Advanced Remanufacturing and Technology Centre
A*STAR

CREATING GROWTH, ENHANCING LIVES

In partnership with:

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

WELCOME TO ARTC

Passion Made Possible

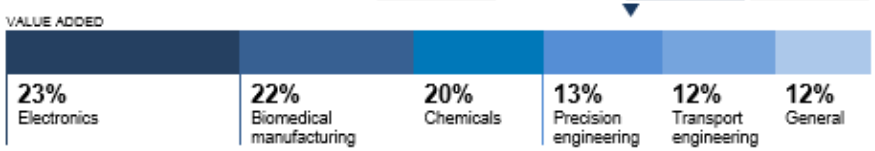
Overview of Singapore Economy

Singapore's economy today

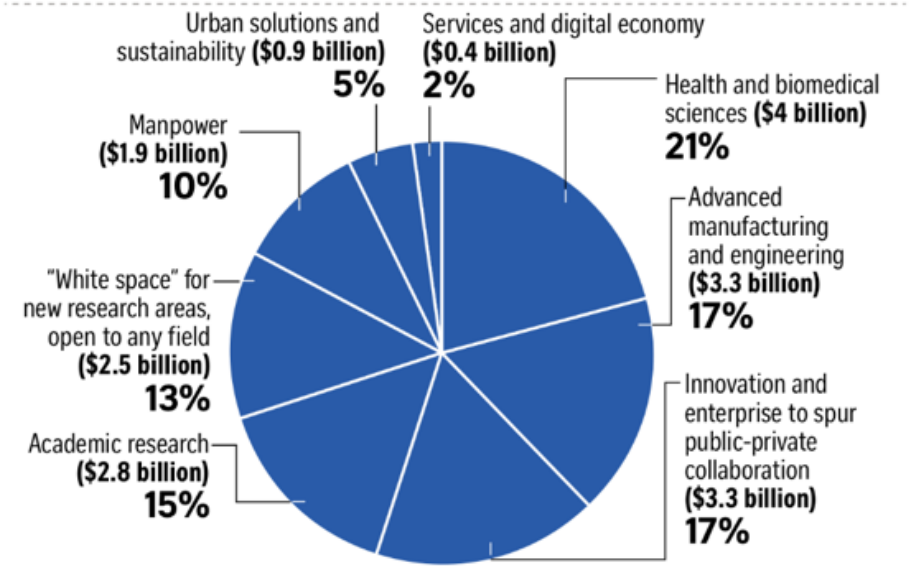
2016 GDP **S$410.3B**

2016 GDP GROWTH **2.0%**

2017 FORECAST GDP GROWTH **1.0% - 3.0%**

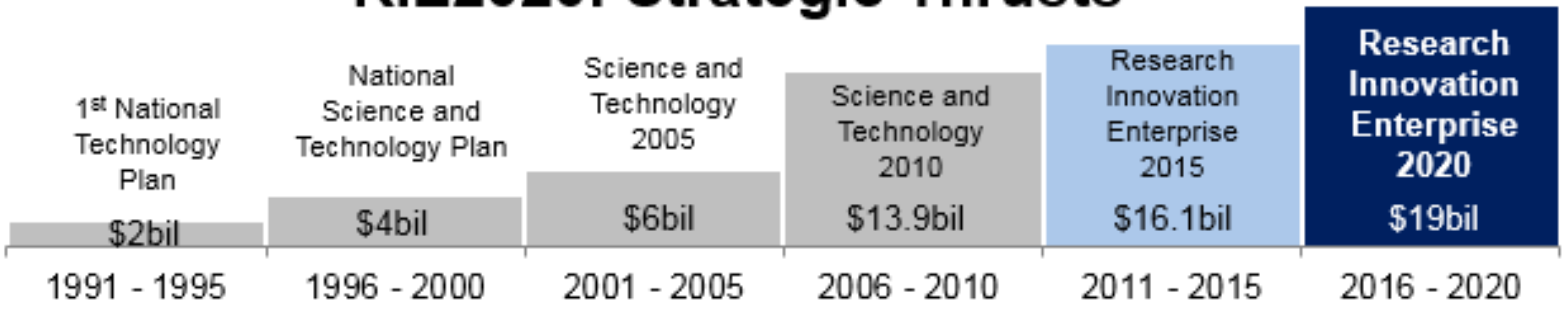


Where funds will go



Source: NATIONAL RESEARCH FOUNDATION ST GRAPHICS

RIE2020: Strategic Thrusts



Domain-based Governance Framework

Prioritization of RIE agenda into four technology domains aligned to areas of competitive advantage and/or national needs

DOMAINS (VERTICAL $)

Advanced Manufacturing and Engineering (AME)

Support growth & competitiveness of manufacturing & engineering sectors

Health and Biomedical Sciences (HBMS)

Advance human health & wellness, and create economic value for Singapore & Singaporeans

Services and Digital Economy (SDE)

Leverage digital innovation to create economic opportunities and meet national priorities

Urban Solutions and Sustainability (USS)

Develop a sustainable & livable city through integrated for Singapore and the world

CROSS-CUTTING PROGRAMMES (HORIZONTAL $)

Academic Research — *Build up a significant base of capabilities and a pipeline of ideas that can drive the next phase of growth*

Manpower — *Build a strong research and innovation community*

Innovation & Enterprise — *Build a strong core of innovative enterprises that drive value creation and economic competitiveness*

ARTC A*STAR

A*STAR Overview

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) 10 Research Entities	**Science & Engineering Research Council (SERC)** 9 Research Entities	**ETPL** Commercialisation	**A*STAR Graduate Academy** Scholarships

>5,200 STAFF

>4,100
Researchers, Engineers and Technical Support Staff

>38%
of whom come from 64 countries

Annual Outputs (FY2011 – 2015)

>1,700
Industry projects a year
5 Industry projects a day

55% MNCs
38% SMEs
7% LLEs

>200
Licenses a year
4 Licenses a week

>2,800
Papers published a year

>14
Start-Ups a year

>270
Patents filed a year

1
RSE spun out to industry a day*
*average number of Research Scientists and Engineers (RSE) per working day in a calendar year

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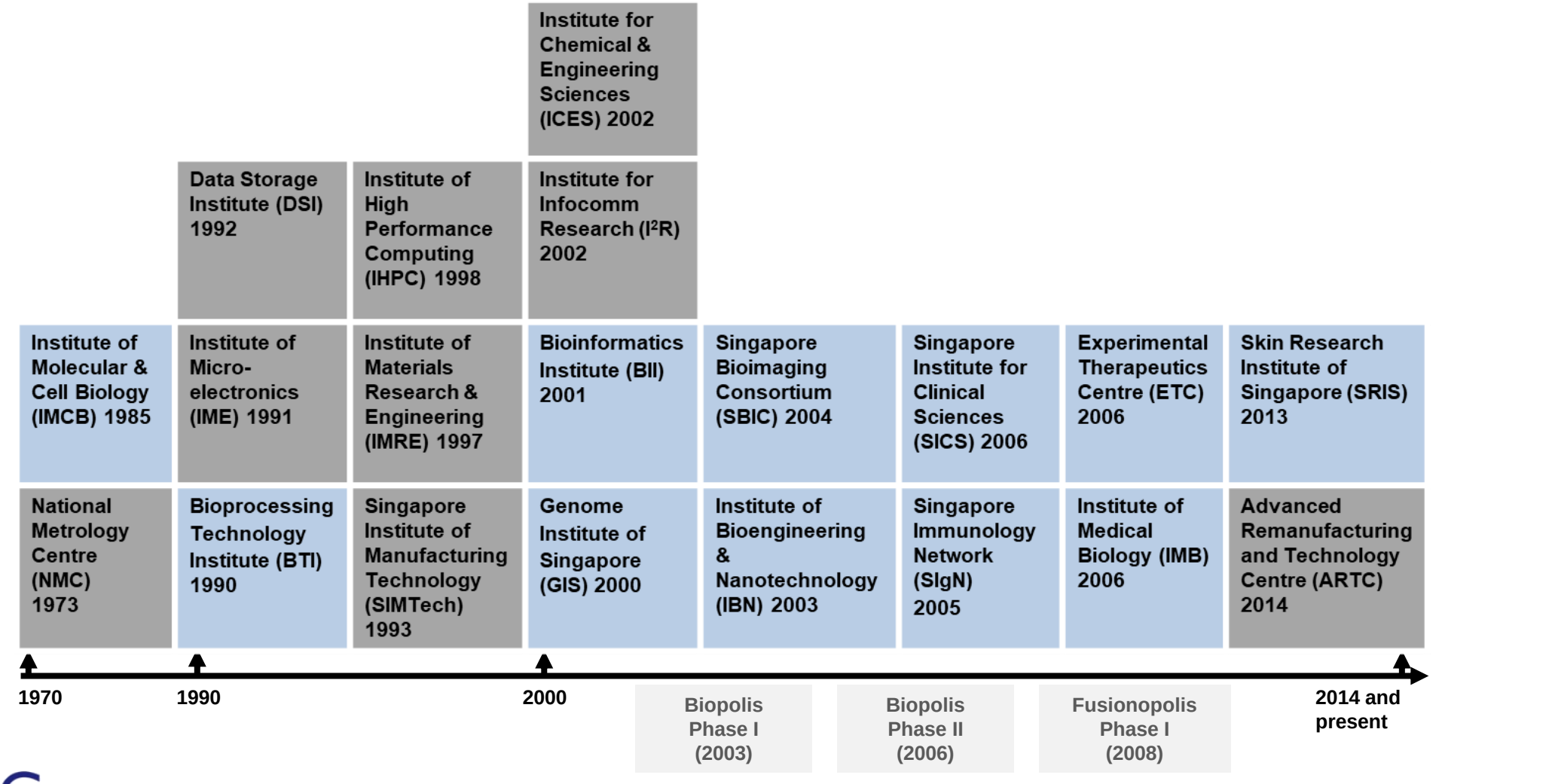
Research Entities



The Advanced Remanufacturing and Technology Centre

Leading Public-Private Partnership Research Centre in Asia.

- Bridge the gap between Research and Industry
- Focused in Advanced Manufacturing and Remanufacturing

Cleantech Park: Courtesy of JTC

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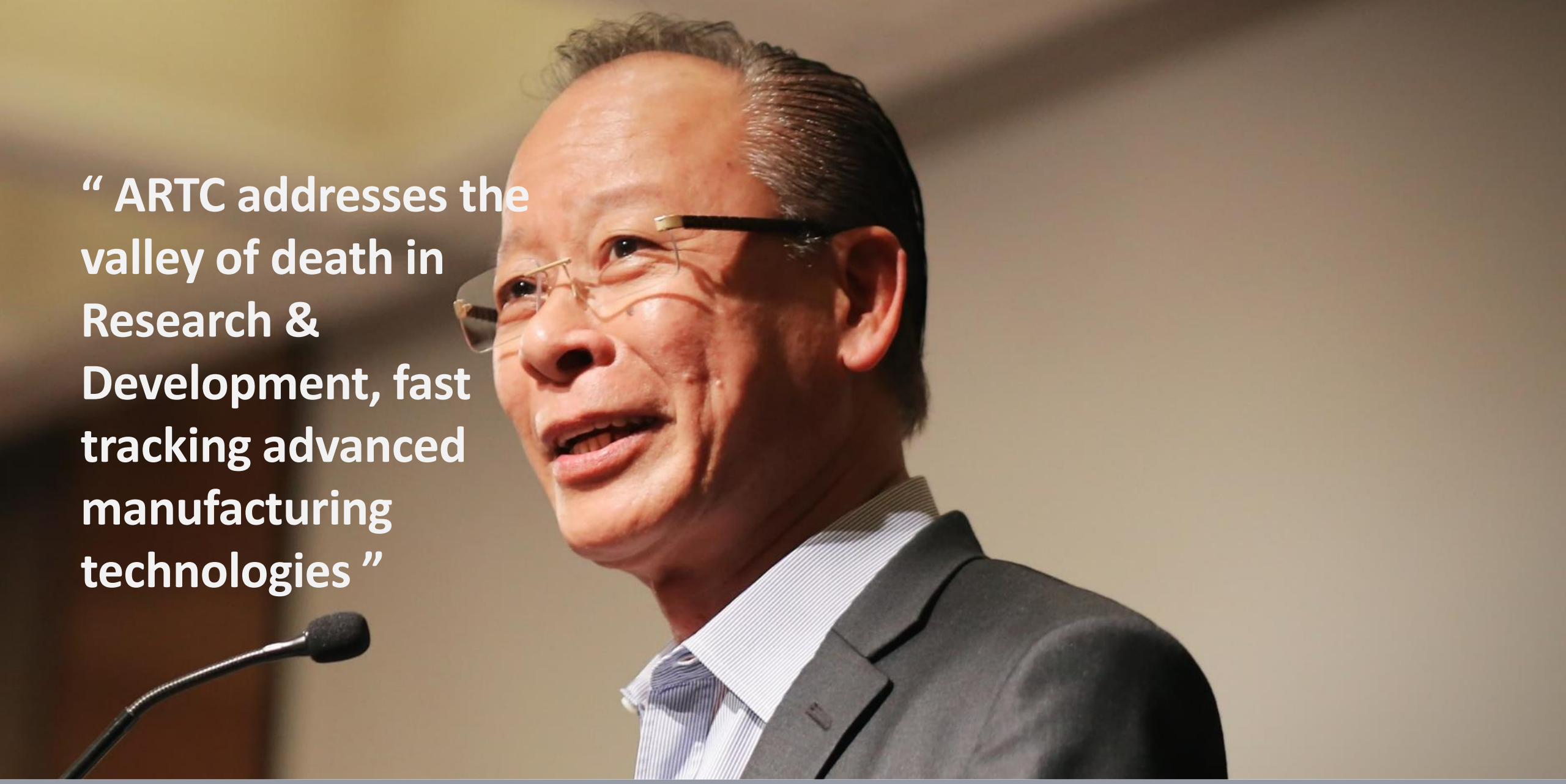
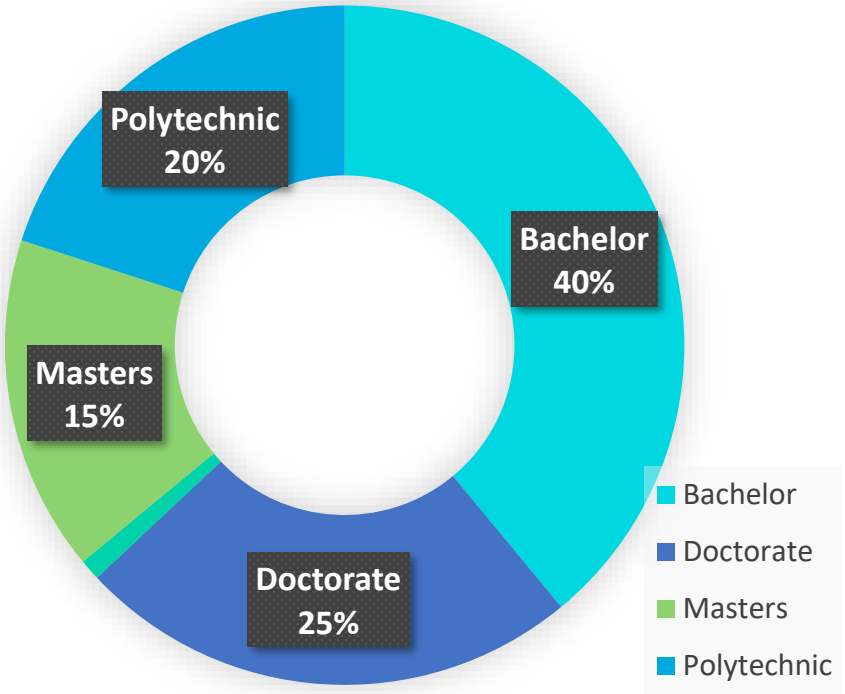


Mr. Peter Tan, Co-Chairman
Advanced Remanufacturing and Technology Centre

Our People

- 211 Core Staff
- 24 Nationalities
- More than 40% from industry
- Age 20 to 79 years old
- 56 interns

Education Profiles



ARTC Management Team : *Dr Wong Chow Cher, Mr Chia Kiang Sum, Mr Christopher Mason, Dr Alastair Johnson, Dr Bertil Brandin, Dr David Low, Mr Nicholas Yeo, Dr Chin Sai Kong, Mr Derrick Lim, Dr Andy Lee and Dr Ong Mei Horng*

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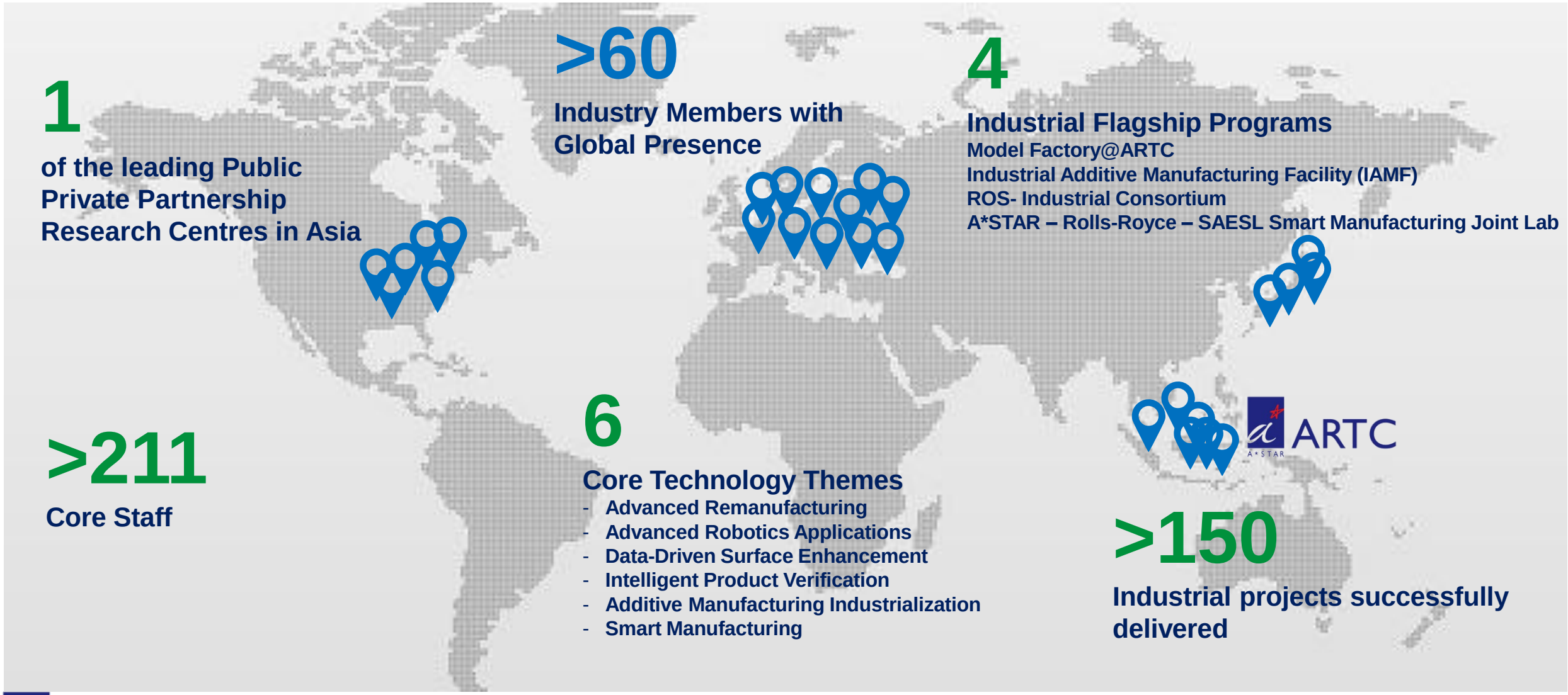
Our Achievements



1

of the leading Public Private Partnership Research Centres in Asia

>60

Industry Members with Global Presence

4

Industrial Flagship Programs

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

>211

Core Staff

6

Core Technology Themes

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

>150

Industrial projects successfully delivered

HQ Locations/ARTC's Members

Bridging the Valley of Death, a historic constraint in Technology Development

Research

TRL 4

- New Discoveries
- Fundamental Research
- Publications

Development

TRL 7

ARTC

Addressing *Valley of Death* in Innovation

- Process Validation & Optimisation
- Conceptualisation of Technologies
- Addressing Industry Core Problems

Production

TRL 9

Industry Companies

- ROI
- Productivity
- Value Creation
- Market Demand

Accelerating Adoption of Technologies

TRL 1 - 3 | TRL 4 - 6 | TRL 7 - 9

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

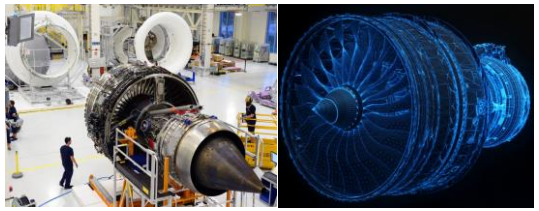
ARTC

Our Member Ecosystem

Industry-led Public-Private Partnership with >60 industry partners

Building Value Chains of End users, Technology providers, Suppliers and System Integrators a cross sectors

4 Tiered Membership for varying levels of benefits

Industry sectors of focus	Aerospace/MRO	Heavy Machineries	Fast Moving Consumer Goods (FMCG)
			

Anchor & Tier 1 members

IHI, Nestlé, Rolls-Royce, Shell, Siemens, SKF, voestalpine, DMG MORI, eos, McKinsey&Company, National Instruments, P&G, SAESL, TYRIDA

Tier 2 members

ABB, Arcstone, Barnes Aerospace, Böhler, Ecoroll, Fujitsu, Hexagon Manufacturing Intelligence, Flexmill, Kennametal, materialise, Microsoft, Nabtesco, Nakanishi, Plasma, Singtel, stresstech, Taylor Hobson, Ametek, Trumpf, TÜV SÜD, UL, Zeiss

Tier 3 members

Accumet Instruments, ACP, Admiralty, Abrasive Engineering, Alphasonics, AmpTec, CREATZ3D, GP, GT, inziGn, JM Vistec System Pte Ltd, JPT Electronics, KA SHIN, Eye2Eye, Laser Cladding Singapore Pte Ltd, M8M, NAKOM-link, Sankei Eagle, SAT Resources Pte Ltd, Spire pte ltd, TruMarine, Wah Son Engineering, vbc, Whits Technologies

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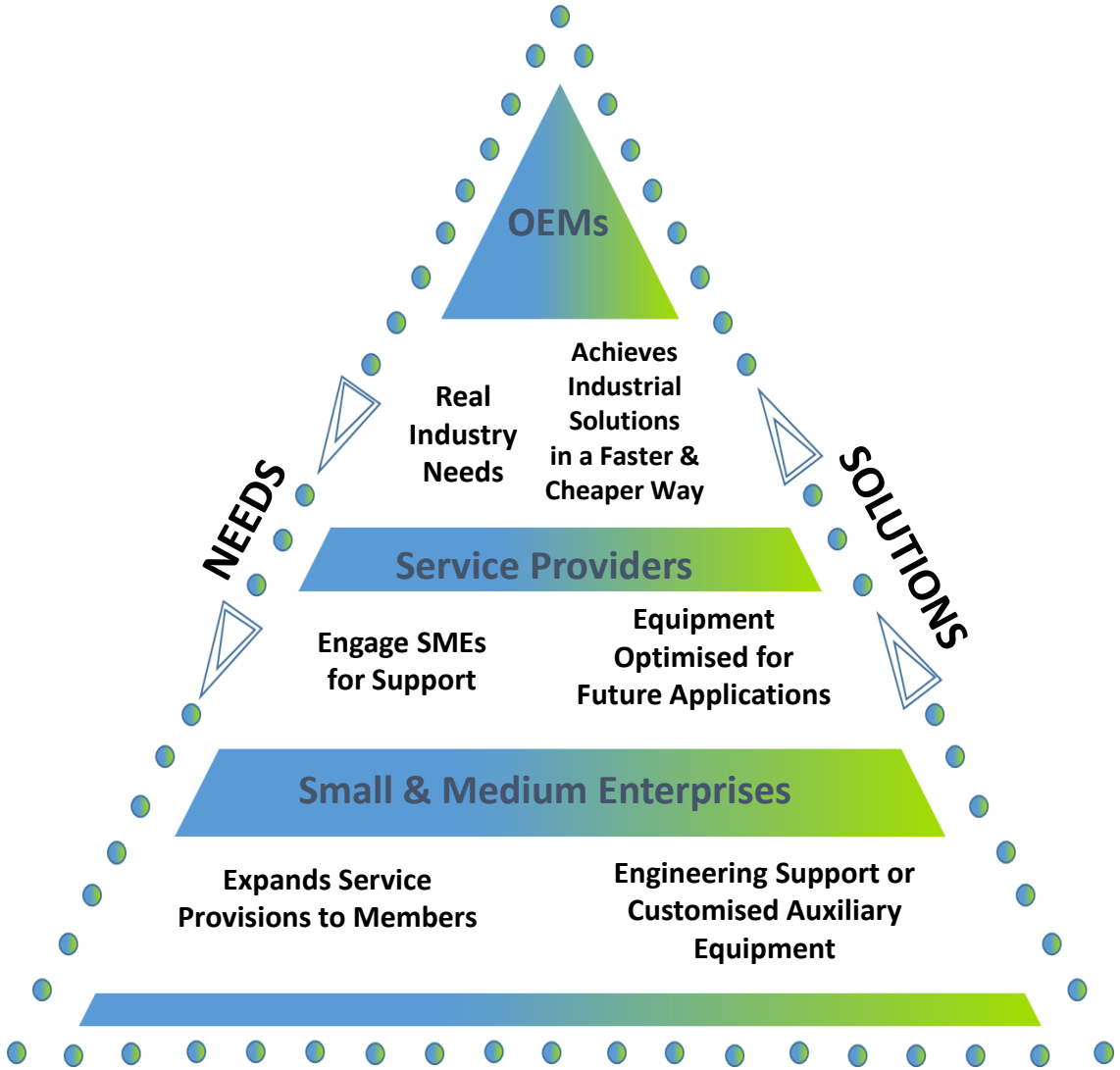
ARTC Model & Value Proposition



1. **Co-create** and **Co-innovate** with end-users and supply chain
2. Beat technology disruptions with **pace, lower cost and risk**
3. Tap on ARTC's **industry experts, world class facilities** and **equipment**
4. Sharing of **best practices and knowledge**
5. Early co-development between end users & supply chain to enable **quicker innovation** and **solutions**

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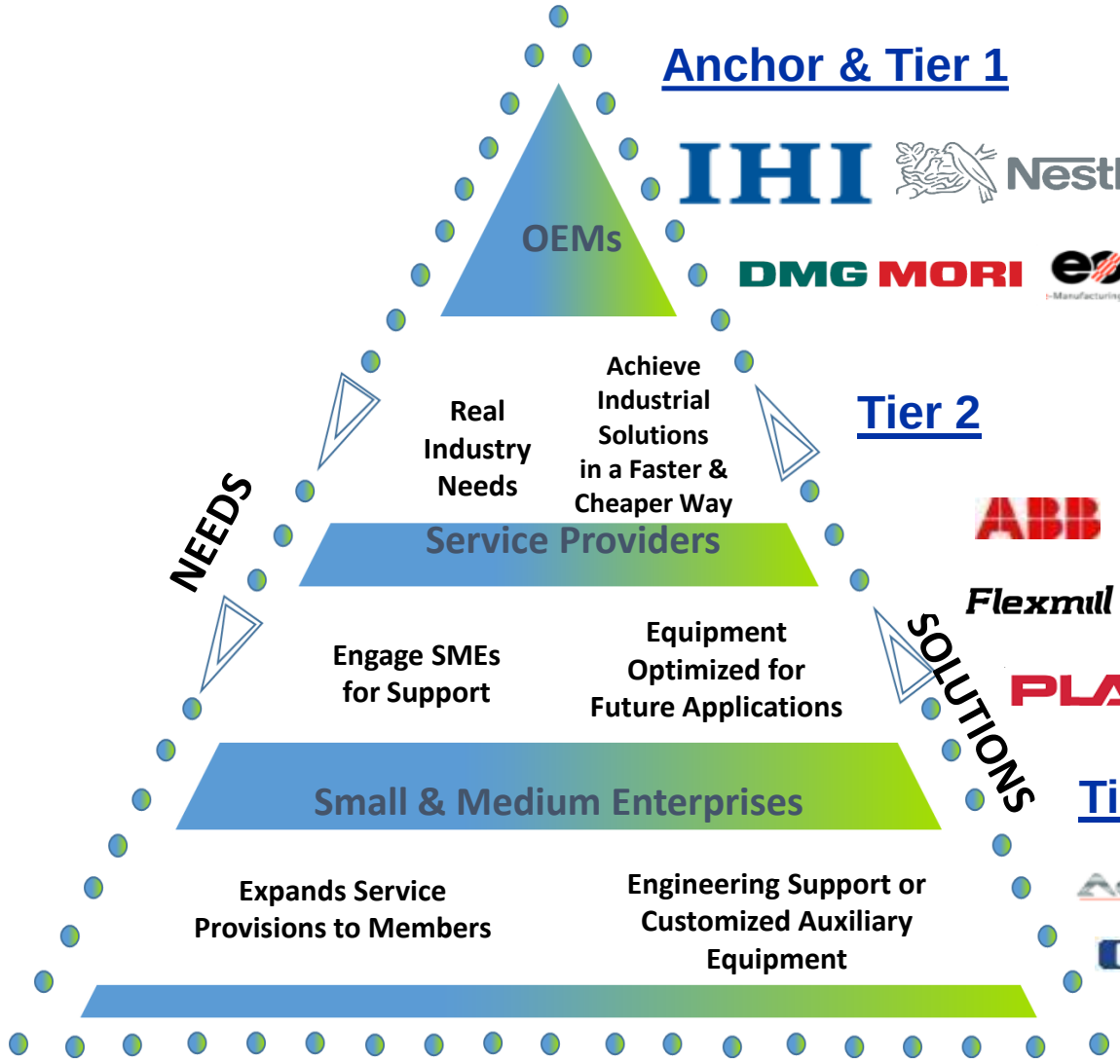
Why Companies Work With ARTC



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Tier 2

ABB, ARCSTONE, Barnes Aerospace, BÖHLER, ECOROLL, FUJITSU, HEXAGON, Flexmill, KENNAMETAL, materialise, Microsoft, Nabtesco, NAKANISHI, PLASMA, Singtel, stresstech, TAYLOR HOBSON, AMETEK, TRUMPF, TÜV SÜD, UL, ZEISS

Tier 3

ACCUMET, ACP, ADMIRALTY, ae Abrasive Engineering, ALPHASONICS, AmpTec, CREATZ, eye2eye, GP, CT, inziGn, JPT Electronics, KA SHIN, LASERCLADDING Singapore Pte Ltd, M8M, NAKOM-link, SANKEI EAGLE, SAT Resources Pte Ltd, Spire pte ltd, TruMarine, vbc, WHITS TECHNOLOGIES 微驰科技

ARTC drives R&D through collaboration

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Our Industry Expertise: Six Technological Groups

Smart Manufacturing and Robotics

Smart Manufacturing

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

Advanced Robotic Applications

- Development of Advanced Robotic Solutions
- Software Development & Integration
- Collaborative Robots
- Optimisation of Robotic Applications

Advanced Manufacturing

Advanced Remanufacturing

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

Additive Manufacturing Industrialisation

- Industrialization of Metal 3D Printing
- Additive Process Development
- Optimizzation of Pre- and Post-Processes
- Material Characterization

Intelligent Product Verification and Surface Enhancement

Intelligent Product Verification

- Complex Geometric & Surface Measurement
- Non-Destructive Testing & Inspection Solutions
- Condition Monitoring & Lifetime Prediction

Data-Driven Surface Enhancement

- Surface Finishing & Preparation
- Robotic Shot Peening
- Alternative Fatigue Enhancement Processes
- Stress & Fatigue Analysis

A*STAR Model Factory @ ARTC Programme

Accelerating the Adoption of Industry 4.0 Technologies

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Industry Revolutions and Disruptive Technologies

Complexity

1st Industry Revolution

Mechanical production through steam power

Late 18th Century

2nd Industry Revolution

Mass production through use of electrical energy

Early 20th Century

3rd Industry Revolution

Further automation of production through IT and electronics

Early 1970s

4th Industry Revolution

Cyber-Physical Systems (CPS) and Digitalization

Present to near future

Revolution

Key Disruptive Technological Drivers

- Advanced Robotics
- Augmented Reality
- Big Data Analytics
- Horizontal & Vertical Digital Integration
- Industrial Internet of Things (IIoT)
- Industrial Additive Manufacturing

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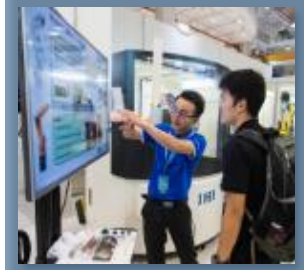
Executive Summary of Model Factory @ ARTC

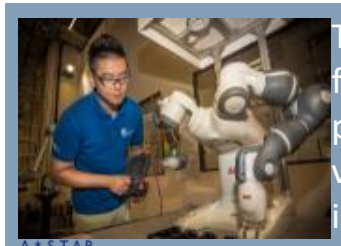
Model Factory @ ARTC, is a **public-private partnership programme** to co-develop a model factory and to collaborate and develop Future of Manufacturing (FoM) technologies, based on **real applications in advanced manufacturing and remanufacturing**



Accelerate adoption of Digital Technologies across key industries in Singapore and create a marketplace for digital technology and applications, with unique reach in Asia and beyond

A*STAR's RIs & IHL

Provide a **training ground** for future engineers and create a digital culture for knowledge management



To jointly develop a **test bed model** on smart factory where heavy equipment industry players (aerospace, marine, machinery) can validate and test new concepts for the next innovation of manufacturing

Technology Partners & Industry Members

Generate potential intellectual property portfolio in Industry 4.0 technologies

Foster industry alignment by Identifying list of immediate outcomes from the development

Regular **sharing of best practices** to facilitate value capture through review of latest learning

Model Factory @ ARTC - Testbeds

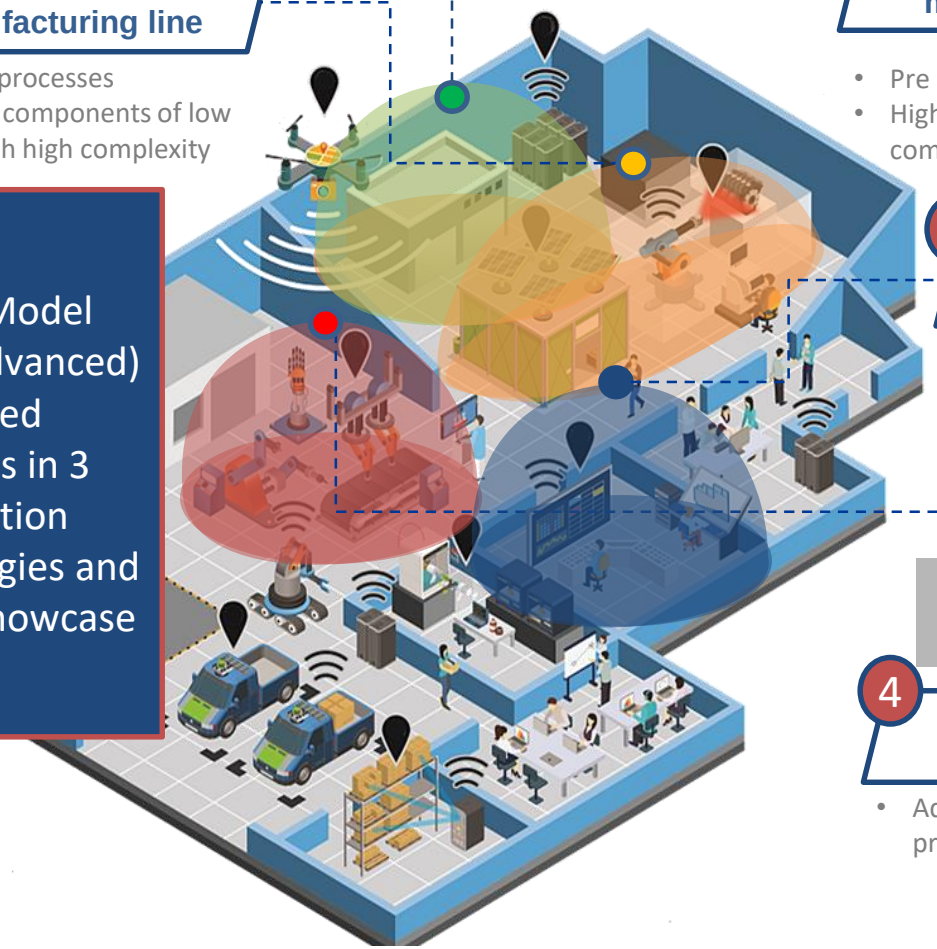
The **24 Project Themes** have been developed based on **relevance** and of **highest priority** to companies across industry sectors

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-I Topics

Phase-II Topics

ARTC's Model Factory (Advanced) Testbed will focus in 3 production methodologies and a Virtual Showcase



Started June 2017

1 **Discrete manufacturing line**

- Focuses in processes addressing components of low volume with high complexity

In Proposal Stage
To start in 2nd Half 2018

2 **Additive manufacturing line**

- Pre and post AM processes
- High mix with high complexity components

3 **Virtual Showcase**

- Digital Factory
- E2E digital thread

Phase 2

In Proposal Stage
To start in 2nd Half 2018

4 **Mini Continuous manufacturing line**

- Addresses high volume products

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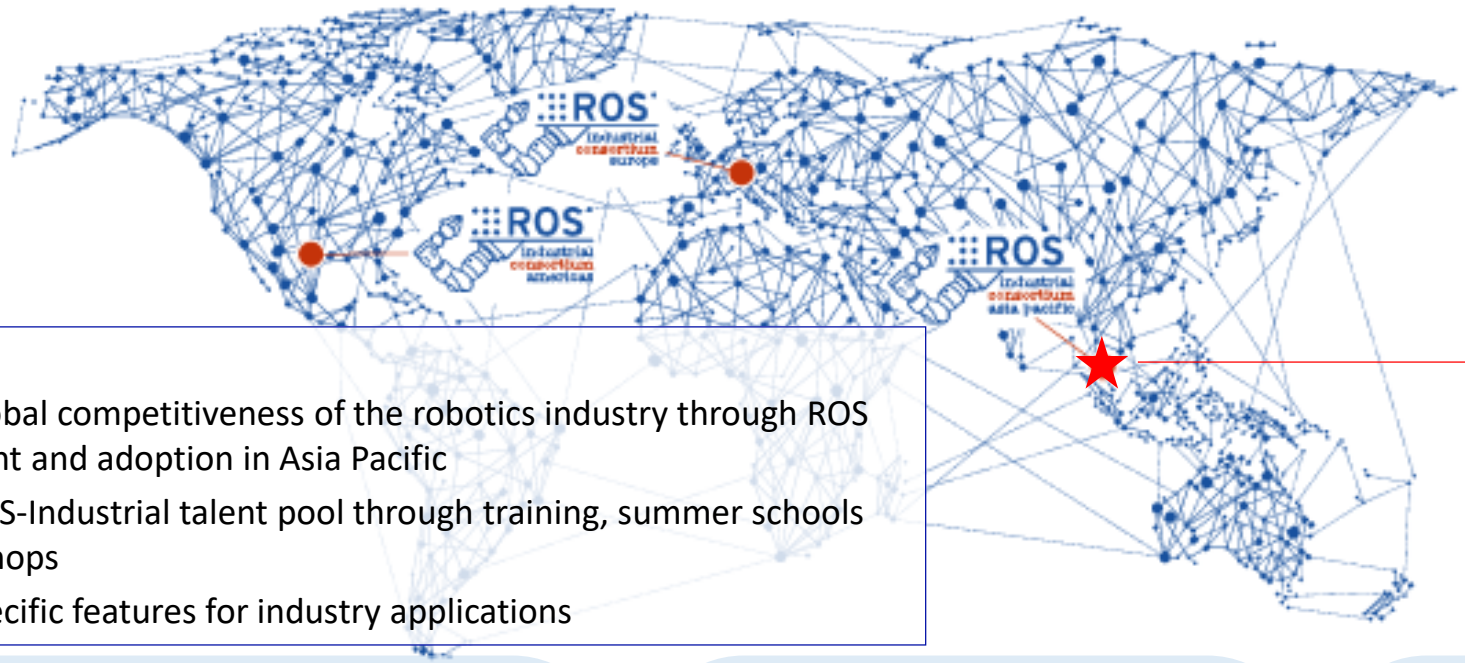
ROS-Industrial Consortium Asia Pacific ★



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

What is ROS-Industrial?

- an *initiative* promoting ***software innovation in industrial manufacturing***
- a software suite becoming an established platform for robotics and automation

Our Purpose ?

- ***Advance*** the ROS-Industrial *software platform*
- ***Promote*** the ROS-Industrial initiative through activities (online meetings, technology and trade events), clarification of non-technical issues (licensing, safety regulations)
- Steer ***robotic software development*** based on companies industrial robotics needs

ROS-Industrial Focus:

- **Leverage** the strengths of Open-Source Software
- Development of **solutions** for SMEs, MNCs and system integrators
- Training & Community Networking

What is the ROS-Industrial Consortium?

- Managed by regional consortiums (Americas, Europe, Asia Pacific)
- Vendor-neutral, managed by non-profit, applied-research institutes

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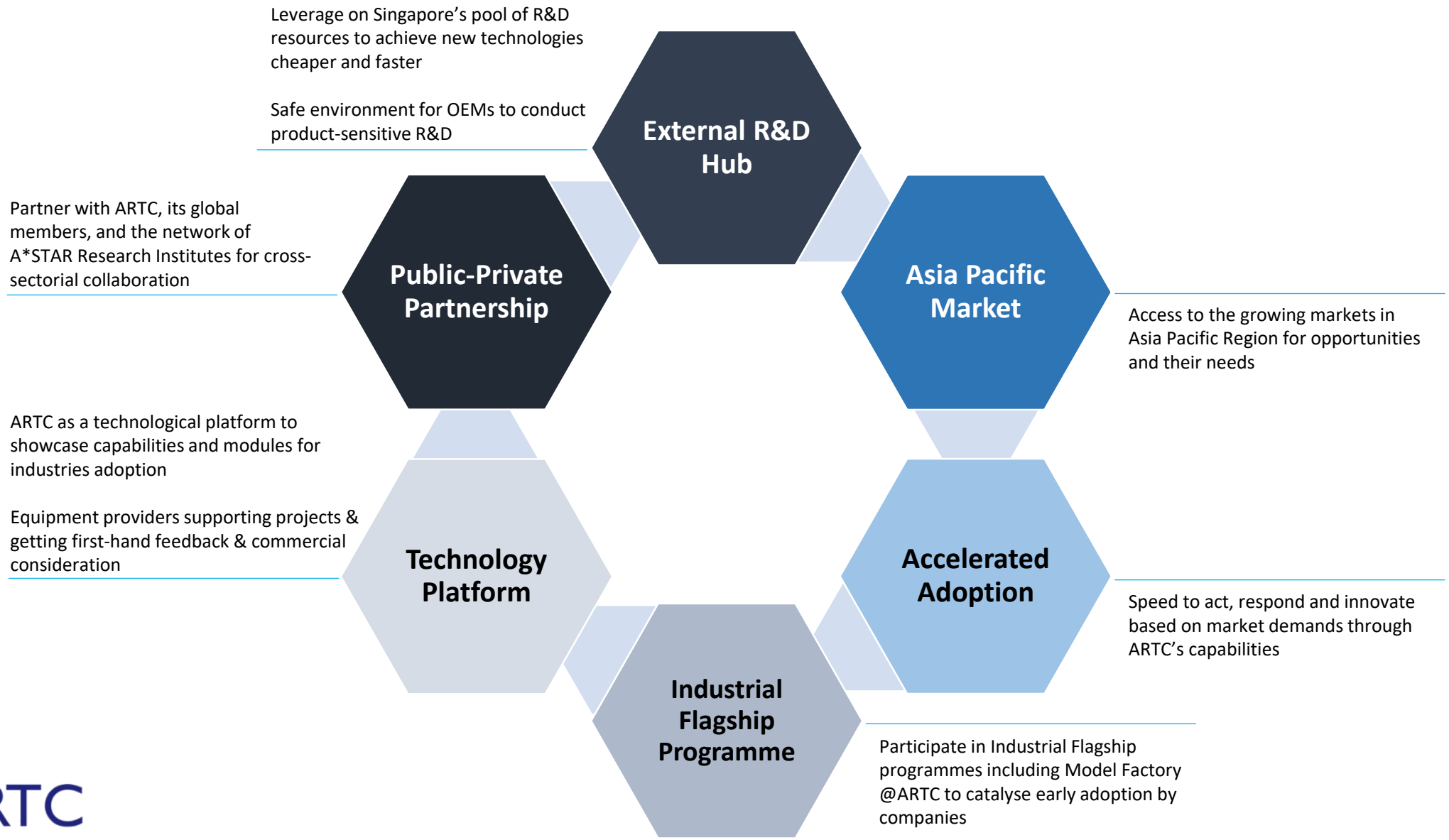
Summary



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THANK YOU

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