7th ROS-Industrial Conference
Stuttgart, Germany (EU)
rosindustrial.org/riceu2019

ROS-Industrial Asia Pacific Updates and ARTC Application Highlights

Erik Unemyr, A*STAR ARTC

Introduction to A*STAR ARTC

Agency for Science, Technology and Research (A*STAR)

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

Biomedical Research Council (BMRC)	Science & Engineering Research Council (SERC)	A*ccelerate	A*STAR Graduate Academy
11 Research Entities	9 Research Entities	Commercialisation	Scholarships

>5,200
Staff

>4,100
Researchers, Engineers and Technical Support Staff

~ 40%
from >60 countries

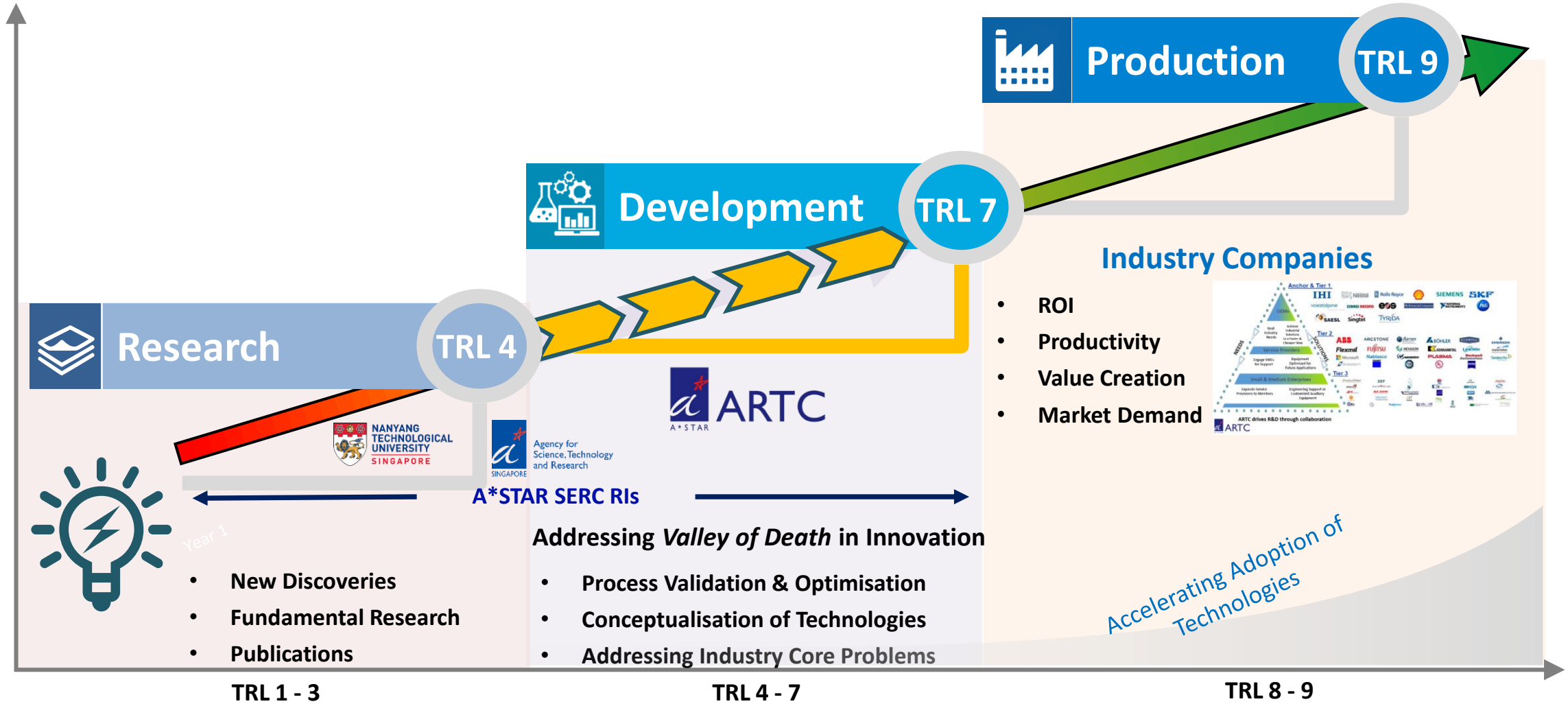
The Advanced Remanufacturing and Technology Centre

Leading Public-Private Partnership Research Centre in Asia

- Bridging the gap between Research and Industry
- Focus in Developing Advanced Manufacturing and Remanufacturing Capabilities
- Co-Create and Value Capture with Industry through the Implementation of Solutions

Cleantech Park: Courtesy of JTC

Bridging the Technological Valley of Death



Technology Readiness Level (TRL) is a scale for determining the maturity of a technology

ARTC was created for a step change model to drive in Public Private Partnership for translational R&D with industry

Our Achievements

1

of the leading Public Private Partnership Research Centres in Asia

>75

Industry Members with Global Presence

5

Industrial Flagship Programmes

- A*STAR Model Factory at ARTC
- Industrial Additive Manufacturing Facility (IAMF)
- ROS- Industrial Consortium
- A*STAR – Rolls-Royce – SAESL Smart Manufacturing Joint Lab
- Hyper-Personalisation Line

>285 Core Staff

>55 PhD students and Interns

6

Core Technology Themes

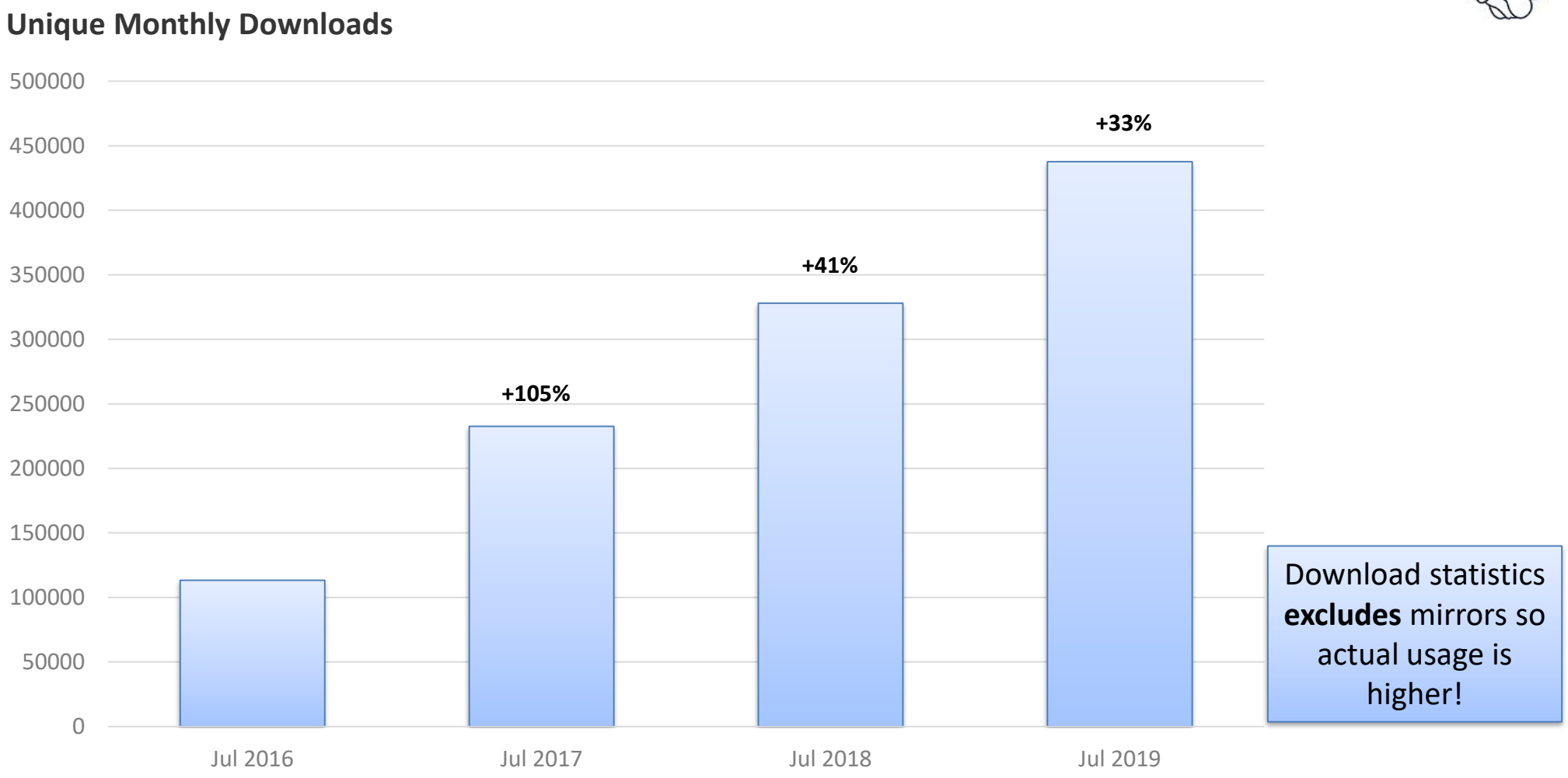
- Additive Manufacturing Industrialisation
- Advanced Remanufacturing
- Advanced Robotics Applications
- Data-Driven Surface Enhancement
- Intelligent Product Verification
- Smart Manufacturing

>430

Industrial projects successfully delivered

ROS-Industrial Asia Pacific Updates

ROS Growth Trend



Download statistics **excludes** mirrors so actual usage is higher!

Reaching towards 0.5 million unique downloads per month

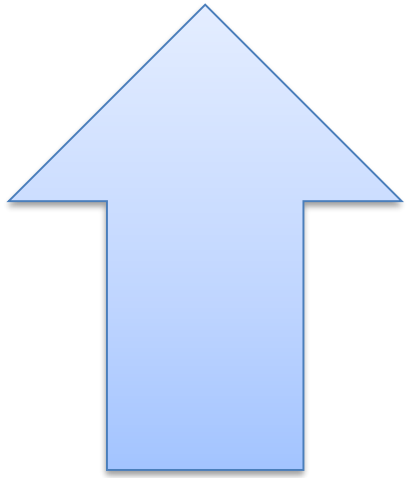
Source: Open Robotics ROS Metrics Reports 2016-2019

ROS Growth Trend

Unique monthly Wiki visitors Jul 2018 → Jul 2019

1.	United States	34,710 (19.08%)
2.	China	31,946 (17.56%)
3.	Japan	15,518 (8.53%)
4.	Germany	12,711 (6.99%)
5.	India	8,400 (4.62%)
6.	Philippines	7,235 (3.98%)
7.	South Korea	6,790 (3.73%)
8.	United Kingdom	4,325 (2.38%)
9.	Taiwan	4,233 (2.33%)
10.	France	3,725 (2.05%)
11.	Canada	3,354 (1.84%)
12.	Spain	2,955 (1.62%)
13.	Singapore	2,842 (1.56%)
14.	Italy	2,744 (1.51%)
15.	Russia	2,465 (1.35%)
16.	Indonesia	2,461 (1.35%)
17.	Australia	2,436 (1.34%)
18.	Brazil	2,231 (1.23%)
19.	Hong Kong	2,147 (1.18%)
20.	Turkey	1,928 (1.06%)

1.	China	41,357 (19.88%)
2.	United States	36,531 (17.56%)
3.	Japan	19,738 (9.49%)
4.	Germany	15,525 (7.46%)
5.	South Korea	9,382 (4.51%)
6.	India	9,345 (4.49%)
7.	United Kingdom	4,972 (2.39%)
8.	Taiwan	4,856 (2.33%)
9.	France	4,056 (1.95%)
10.	Canada	3,854 (1.85%)
11.	Singapore	3,516 (1.69%)
12.	Italy	3,464 (1.66%)
13.	Russia	3,207 (1.54%)
14.	Australia	3,114 (1.50%)
15.	Spain	3,080 (1.48%)
16.	Hong Kong	2,941 (1.41%)
17.	Brazil	2,548 (1.22%)
18.	Turkey	2,253 (1.08%)
19.	Netherlands	1,822 (0.88%)
20.	Poland	1,820 (0.87%)



- 8 APAC countries in top 20
- APAC user base grew 12% YoY

- China now number #1 ROS user
- China user base grew 29% YoY

- Japan user base grew 27% YoY

Source: Open Robotics ROS Metrics Reports 2018-2019

Asia Pacific Membership

ROS industrial consortium asia pacific

- 16 members in Asia Pacific (since Jul 2017) – **6 new members in 2019!**

ADLINK Leading EDGE COMPUTING

BLUE OCEAN ROBOTICS - for humans

KONICA MINOLTA

M8M

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

OMRON

Panasonic

PEPPERL+FUCHS

REPUBLIC POLYTECHNIC

SiAA

SINGAPORE POLYTECHNIC SP

Tokyo Opensource Robotics Kyokai

TONY ROBOTICS

UniTech

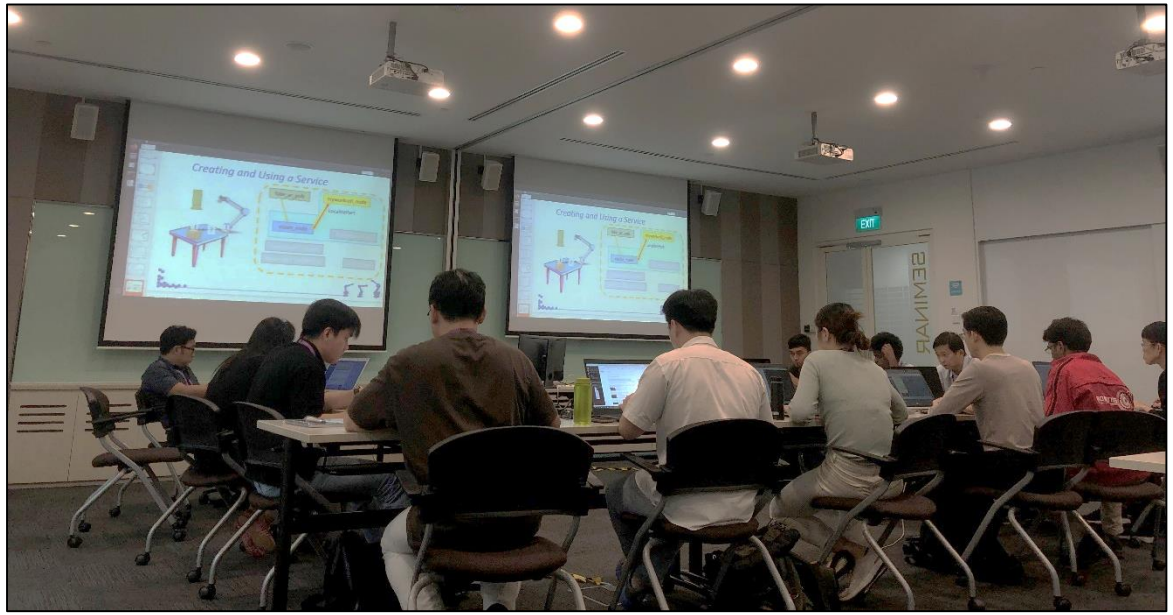
Woodside

YOKOGAWA

Highlights - Training

- We continue to support the industry with ROS training on regular basis:
  - May 21-24th - Developer's Training – First training on Melodic
  - Sep 21-24th - Developer's Training
  - Dec 10-13th - Developer's Training – As we speak!

- Future plans:
  - We are reviewing and improving training content
  - Planning for ROS 2.0 based training
  - Exploring more specialized ROS topics as additional courses and scaling up training

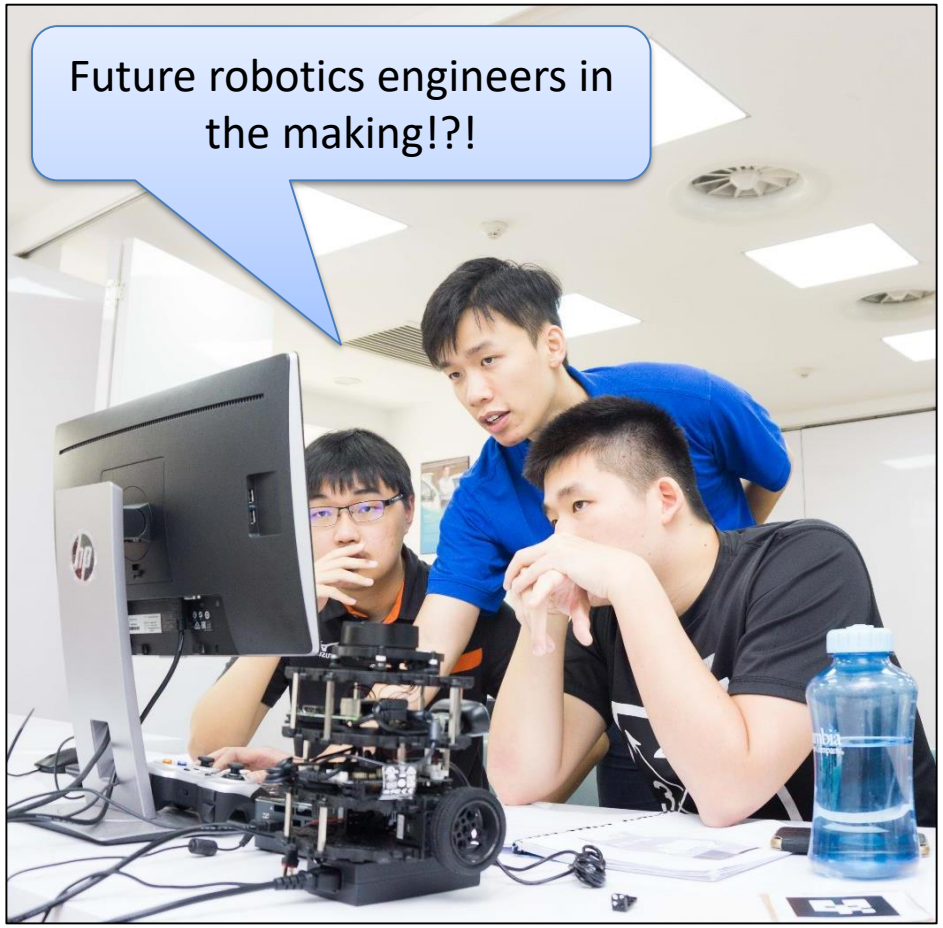


Highlights – Community and Student Engagement

- In March, organized together with new member Singapore Polytechnic a one week ROS Turtlebot hands on learning and coding challenge with participating Polytechnic students to spur further interest in ROS and robotics in our youth

- World ROS-I Day – 2nd July

- World MoveIt Day – 20th November

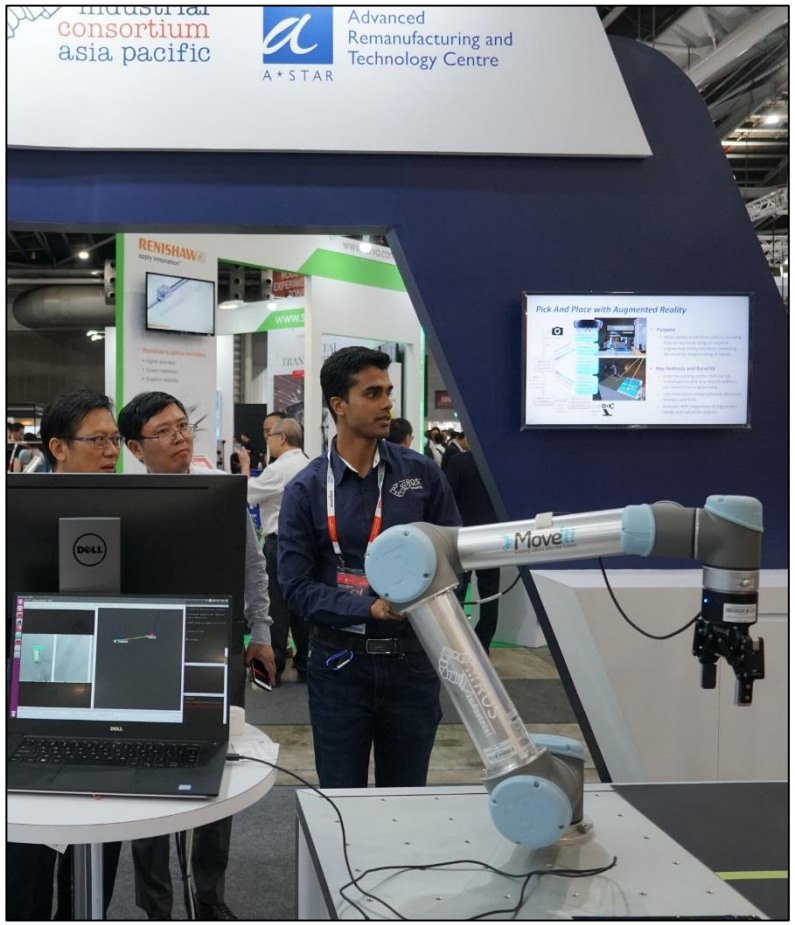


Highlights – Asia Pacific Workshop

- The 2019 edition of the Asia Pacific Workshop held 18-19th June hosted over 100 attendees (from more than 25 countries) and included industry talks, demonstrations and group activities.

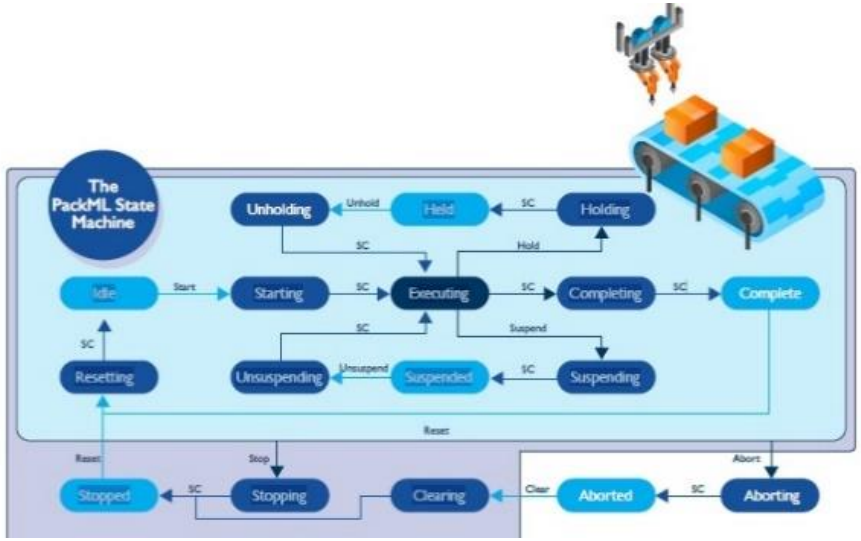
Highlights – Exhibitions

- The team exhibited at Industrial Transformation Asia Pacific (Singapore) 22-24 Oct and ROSCON (Macau) 31 Oct – 1 Nov, showcasing technology demos on ROS 2.0, Augmented Reality Robotics, Sensors Integration et c



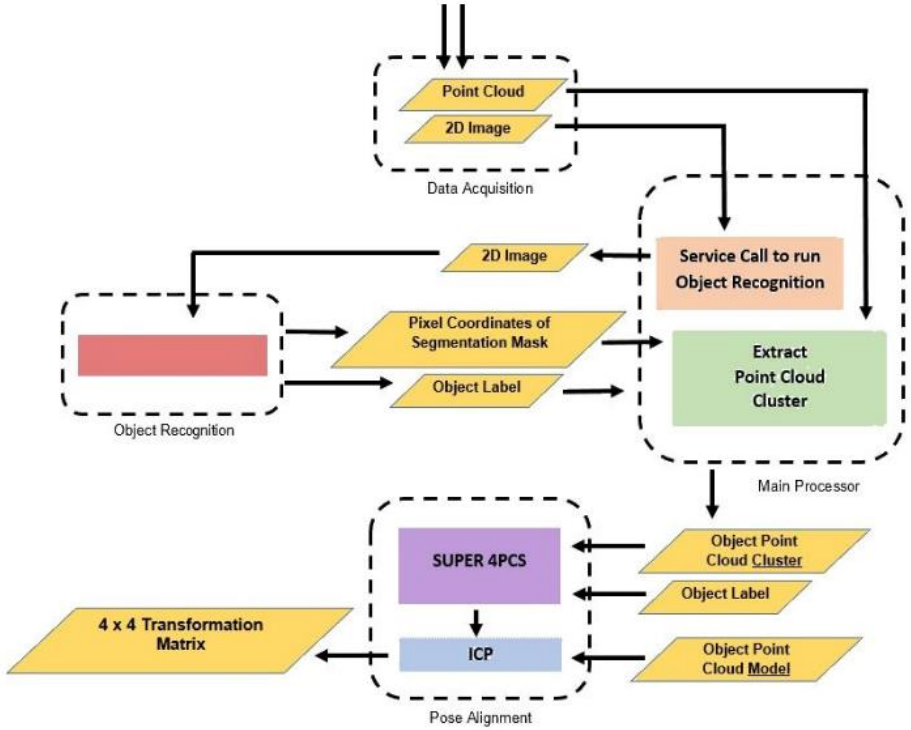
Highlights - Packages to be Open Sourced

- **PackML2**
  - Solution that enables control of a PackML state machine that communicate between PLCs and ROS
  - Has been upgraded from original ROS 1.0 support to ROS 2.0 (tested on Dashing)



PackML (Packing Machine Language) state machine is commonly used by PLCs in packaging

- **Robotic Vision Integration Pipeline (RVIP)**
  - Skeleton project that implements a complete pipeline for object detection, accurate object positioning using ML models, and pose estimation



RVIP architectural overview

2020 Key Focus

- **Membership** – ROS-Industrial Asia Pacific is continuing to grow its membership base with companies embracing open collaboration as well as equipment providers to grow the ROS ecosystem

- **ROS 2.0** – core development started are now based on ROS 2.0

- **Technology** – developing enabling features for the industry on top of ROS 2.0 that will help to *reduce barriers for adoption*. Technology areas include:


Advanced Perception


Intelligent Navigation


Smart Manipulation


Unified Communication with Robots (Interoperability)

Upcoming: Asia Pacific Workshop 2020

Welcome to next year's ROS-Industrial Asia Pacific Workshop!

When: 20-21st May 2020

Where: Advanced Remanufacturing and Technology Centre, Singapore

QR Link for Online Registration and Info

Early Bird Promotion now Applicable!

SCAN ME

Advanced Remanufacturing and Technology Centre – Application Highlights

Topic 1 – Simplified Robotics

Moving the needle for adoption by reducing the technology barrier from Engineer ➔ Operator

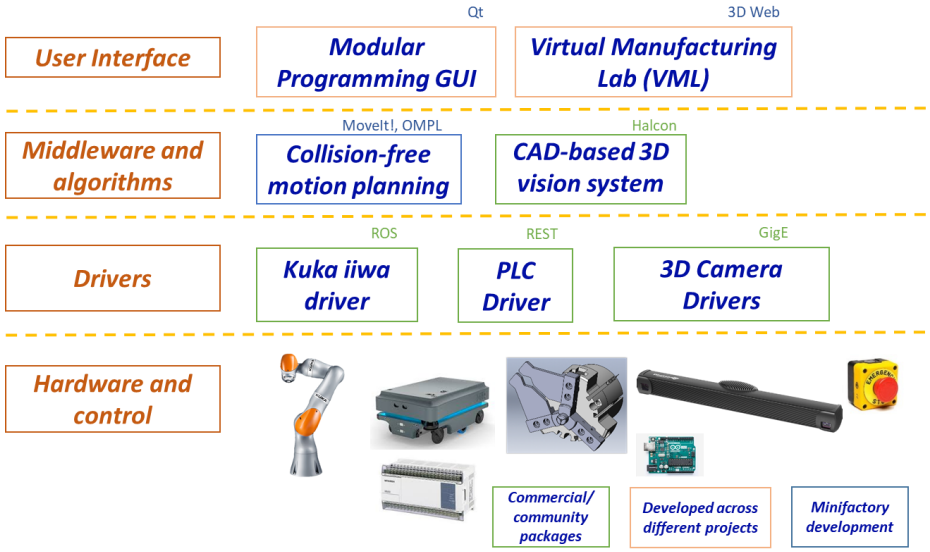
Model-based Teaching of Robotics - Introduction

- **Problem Statement/Objectives**
  - A cobot is used in a gearbox assembly line to reduce human intervention in heavy and dangerous tasks. However, the objects to-be-picked currently have to be in precise predefined positions which is sometimes not feasible in an agile shopfloor environment
  - To automate cobot movement generation based on 2D/3D computer vision, allowing personalised order without re-programming the cobot

- **Benefits**
  - 3D computer vision based system is used to detect the gearbox parts placed anywhere on the tray. Optimal, collision-free robot motion are generated automatically based on this visual input
  - Process sequence is modeled as a state-machine that invokes the different devices and software modules

- **Using ROS**
  - MoveIt for motion control
  - Kuka robot driver control

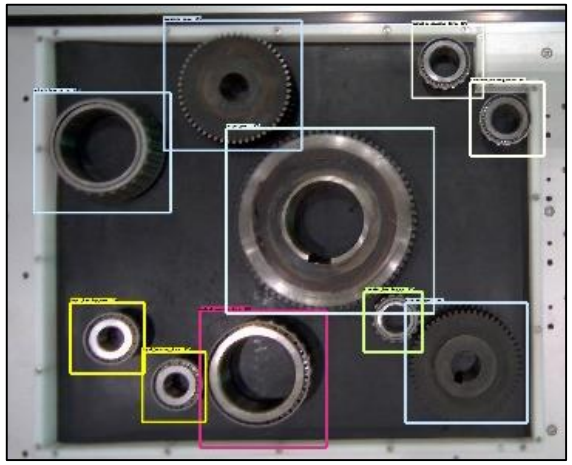
- **Architectural Overview**



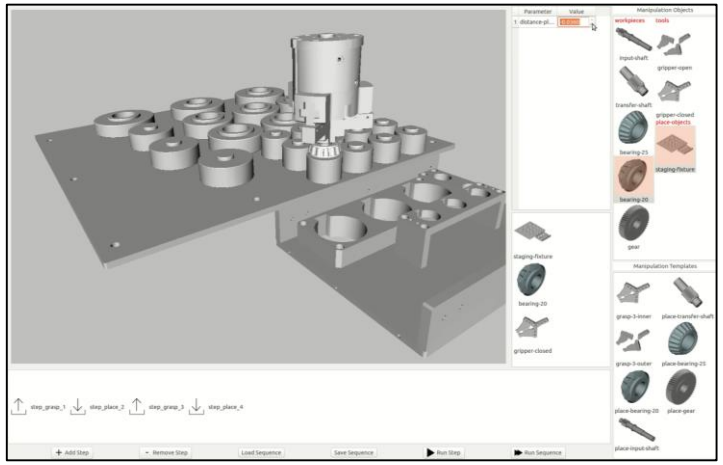
Courtesy of ARTC Advanced Robotics Applications Team

Model-based Teaching of Robotics - Showcase

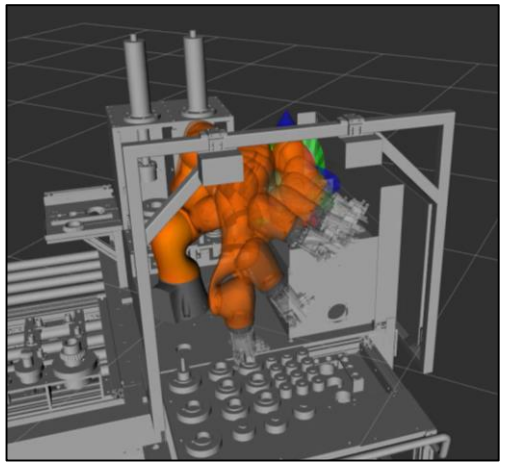
1) Cobot station for gearbox assembly



2) Detection of gearbox parts on a tray

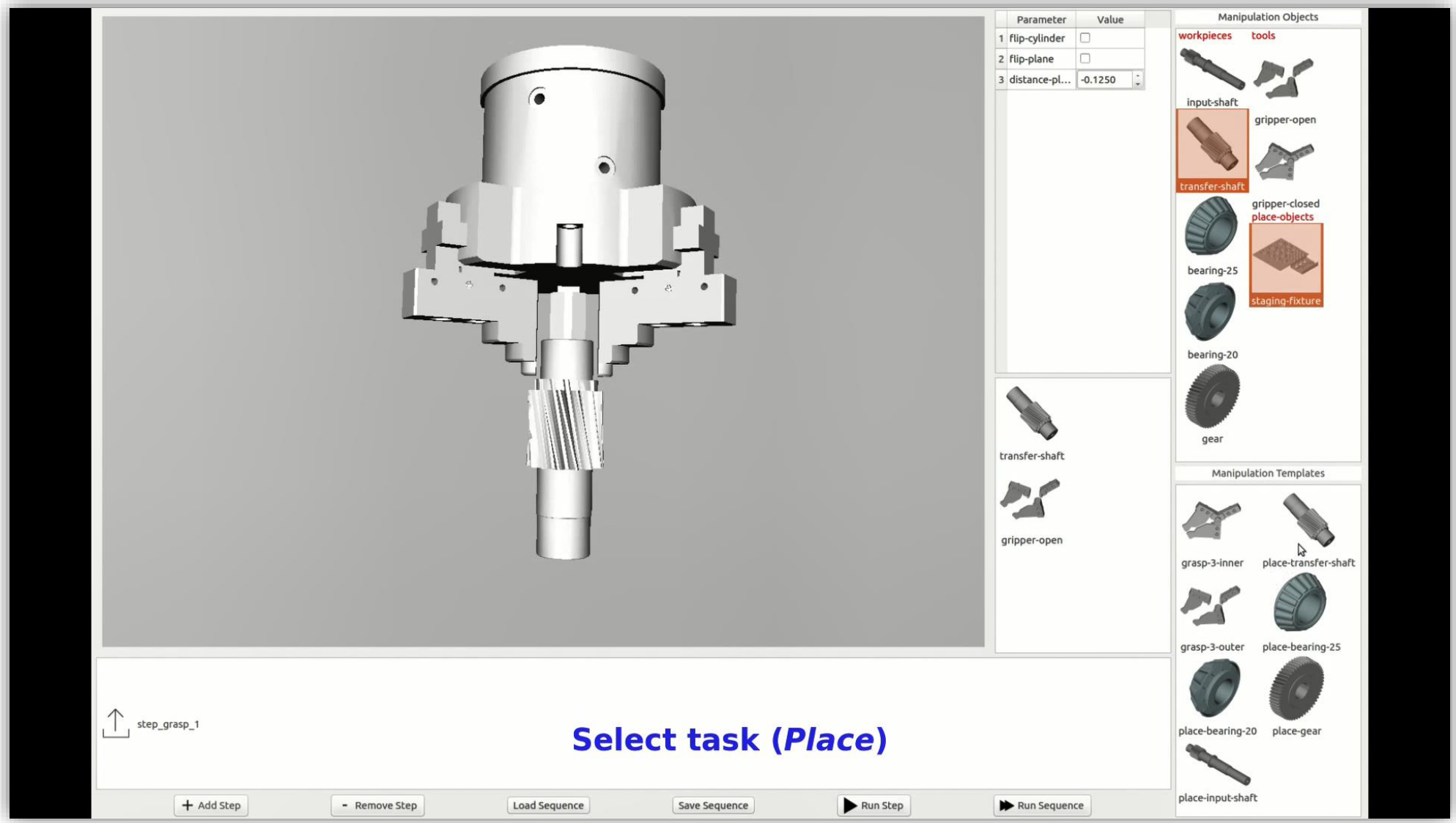


3) Modular programming GUI



4) Collision-free motion planning

Model-based Teaching of Robotics - Showcase



Courtesy of ARTC Advanced Robotics Applications Team

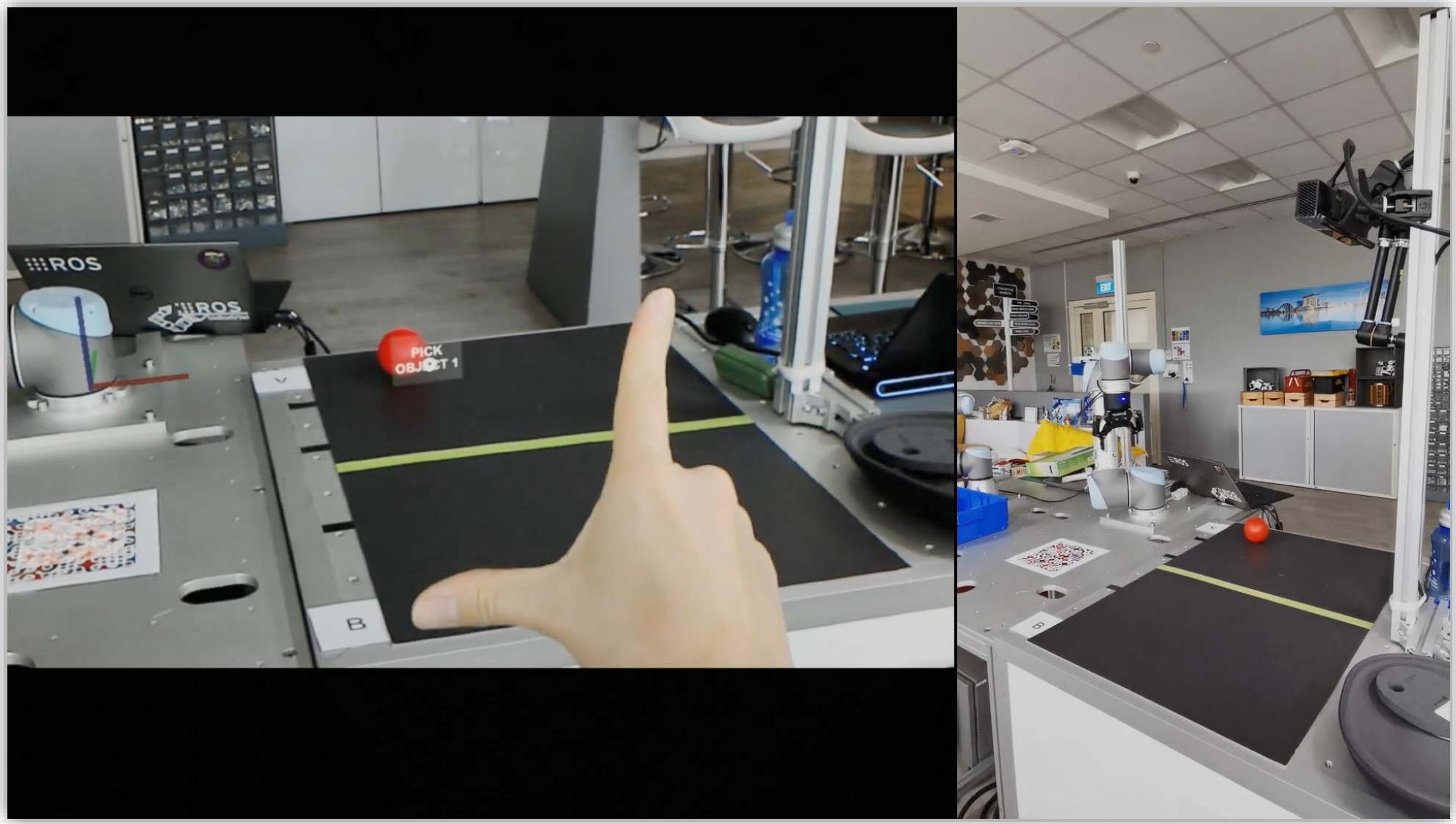
Augmented Reality Teaching - Introduction

- **Problem Statement/Objectives**
  - Scalability of robotics solutions are hampered by the need of skilled engineers/technicians to program robots
  - Human robot collaboration requires improved safety visualization

- **Benefits**
  - Provides an operator with a simple user interface that can be used to program instructions for the robot directly in its deployment environment interacting with both static and dynamic objects in the robot's work cell

- **Using ROS**
  - Developed a ROS module that can communicate with a Microsoft Hololens application
  - MoveIt for motion control
  - UR robot driver control

Augmented Reality Teaching - Showcase



Topic 2 – Process Applications

Providing flexibility to provide more automation in high-mix applications

Automatic Toolpath Generation - Introduction

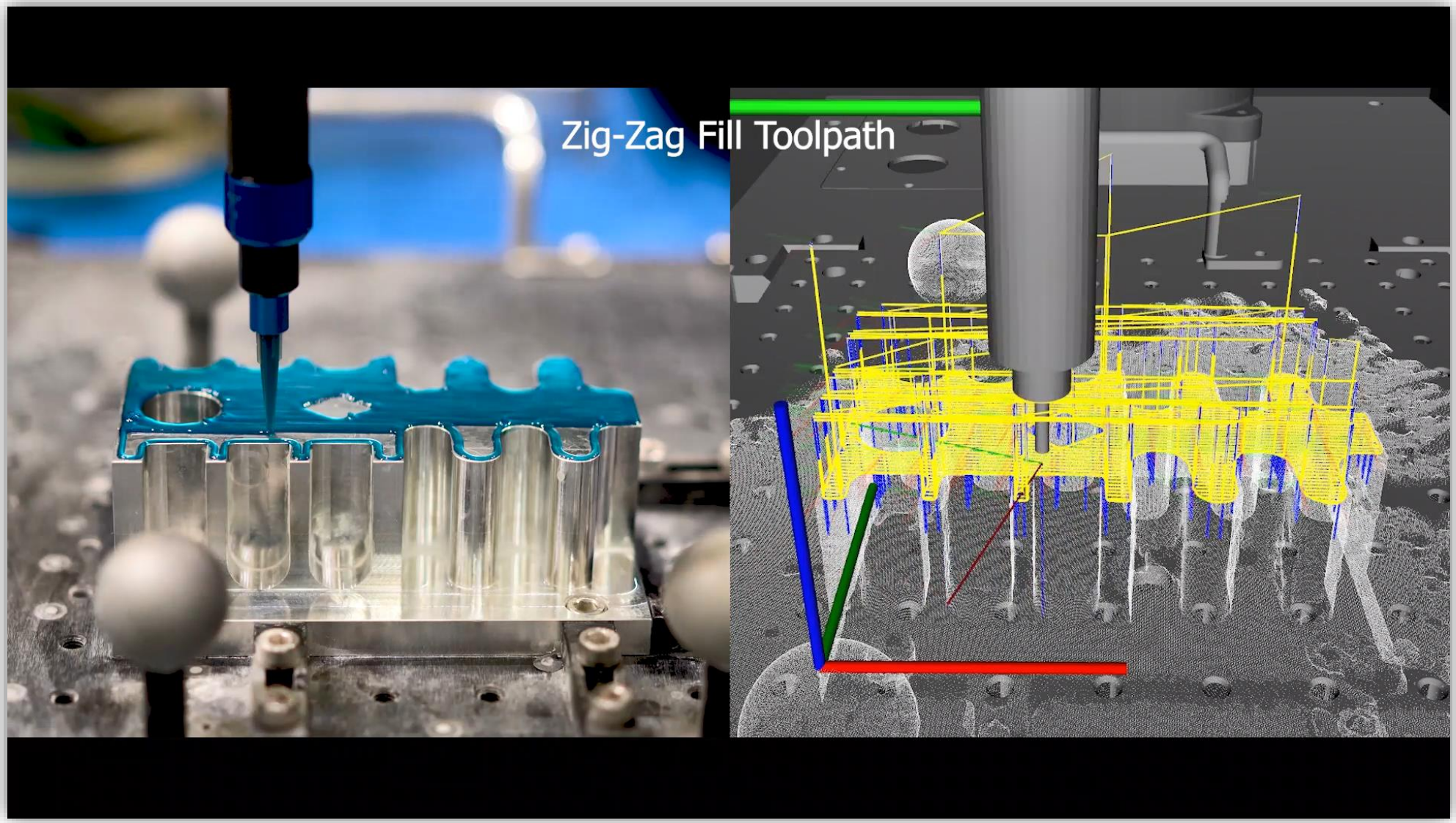
- **Problem Statement/Objectives**
  - Machining industry demands robotic surface finishing capability for material removal process in order to achieve higher efficiency. Conventional robotic surface processing relies on CAD files and very skilled technicians, which could be time consuming especially for high-mix-low-volume production

- **Benefits**
  - The system is dynamic and particularity suitable for high-mix-low-volume production, and applicable for those jobs that do not have CAD files or 3D models available
  - Outline support
  - This system can be applied to various surface finishing processes: such as polishing, deburring, laser peening et c

- **Using ROS**
  - MoveIt for motion control
  - Descartes for Cartesian path planning

Courtesy of ARTC Advanced Robotics Applications Team

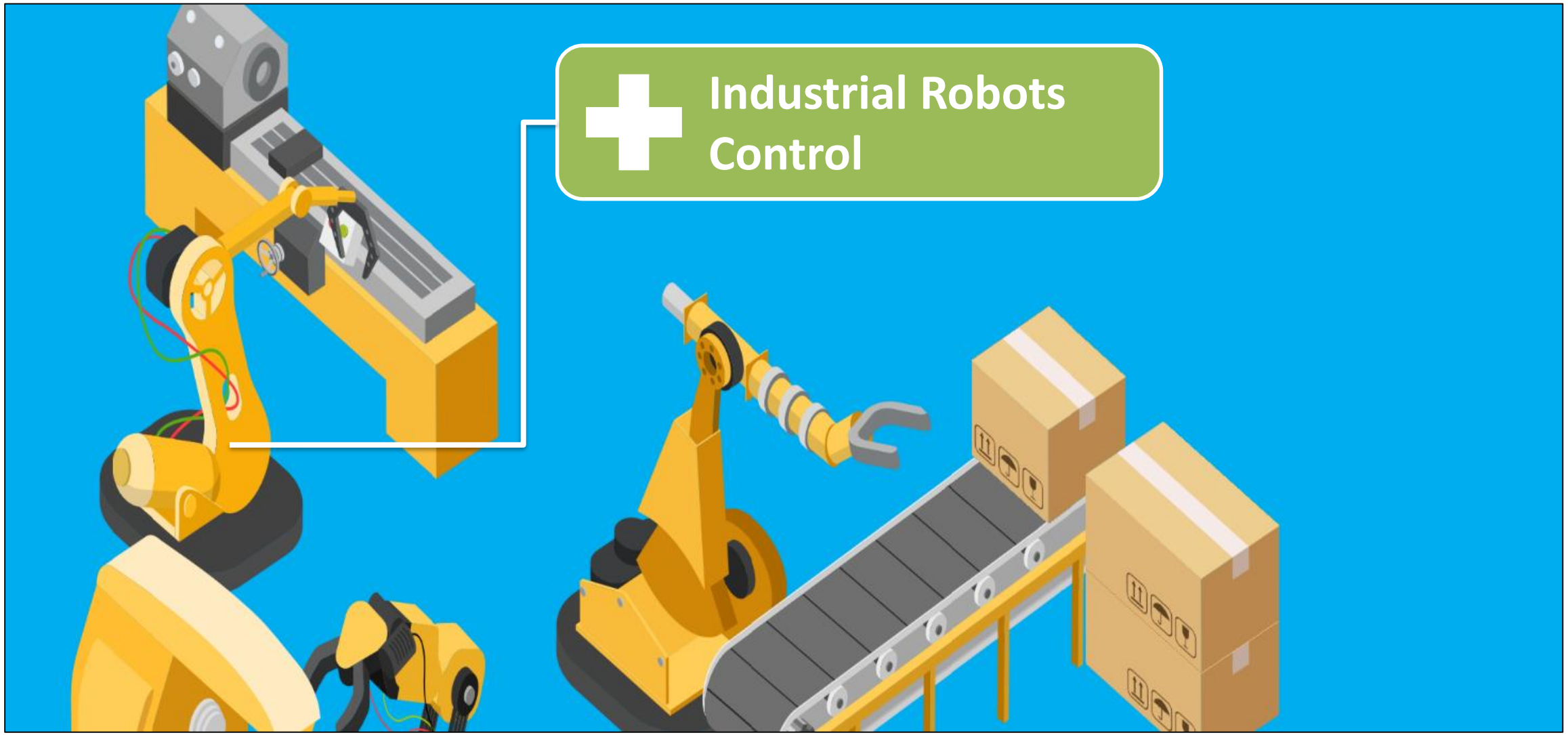
Automatic Toolpath Generation - Showcase



Courtesy of ARTC Advanced Robotics Applications Team

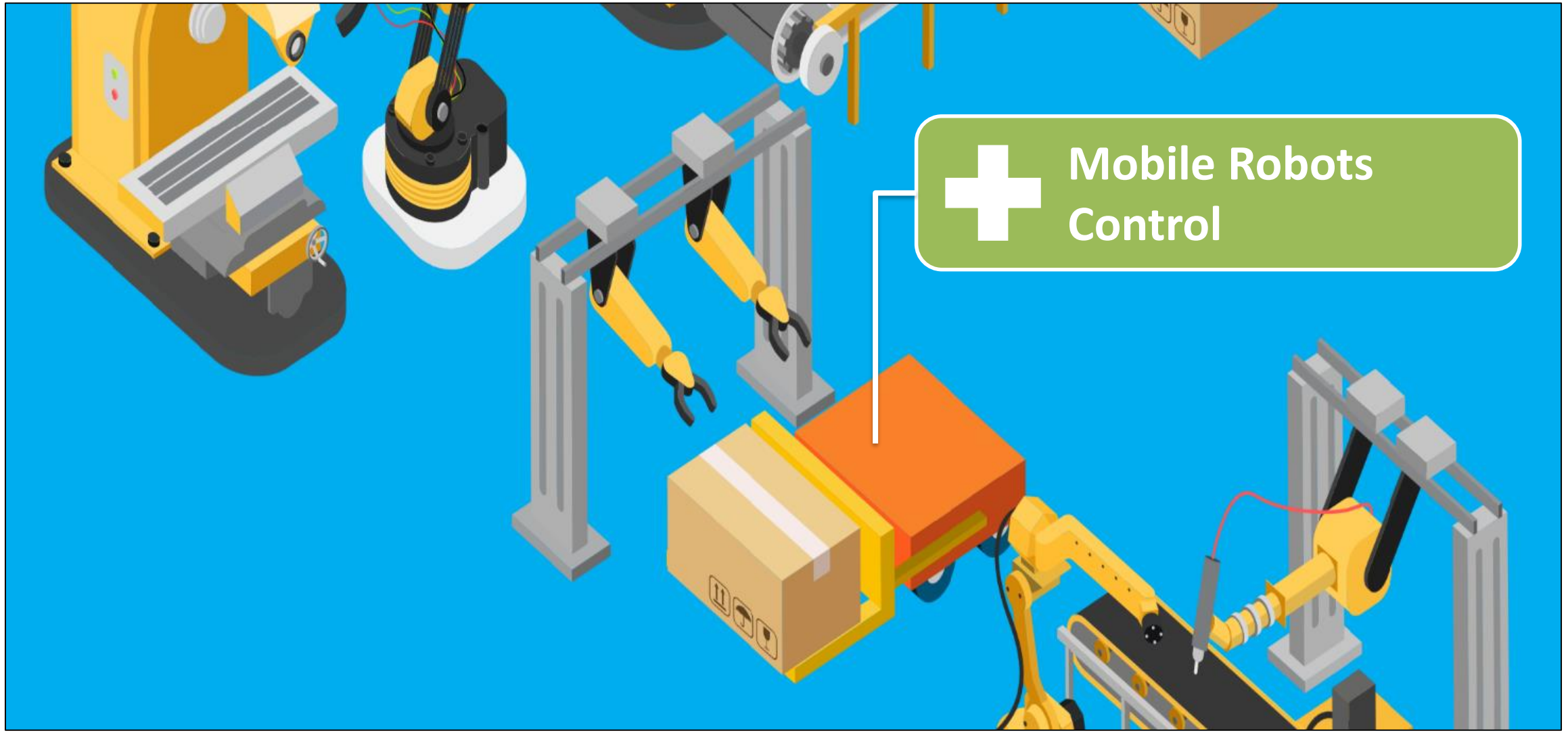
Singapore Key ROS Initiatives

ROS-Industrial Capabilities



ROS-Industrial Capabilities

ROS-Industrial Capabilities

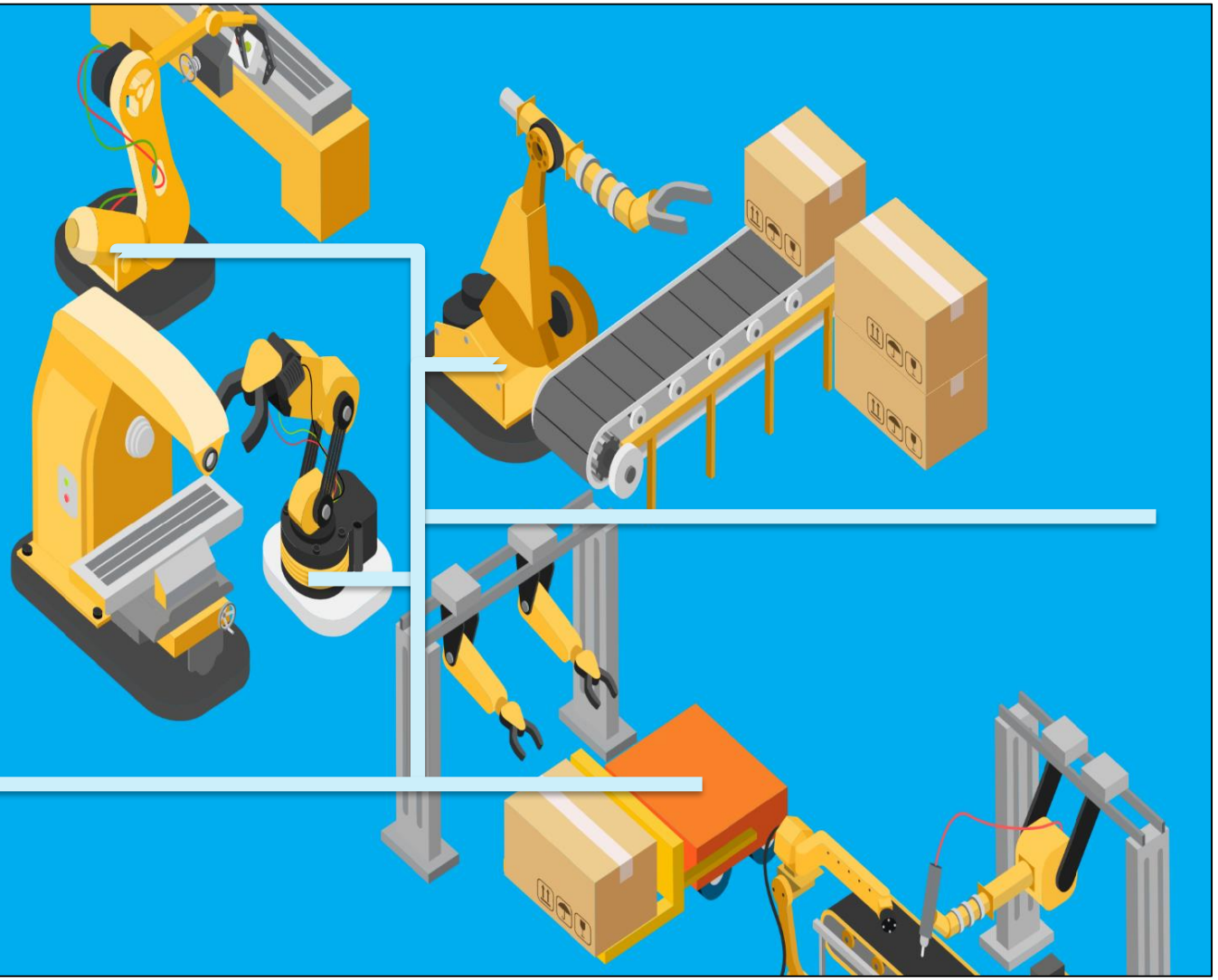


ROS-Industrial Capabilities – Next Logical Step

ROS industrial consortium asia pacific

Integration of Robotic Systems

Integration with Industrial Systems



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Robotics Middleware Framework (RMF) for Healthcare

- **Project Overview**
  - Formally announced at ROSCON 2019 Macau
  - Government sponsored project to allow for large scale adoption of robots for Singapore healthcare sector
  - **ROS 2.0 middleware** allowing:
    - **Connectivity** to Hospital IT systems
    - **Interoperability** between robots as well as edge devices (including building infrastructure)
    - **Task and fleet scheduling**
  - Significant portions of project will be **Open Sourced**

- **Sponsor**
  - National Robotics Programme (NRP)

- **Participating Organizations**

Centre for Healthcare Assistive & Robotics Technology (CHART)

HOPE technik

IHiS – Because IT's in Healthcare

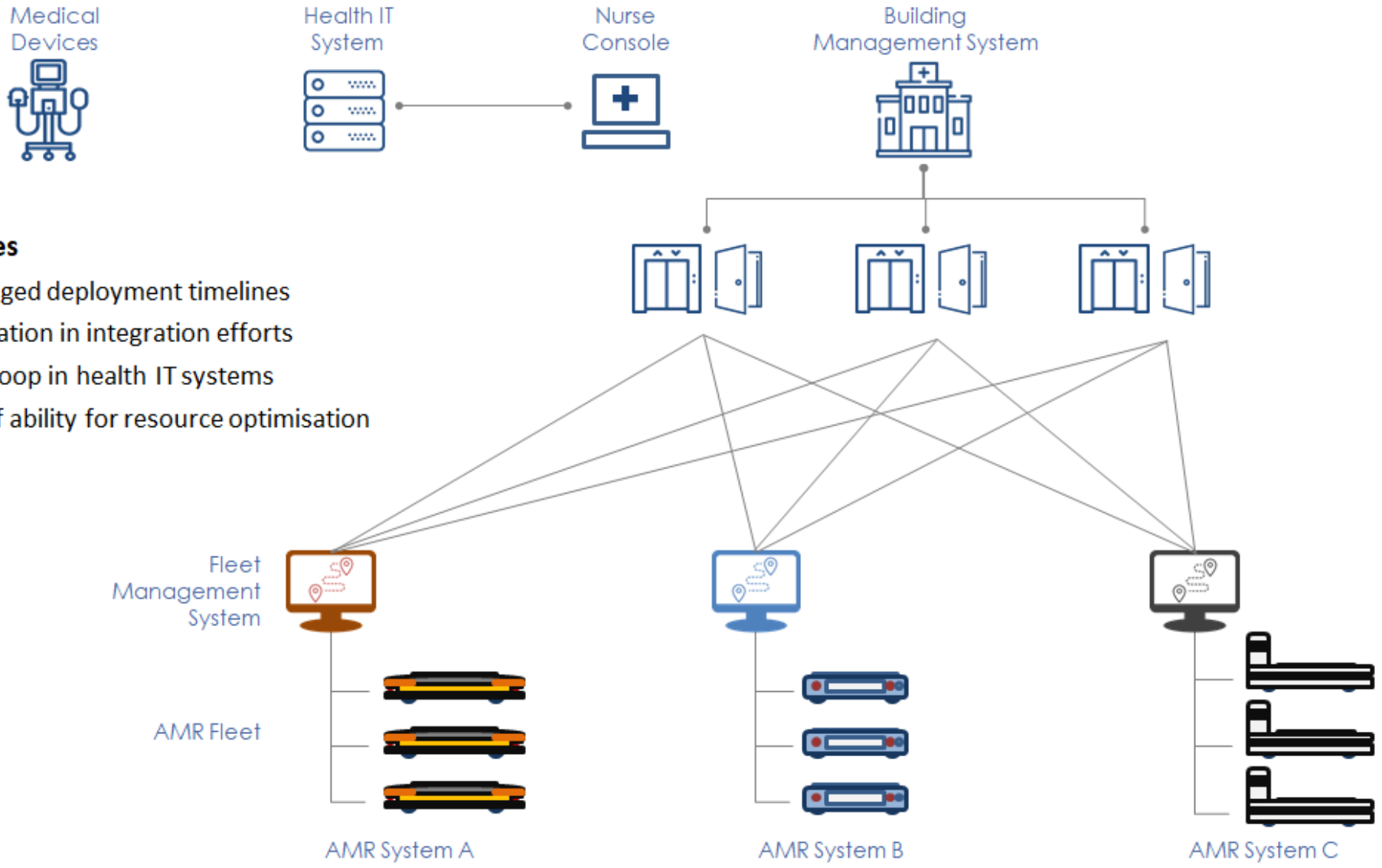
open robotics

GOVTECH SINGAPORE

Current Situation

Challenges

- Prolonged deployment timelines
- Duplication in integration efforts
- Open loop in health IT systems
- Lack of ability for resource optimisation



Courtesy of Open Robotics (Singapore)

Challenges in Multi-fleet Deployment

Lack of Interoperability

- Lack of communication and integration between robots, medical devices, building infrastructure and health IT systems

Infrastructure Constraints

- Need to interface with lifts and doors
- Dedicated routes and lifts for robot

Lack of Realistic Test Environment

- Challenging and expensive to test effectiveness of large scale deployment of robotic solutions

Dynamic Environments

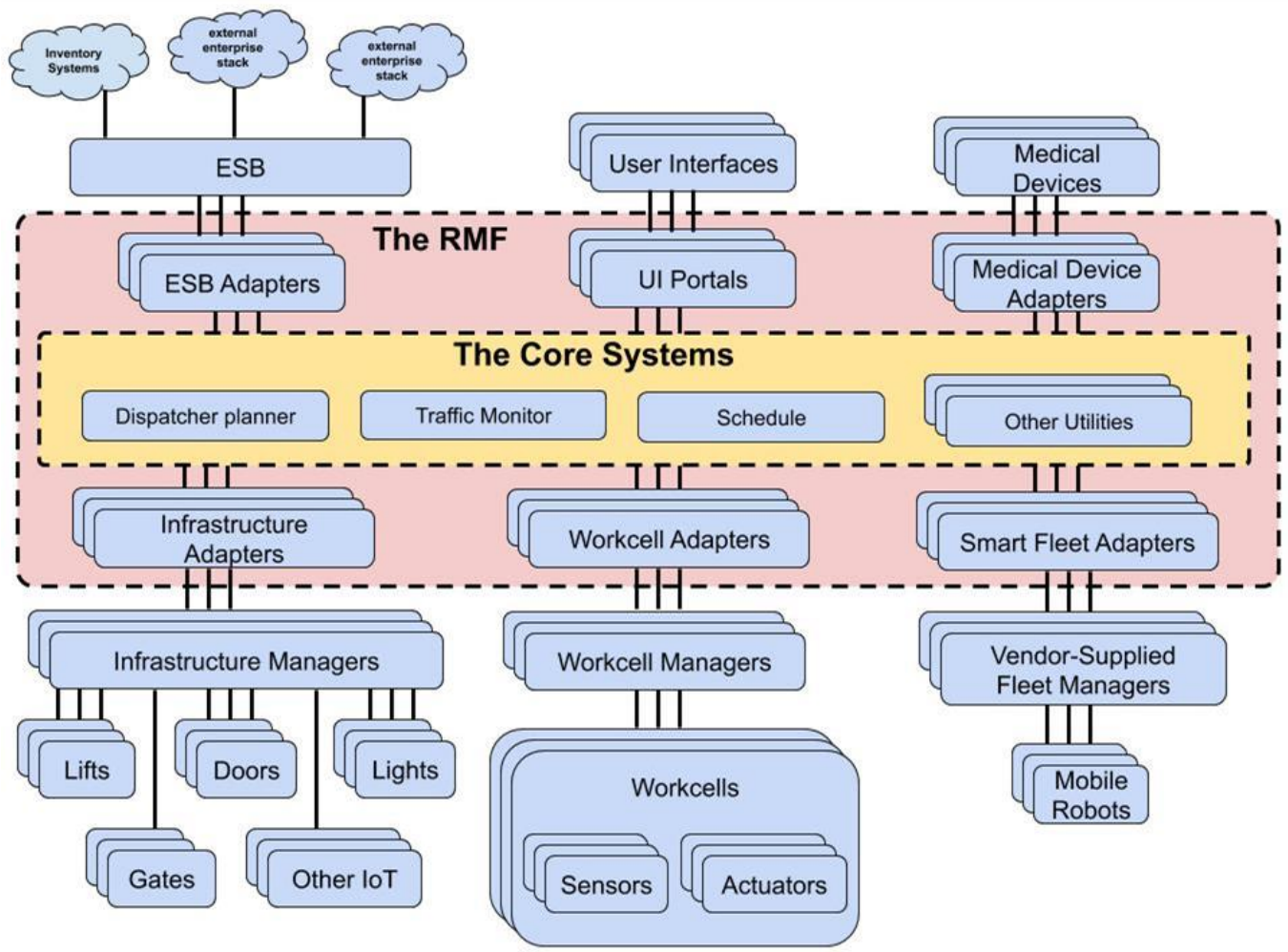
- Dynamic human traffic and crowds
- Direct contact with high volume of untrained personnel and visitors

Cybersecurity Concerns

- Increased reliance on network for data transmission

Courtesy of Open Robotics (Singapore)

Architectural Overview



Connecting Heterogeneous Fleets

- Submit spatio-temporal updates of robots in fleet
  - in standardized measurement frames
  - at regular intervals
- Receive job requests from *Dispatch Planner* and submit plan to *Scheduler*
  - conflict free
  - time optimal
- Submit requests to other building/automation systems
  - open doors, operate lifts
  - other robotic workcells
- Interface through common UI platforms
  - using hospital protocols

http://github.com/osrf/rmf_core

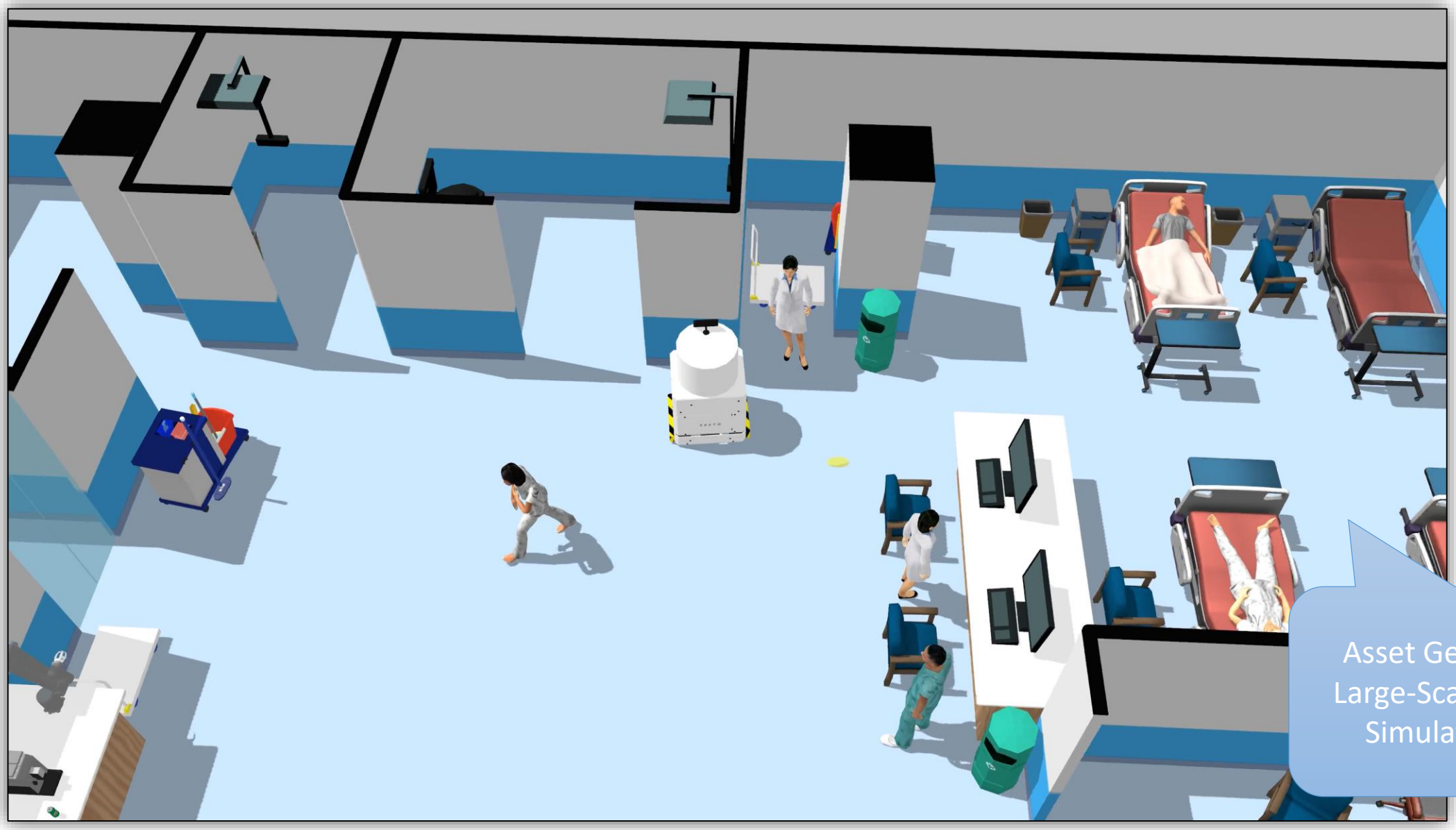
https://github.com/osrf/traffic-editor

https://github.com/osrf/soss

Cautionary note: Packages are works-in-progress and not yet well documented

Courtesy of Open Robotics (Singapore)

Example – Coffee Delivery Task to Hospital Ward



Courtesy of Open Robotics (Singapore)

Robotics Middleware Framework (RMF) for Industry

- **Project Overview**
  - ROS-Industrial Consortium and Open Robotics will collaborate **to develop enhancements required to adopt RMF for commercial and industry** sectors
  - **ROS 2.0 middleware** allowing:
    - **Connectivity** to brownfield systems
    - **Interoperability** between robots as well as edge devices (including building infrastructure)
    - **Task and fleet scheduling**
  - Significant portions of project will be **Open Sourced**

- **Sponsor**
  - National Robotics Programme (NRP)

- **Participating Organizations**

Robotics Interoperability – Allowing for Large Scale Deployments

ROS-I
CONFERENCE
2019

Thank You

Contact Information

Erik Unemyr

Consortium Manager

ROS-Industrial Consortium Asia Pacific

Senior Programme Manager

Advanced Remanufacturing and Technology Centre

E-mail: erik_unemyr@artc.a-star.edu.sg

WWW: www.rosindustrial.org