Bootstrapping ROS-Industrial in Asia Pacific

Prepared by: Min Ling Chan
12\textsuperscript{th} December 2017
Agenda

• Who we are?
• Bootstrapping ROS-Industrial in Asia Pacific
  – Leveraging Open-Source Software → ROS-Industrial
    • Awareness of shift towards industry adoption
      - AP members
• Leveraging Open-Source Software for SMEs and Startups
• Using ROS for “ROS-Industrial” applications
WHO WE ARE?
Who we are? A*STAR, Singapore Research Ecosystem

MISSION
We advance science and develop innovative technology to further economic growth and improve lives

VISION
A global leader in science, technology and open innovation

**Annual Outputs (FY2011 – 2015)**
- >1,700 Industry projects a year
- >2800 Papers published a year
- >14 Start-Ups a year
- >270 Patents filed a year

**Our Membership**

- Industry-led Public-Private Partnership
- AxRC Model
- Mission – Bridge the Gap from Research to Industry Applications for Remanufacturing & Manufacturing for Cross-Sectorial Industries

**Advanced Remanufacturing and Technology Centre, ARTC**

- Biomedical Research Council (BMRC)
- Science & Engineering Research Council (SERC)
- ETPL
- A*STAR Graduate Academy Scholarships

>5,200 STAFF

>4,100 Researchers, Engineers and Technical Support Staff

>38% of whom come from 64 countries

**Our Member Ecosystem**

- Aerospace
- FMCG
- Oil & Gas
- Marine
- Machinery

**Project Delivery**

- Our Manpower
- Facility Growth
Our Industry Expertise: Six Technological Groups

**Smart Manufacturing and Robotics**
- Test-bedding of Industrie 4.0 Technologies
- Intelligent System and Connectivity
- Virtual Manufacturing & Digital Twin
- E2E Cyber-Physical Solutions

**Advanced Manufacturing**
- Industrial Manufacturing and Remanufacturing Process
- Masking & Automation Technologies
- Intelligent Machining Technologies
- Regenerative Repair Processes

**Intelligent Product Verification and Surface Enhancement**
- Complex Geometric & Surface Measurement
- Non-Destructive Testing & Inspection Solutions
- Condition Monitoring & Lifetime Prediction

**Additive Manufacturing Industrialisation**
- Industrialisation of Metal 3D Printing
- Additive Process Development
- Optimisation of Pre- and Post-Proceses
- Material Characterisation

**Data-Driven Surface Enhancement**
- Surface Finishing & Preparation
- Robotic Shot Peening
- Alternative Fatigue Enhancement Processes
- Stress & Fatigue Analysis
The 24 Project Themes have been developed based on relevance and of highest priority to companies across industry sectors.

Model Factory @ ARTC will be divided into 2 phases featuring 3 manufacturing lines and 1 virtual showcase, covering end-to-end digital thread along the manufacturing value chain.

Phase 1:

1. Discrete manufacturing line
   - Focuses in processes addressing components of low volume with high complexity

Phase 2:

2. Additive manufacturing line
   - Pre and post AM processes
   - High mix with high complexity components

3. Virtual Showcase
   - Digital Factory
   - E2E digital thread

4. Mini Continuous manufacturing line
   - Addresses high volume products

ARTC’s Model Factory (Advanced) Testbed will focus in 3 production methodologies and a Virtual Showcase.
BOOTSTRAPPING ROS-INDUSTRIAL IN ASIA PACIFIC
The 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.

Examples of ROS based products in Asia Pacific

- Hope Technik (Singapore)
- Ctrlworks (Singapore)
- DJi (China)
  VCs include Sequoia Capital, Accel
- YuJin Robotics (Korea)
- Kawada Robotics (Japan)
- CSIRO – Bobcat (Australia)
- Jinan Tony Robotics (China)
**ROS Statistics**

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<th>Country</th>
<th>Unique Wiki Visitors 2016</th>
<th>Country</th>
<th>Unique Wiki Visitors 2017</th>
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- Statistics for ROS.org downloads
- 7 EU countries in top 20
- 8 AP countries in top 20

**Number of ROS users in AP is growing**

Source: OSRF
ROS-Industrial Consortium Members > 55

Source: http://rosindustrial.org/
AP New Members in November

- Who they are?
  - HQ: Taiwan
  - 1400+ Employees
  - ADLINK is becoming a technology-leading platform *provider in the applied computing industry, IOT*

- Benefit for joining
  - Able to develop hardware for ROS (DDS)

- Who they are?
  - HQ: Tokyo Japan
  - 20 people incl. 16 researchers
  - Consortium based in Japan

- Benefit for joining
  - Community bridge to Japan users
Latest AP Member

• Who they are? Tony Robotics
  • HQ: China
  • 40+ people
• Benefit for joining
  – RoboWare: Open Source IDE based on ROS
  – RoboStore, Robo School

• Who they are? M8M Pte Ltd
  • HQ: Singapore
  • 75+ people
• Benefit for joining
  – Adoption of ROS-Industrial in their development of material handling systems for Intralogistic systems
  – System integration company
What can ROS-Industrial do for you?

**Hardware interfaces**
- Common software capabilities for various hardware

**Software Development**
- ROS drivers
- Maintenance
- Applications

**Education & Training**
- Workshops
- Training
- Summer Schools

**Community & Networking**

FTP Projects (Multi-Member)

Specific Member Projects
LEVERAGING OPEN-SOURCE SOFTWARE FOR SME AND STARTUPS
ROS for ?

• System integrators / startups:
  – Depends on HW, SW selected
  – Improving application software development pain.
  – Beneficial by joining consortium from a PR & Marketing perspective

• OEM:
  – HW manufactures are beginning to request that their software also works with ROS
How ROS-Industrial can help SMEs and industry?

- Technology growth is rapid
- New technology is cost consuming to implement
- Don’t re-invent the wheel
- Re-use of programming packages and code
- Improve efficiency
USING ROS FOR “ROS-INDUSTRIAL” APPLICATIONS
Scan-N-Plan™ in Singapore

- Adding capability for:
  - UR
  - 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 Architecture

Original State:
ROS does not interact and communicate between PLC

Final State:
ROS is acting as a middleware and PLCs
Communicating ROS ↔ PLC

Methods:
2 Methods of ROS as a Middleware communication with PLC
1. PLC as the master sending signals to ROS
2. ROS as the master
   – Signals and messages to the PLC (Siemens) – KUKA via ROS as a middleware

Benefits:
• State machine applied to ROS C++ node for any industrial application
• State control reporting ROS-I messages, reusable GUI widget

GitHub https://github.com/ros-industrial-consortium/bohr_devel
**Business Analytics Dashboard**

**Approach**
- Open source tools will be used to create the Dashboard, there is no need to “invent the wheel” on any components, leveraging the benefits of ROS.
- The components for development are available gui (QT), plots (pyqtplot) and communication with the robot (ROS).
- A generic PackML test system is available to developers for testing.
- A web-based Ruby on Rails implementation of the dashboard is desirable for operation on ANY system (windows, tablet, etc.)

**Metrics for success:**
- GUI demonstration on PackML system

**Motivation/Objective**
- **Motivation:**
  - Displaying the real-time OEE allows the end-user to measure and increase the ROI of the robot asset.
  - Standardization using the PackML state machine allows for swift implementation and reporting.
- **Objectives:**
  - Real-Time Pareto Analysis
  - Instantaneous & Historical OEE (Overall Equipment Effectiveness)
  - QT & Ruby on Rails implementation
  - Example code and documentation

**Scope Of Work**
- **Developer 1**
  - Task: QT implementation of OEE displays
  - Schedule: 1 week
- **Developer 2**
  - Task: QT implementation of Pareto Analysis
  - Schedule: 1 week
- **Developer 3**: 
  - Task: Documentation, Examples & Testing
  - Schedule: 2 week
- **Developer 4:**
  - Ruby on Rails implementation of the
  - Schedule: 3 weeks
PackML Call for Contributors

Current Contributors:

• ROS-I AP: Mingli Han, SMACH and remote plc
• PlusOne Robotics: Shaun Edwards, C++ Package
• 3M: Schoen Schuknecht, Lex Tinkett, Tom Strey: PLC and PackML support
• SwRI: Austin Deric, Paul Evans

• Call for contributors and testers: C++ Package, SMACH, GUI interface
• Call for contributors for next phase 2: (3-4 months)
  – OEE (limited to “Availability”)
  – Other PLCs with OPC-UA connectivity
Bootstrapping moving forward ...

- Increase Asia Pacific engagement thru
  - Projects (FTP, Member)
  - Increase ROS-Industrial use and talent pool
  - Focus on industry specific applications
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