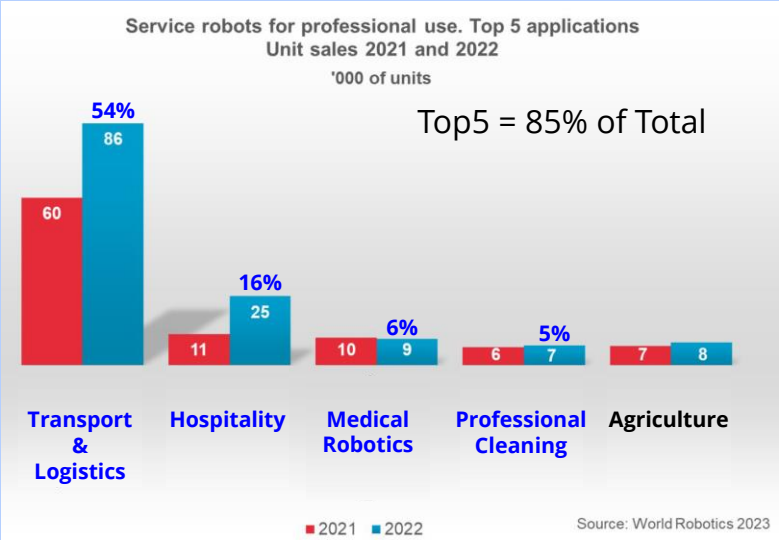
Advanced Remanufacturing and Technology Centre
ARTC

RMF 2.0 – Enabling Interoperable Solutions for Large-scale Mobile Robotics Applications

Zhang Jingbing, PhD
R&D Director, Smart Robotics and Automation (SRA) Division

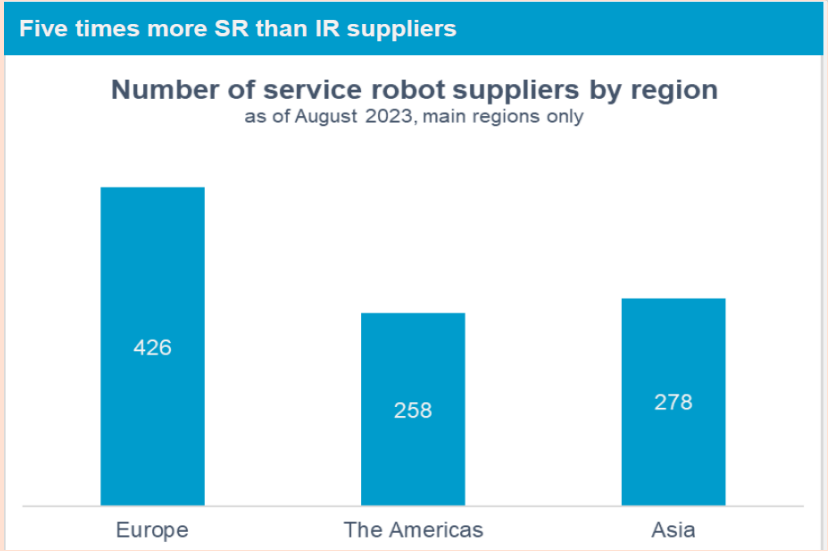
29 Nov 2023

Booming Market for Professional Service Robots



Worldwide Market for Professional Service Robots

- **158,000** new robots installed in 2022
- **48% YoY growth** over 2021
- **Transport & Logistics** account for 54.4% of the new installation



More Vendors/Robots Entering the Market

- 1000 suppliers (80% SMEs; 10% new startups)
- **Opportunities** to benefit from new innovations
- **Challenges** to manage different brands/models
- High demand for interoperability solutions

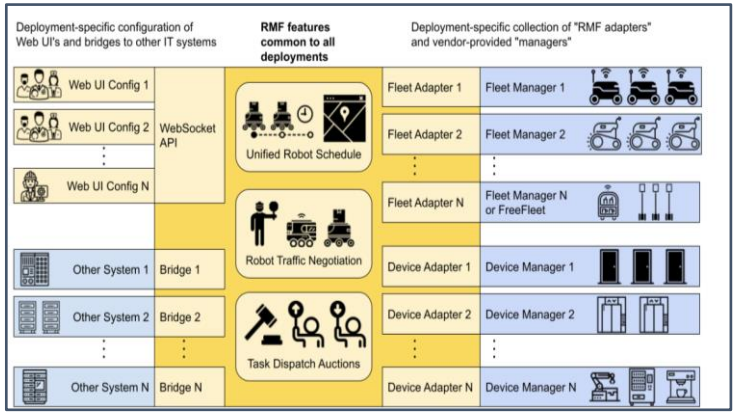
The Challenges

- Vendor lock-in
- IT/OT Integration
- Total cost of Deployment
- Safety and Collaboration
- Scalability
- Talent Crunch

CREATING GROWTH, ENHANCING LIVES

Robotics Middleware Framework (RMF)

- Initiated in 2018, with funding from Singapore's National Robotic Program (NRP) office
- Collection of software modules and tools that enable interoperability among:
  - Fleets of heterogeneous mobile robots (different vendors, models, specs)
  - Building infrastructure (door, elevators, etc.)
- Primary focus on healthcare and hospital applications



https://www.open-rmf.org/

Catalysed by NATIONAL ROBOTICS PROGRAMME

CREATING GROWTH, ENHANCING LIVES

RMF2.0: Next-generation Interoperation Platform and Technologies

- **The RMF2.0 Program** (Jul 2023- Jun 2025) led by ARTC will be focused on use cases in manufacturing & logistics (M&L), and facility management (FM).
  - Programme is funded by NRP and supported with additional internal fund from ARTC
  - New features to support IT/OT integration, co-simulation, and robot execution
  - Interoperability among mobile robot fleets with automated M&L systems, such as ERP, MES, WMS, SCADA, ASRS, workcells, etc.
  - New web UI based control tower and configuration support

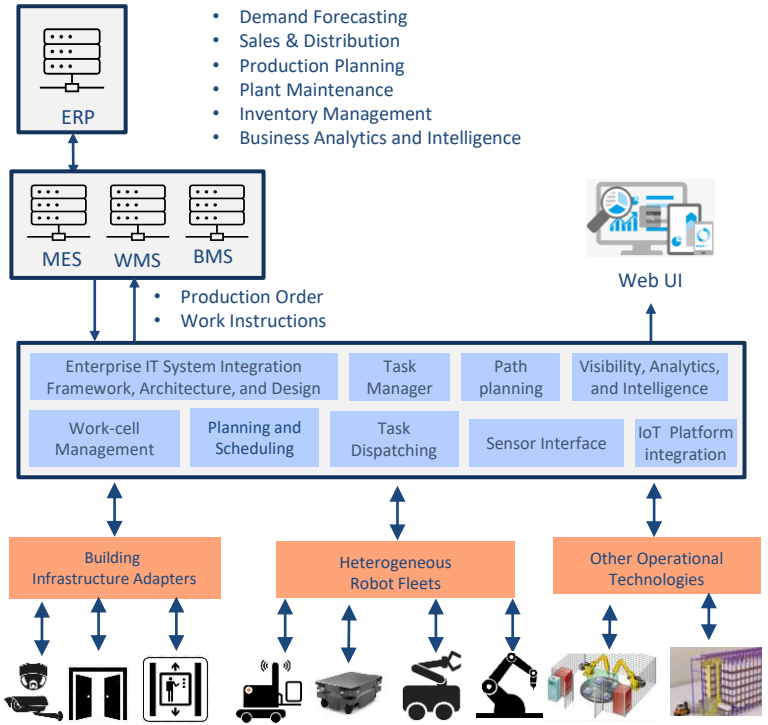





Photos for illustration only. Copyrights belong to the original creators.

Interoperable Robotics for Multiple Industries

— *To better enable the integration, inter-operation, and orchestration of heterogeneous mobile robot fleets and related enterprise IT & OT systems*



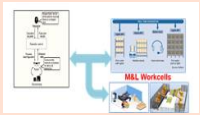
1 Integrative Dynamic Co-Simulation for Digital Twin-based Scenario Planning & Performance Optimization

- Certainty in production schedule execution
- Early detection and elimination of bottle-necks
- Optimal utilization of AMR resources
- Digital twin-based scenario planning and optimization.

2 Hyper Connectivity for Enterprise IT/OT Integration in Manufacturing and Logistics

- Seamless integration of IT/OT systems
- Unified data structure and unambiguous semantics across systems and applications
- Elimination of islands of automation/data/analytics

3 Robot Execution System for Autonomous Manufacturing Value Chain



- Optimal execution of schedules by AMRs
- Agility in accommodating operation dynamics
- Learning-based continuous optimization
- Control tower of AMRs and related operations

Ecosystem Approach to Capability Development

CREATING GROWTH, ENHANCING LIVES

RMF2.0 Program Team

- **Collaborate** with ecosystems players: end-users, product owners, systems integrators
- **Define** and **Prioritize** technologies, features and functions based on industries' inputs
- **Develop** technologies that best reflect the needs of participating companies
- **Demonstrate** and **Prove** the values at select partners' factory, warehouse, or facility

Define → Develop → Demonstrate → Deploy → Scale-up

Industrial Partners

- **Voice** your company's specific needs, requirements, and priorities
- **Co-steer** the direction of RMF2.0 technologies development
- **Prove** the values ahead of competition
- **Maximize** your return on investment

Photos for illustration only. Copyrights belong to the original creators.

End-users · Systems Integrators · Product/Technology Suppliers

Manufacturing Logistics Facility Management

CREATING GROWTH, ENHANCING LIVES

Advanced Remanufacturing and Technology Centre
ARTC

THANK YOU

www.a-star.edu.sg