing technologies
- Bridge the gap between Research and Industry
- Private Public Partnership Consortium with a membership ecosystem

**Smart Manufacturing**
- Test-bedding of Industrie 4.0 Technologies

**Advanced Remanufacturing**
- Regenerative Repair Processes

**Advanced Robotic Applications**
- Develop niche robotic application for manufacturing

**Additive Manufacturing Industrialisation**
- Focus metal printing for production use

**Intelligent Product Verification**
- Metrology, Inspection, condition monitoring technologies

**Data-Driven Surface Enhancement**
- Fatigue life improvement

**Industrialisation**
- Test-bedding of Industrie 4.0 Technologies

**Smart Manufacturing**
- Focus metal printing for production use
ROS-Industrial is an open-source project that extends the advanced capabilities of ROS software to manufacturing.

Asia Pacific’s Objective:

- Increase global competitiveness of the robotics industry through ROS development and adoption in Asia Pacific
- Develop ROS-Industrial talent pool through training, summer schools and workshops
- Address specific features for industry applications

This runs separately from ARTC’s consortium. Projects run by ROS-I APAC Consortium will be managed by ROS-I Consortium structure and guidelines in the ROS-I APAC membership agreement.
ROS-Industrial Consortium Members > 60

AP Members since Oct 2017

And growing.....
Industry adoption of ROS

Manufacturing
Logistic
Agriculture
Automotive

Military
Disaster Mgt
Aerospace
Space
Construction
Why did it start?

> technology push <

> market pull <

- Mass customization: Industry 4.0, low-volume high-mix production ("lots of size 1")
- Expansion of robotics and automation in logistics; new markets (e.g., service robotics)
  -> need for advanced, adaptable, and flexible automation

"Smart skills" + modern hardware -> automation technology meeting demands

From preprogrammed motions triggered by simple sensor inputs to on-the-fly trajectories driven by a perception-rich environment

"Robotics science" is rapidly maturing robots every day at lower costs:
- New collaborative robot arms, 10k EUR
- Sensors for high-volume markets
- Smartphones, IoT, gaming devices, high performance computing in small packages
- Mobile and intuitive interfaces

Source: SwRI ROS-Industrial Brochure
<table>
<thead>
<tr>
<th>Political Factors</th>
<th>Economic Factors</th>
<th>Social Factors</th>
<th>Technological Factors</th>
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- **Government Support on collaboration & adoption (Private / Public)**
- **Legislation**

- **Business ROI**
- **Economy of Scale**
- **Fragmented supply chain**
- **IP & Legal Challenges**
- **R&D Funding Limitation in private entities**

- **Scarcity of talent pool**
- **Retraining of workforce**
- **Awareness of open source**
- **Less successful cases of robotic solutions adopted in Asia**

- **Technology maturity** (eg: reliable performance, cybersecurity, supporting hardware)
- **Quality of sw codes**
- **Standardization** (eg: HRC, safety, interoperability)
- **Regulatory**
Key challenges with industry adoption

• In robotics, the success depends on the entire system; not individual performance of modules
  – Robot solutions are often unique; existing complexity and issues make it difficult for companies to learn and figure it out

• In industry environment, companies want guarantee in performance (eg: Security, real-time) and certified to safety standards (eg: ISO/TS 15066)

• Skeptical on open source codes due to business risks and intellectual property liability

We need to win the trust of industry
Engaging the ROS-Industrial Ecosystem
Collaborate & improve quality of ROS compliance tools & drivers
- Code maintenance & updates
- Conduct Hackathons

Focus on talent pool development

Develop solution providers to address market needs
- Same as above

Invest R&D in key industry problem statements
- Roadmapping
- Focus Technical Projects
- Direct Projects

End Users

Solution Providers

Technology Providers

Institutes of higher Learning

Focus on talent pool development

- Developers Training (Basic / Advance Class)
- Summer Schools
- Future: Application level

ROS-Industrial AP Strategy
Holistic view of our journey

<table>
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<tr>
<th>Phases</th>
<th>Start-up</th>
<th>Ramp up</th>
<th>Expand</th>
<th>Stable</th>
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1. **2017**
   - Jun: Inception of ROS-I AP
   - Oct: 1st Membership Signed

2. **2018**
   - Jan: ROS-I Office Completed
   - Mar: Focus on value creation with industry partners
   - Dec: Build core team

3. **2019**
   - Q2: Deepen technologies
   - Oct: Scale up competency

4. **2020**
   - Q4: Strengthen Ecosystem

5. **2021...**
Talent Development

ROS Developer Training

• Conduct quarterly (Basic / Advanced packages)
• 6 training since Jun 2017
• > 60 participants trained

Summer School

• Conduct annually with a local school
• Mar 2018 collaborated with Singapore Polytechnic
• Focus on student awareness
• ~ 20 students
Events – Promote ROS awareness

International Conference on Robotics and Automation (ICRA) 2018 – Brisbane, Australia

Singapore International Robotic Event (SIRE) 2017
Annual Workshop – Jun 2018

27th – 28th June 2018
2 Days of presentations (International, Regional and Local)
Demonstrations and Exhibition

66 > participants
Over 20 Countries

Singapore
China
Malaysia
Taiwan
Japan
India
United States
Philippines
Italy
United Kingdom
Colombia
Sweden
South Korea
Lebanon
Iran (Islamic Republic Of)
Indonesia
Canada
Vietnam
Netherlands
Norway

By Geographical

Asia 80%
Europe 11%
America 6%
Middle East 3%

By Category

12
Institute of Higher Learning
Limited Liability Enterprise

4
Limited Liability Corporation

20
Nonprofit Organization (NPO)
Small and Medium-sized Enterprise

8

ROS-INDUSTRIAL PROJECTS EXAMPLES
ROS-I added capability for:

- Universal Robotics
- Fanuc
PackML: Scope & Deliverables

- **Collaborators:** 3M, ARTC, SwRI, PlusOne Robotics

- **Problem Statement:** Software development of using PackML state machine to communicate between PLC and ROS.

- **Delivered:**
  - **Tested** with a remote PLC using a standard PackML implementation using OPC-UA to connect to the PLC
  - **Developed** an open-source C++ library, python (SMACH) to implement the PackML state machine abstraction for use in ROS-I.
  - **Integrate** RVIZ plugin for PackML
    - PACKML State Machine
    - Provide options for mode selection
    - Show accumulative timer per state

PackML (Packing Machine Language) state machine commonly used by PLCs in packaging.
Robotic Vision: Object recognition and picking task

Problem Statement
Industrial robotic tasks are often constrained by specific hardware requirements. Integration through ‘traditional control system’ is challenging and highly complex

ROS drivers power the hardware
- Industrial conveyor, UR robot, Ensenso stereovision camera

ROS libraries process the data
- Point Cloud library performs object recognition and localisation
- Robot motion planning handled by Moveit.

ROS middleware
- Provides hardware agnostic communication to system components
- Significant reduction in complexity when changing hardware setup.

ROS allows for real time visualization of sensor data
Problem/Current Situation:
- Human Robot Collaboration required improved safety visualisation
- Scalability of robotic solution is hamper by the need of skilled engineers for programming

Approach: Simplified Robot Programming (SRP) – Phase 1
- Easy and interactive UI in Microsoft HoloLens
- Design translation tool to handle communication with ROS interface

Challenges
- Require higher accuracy to meet application needs
- Need higher processing power for more complex application

Future Work:
- Future: build application specific libraries (picking, polishing, assembly etc)
MTConnect + ROS-I

Demonstrate the ability to implement ROS-Industrial to program a robot and use MTConnect protocol for communications between the robot and a CNC machine tool.

Collaboration between South West Research Institute with MTConnect, AMT, Hurco, Hexagon Metrology, and Universal Robots.
Timeline of Events

2018

- **ROS-I Training (Singapore)**
  - 29 Jan – 2 Feb

- **ROS-I Summer School (Singapore) – Singapore Poly**
  - 12-16 Mar

- **ICRA 2018**
  - 29 May – 3 Jun

- **World ROS-I Day (Hackaton)**
  - 10 – 11 July

- **ROS-I AP Workshop (Singapore)**
  - 27 – 28 Jun

- **ROS-I Developer Training (Singapore)**
  - 27 – 31 Aug

- **ROS-I Developer Training (Singapore) Dec TBC**

- **RIC-Americas Annual Meeting**
  - 7-8 Mar

- **ROSCON 2018 / IROS 29-30 Sept**

- **SIRE 2018**
  - 1 – 2 Nov

- **World MoveIt! Day 26 Oct**

- **ROS-I Conference 11-13 Dec**

- **Training / Workshop**

- **Annual Meeting Hackathon**

- **Events**

Current
Our aim is to drive consistency over time

Create **Values** and **Trust**
Themed ‘Riding Opportunities in Exponential Change’, the Singapore International Robo Expo (SIRE) aims to be a platform that creates opportunities for people to meet, connect and convert.

**KEY HIGHLIGHTS**

**From R&D to Commercialisation**
- A feature showcase of 07 cutting-edge robotic solutions by Dr. Mohan Rajesh Elara
  - Mantis, hTetro, sTetro and more!

**Multi-Agency Panel Discussion**
- First and only session featuring various sectors of the Singapore public service (i.e. Maritime and Port Authority of Singapore, Building & Construction Authority) convening on their requirements for robotics solutions

For any queries on event participation, please contact Ms Chloe Pung, Project Manager at chloepung@experiaevents.com
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