Agency for Science, Technology and Research
SINGAPORE

AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH

ANNUAL REPORT
April 2015 – March 2016

Creating Growth, Enhancing Lives

AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH

ANNUAL REPORT FOR THE YEAR ENDED 31 MARCH 2016

In the opinion of the directors, the annual report of the Agency for Science, Technology and Research (A*STAR) is drawn up so as to present fairly the state of affairs of A*STAR as at 31 March 2016.

On behalf of the Board of Directors,

Lim Chuan Poh	Raj. Thampuran
Chairman	Managing Director
19 August 2016	19 August 2016

ORGANISATION DETAILS

Board Secretary	Ms Emily Liew Director Planning & Policy Department Agency for Science, Technology and Research
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Introduction to Agency for Science, Technology and Research (A*STAR)

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

The Agency for Science, Technology and Research (A*STAR) drives mission-oriented research that advances scientific discovery and technological innovation. We play a key role in nurturing and developing talent and leaders for our research institutes, the wider research community, and industry.

Our research creates economic growth and jobs for Singapore. As a Science and Technology organisation, we bridge the gap between academia and industry in terms of research and development. In these endeavours, we seek to integrate the relevant capabilities of our research institutes and collaborate with the wider research community as well as other public sector agencies towards meaningful and impactful outcomes. Together with the other public sector entities, we develop industry sectors by:

- integrating our capabilities to create impact with Multi-National Corporations and Globally Competitive Companies;
- partnering Local Enterprises for productivity and gearing them for growth; and
- nurturing R&D-driven Start-ups by seeding for surprises and shaping for success.

Our research, in addition, also contributes to societal benefits such as improving outcomes in healthcare, urban living, and sustainability. These serve to enhance lives in Singapore and beyond.

Vision: A global leader in science, technology and open innovation

The Agency for Science, Technology and Research (A*STAR) is a catalyst, enabler and convener of significant research initiatives among the research community in Singapore and beyond. Through open innovation, we collaborate with our partners in both the public and private sectors, and bring science and technology to benefit the economy and society.

We aspire to be a global leader in Science, Technology and Open Innovation.

Board Members

Chairman	**Mr Lim Chuan Poh** Chairman, A*STAR
Deputy Chairman	**Professor Tan Chorh Chuan** Deputy Chairman, A*STAR President, National University of Singapore
Members	**Dr Raj. Thampuran** Managing Director, A*STAR
	Professor Sir George Radda Chairman, Biomedical Research Council, A*STAR
	Professor Sir John O'Reilly Chairman, Science and Engineering Research Council, A*STAR
	Dr Sun Shih-Wei Chairman, Sunterprise Ltd
	Mr Bruce Brown Retired Chief Technology Officer, Procter & Gamble
	Dr William Chin Executive Vice President, Scientific and Regulatory Affairs, PhRMA
	Professor Jonathan Knowles Finnish Distinguished Professor, Institute for Molecular Medicine Finland FIMM
	Professor Isaac Ben-Israel Chairman, Israel Space Agency
	Professor Sir Keith O'Nions Chairman, Cambridge Enterprise
	Professor Chong Tow Chong Provost, Singapore University of Technology and Design
	Mr Ong Boon Hwee Chief Executive Officer, Stewardship Asia Centre Pte Ltd
	Professor Bertil Andersson President, Nanyang Technological University
	Mr Yeoh Keat Chuan Managing Director, Singapore Economic Development Board

Mr Lam Yi Young
Deputy Secretary (Policy), Ministry of Education

Ms Tan Li San
Deputy Secretary (Industry & Information), Ministry of Communications and Information

Mr Yee Ping Yi
Deputy Secretary (Policy), Ministry of Finance

Dr Tatsumi Yamazaki
Distinguished Advisor, Chugai Pharmaceutical Co. Ltd
Wef 1 February 2016

Mr Quek Gim Pew
Chief Defence Scientist, Ministry of Defence
Wef 1 August 2016

Two board members stepped down upon completion of their terms or relinquished their ex-officio appointments. We thank them for their invaluable contributions to A*STAR. They were:

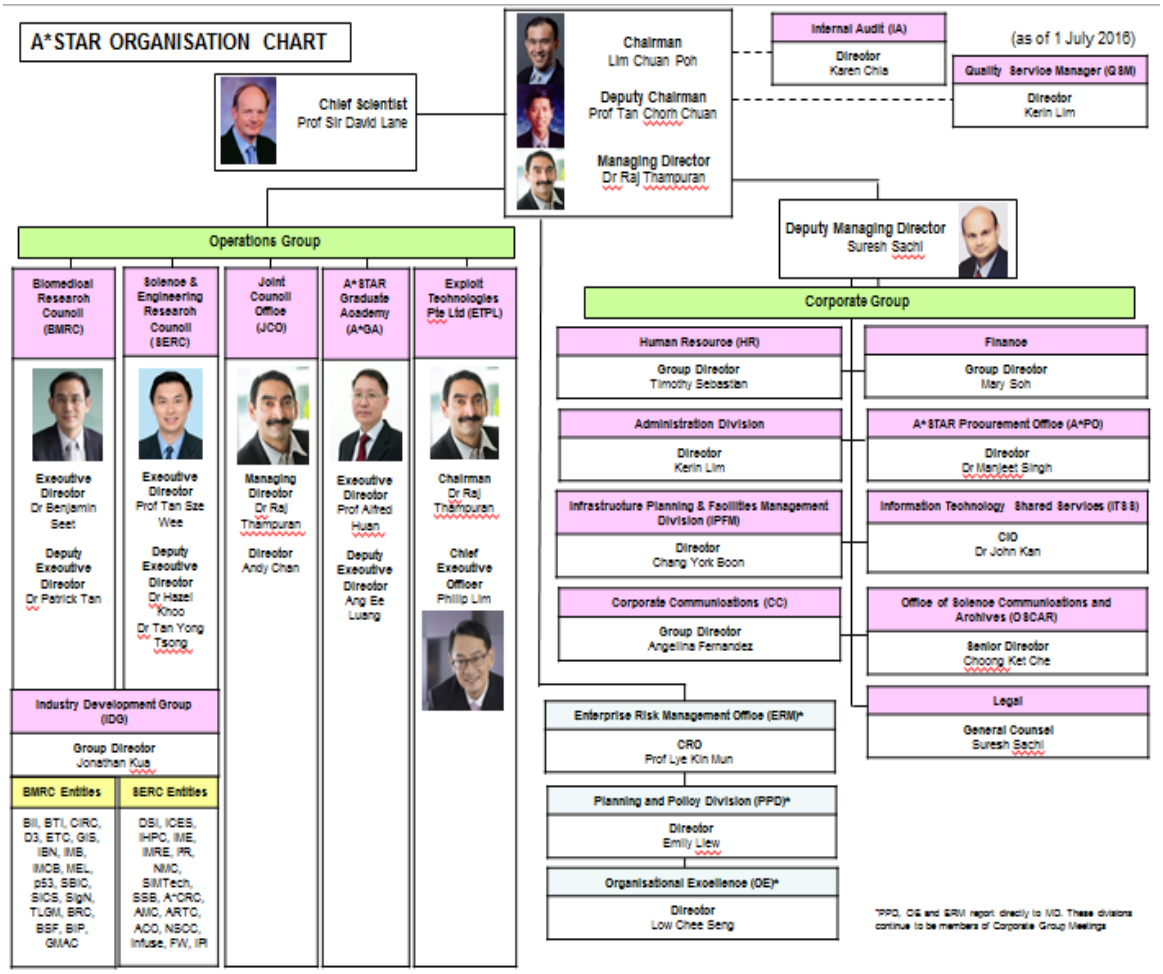
Dr Tadataka Yamada
Venture Partner at Frazier Healthcare
(Stepped down on 31 January 2016)

Prof Quek Tong Boon
Advisor to DSO National Laboratories
Former Chief Defence Scientist, Ministry of Defence
(Stepped down on 31 July 2016)

Key Management Personnel

Chairman, A*STAR	Mr Lim Chuan Poh
Deputy Chairman, A*STAR	Prof Tan Chorh Chuan
Managing Director, A*STAR	Dr Raj. Thampuran
Scientific Advisor to A*STAR Chairman	Dr Sydney Brenner
Chairman, Biomedical Research Council (BMRC)	Prof Sir George Radda
Chairman, Science and Engineering Research Council (SERC)	Prof Sir John O'Reilly
Chief Scientist, A*STAR	Prof Sir David Lane
Deputy Managing Director (Corporate & Legal), A*STAR and General-Counsel	Mr Suresh Sachi
Executive Director, Biomedical Research Council, A*STAR	Dr Benjamin Seet
Executive Director, Science and Engineering Research Council, A*STAR	Prof Tan Sze Wee
Chief Executive, Exploit Technologies Pte Ltd (ETPL), A*STAR	Mr Philip Lim
Executive Director, A*STAR Graduate Academy, A*STAR	Prof Alfred Huan

A*STAR Organisation Chart



Updated as at 1 July 2016

Major Shareholder of Subsidiary Companies

Name of subsidiary company:	Exploit Technologies Pte Ltd
% shareholdings in company:	100%

Exploit Technologies Pte Ltd (ETPL)

ETPL is the technology transfer arm of the Agency for Science, Technology and Research (A*STAR), Singapore's lead agency for fostering world-class scientific research and talent. A*STAR oversees 18 biomedical sciences, physical sciences and engineering research institutes and consortia. As a one-stop resource, ETPL supports A*STAR in the arenas of IP management, licensing and entrepreneurship.

For more information, please visit http://etpl.sg

A*STAR Research Institutes and Consortia

A*STAR has 18 research institutes and consortia, spanning a broad range of research areas from the biomedical sciences, to the physical sciences and engineering.

Biomedical Research Institutes and Consortia
Bioinformatics Institute (BII)
Bioprocessing Technology Institute (BTI)
Experimental Therapeutics Centre – Drug Development and Discovery (ETC-D3)
Genome Institute of Singapore (GIS)
Institute of Bioengineering and Nanotechnology (IBN)
Institute of Medical Biology (IMB)
Institute of Molecular and Cell Biology (IMCB)
Singapore Bioimaging Consortium – Clinical Imaging Research Centre (SBIC-CIRC)
Singapore Institute for Clinical Sciences (SICS)
Singapore Immunology Network (SIgN)

Science and Engineering Research Institutes and Consortia
Data Storage Institute (DSI)
Institute of Chemical and Engineering Sciences (ICES)
Institute of High Performance Computing (IHPC)
Institute for Infocomm Research (I^2R)
Institute of Materials Research and Engineering (IMRE)
Institute of Microelectronics (IME)
National Metrology Centre (NMC)
Singapore Institute of Manufacturing Technology (SIMTech)

A*STAR Community

The total strength of the A*STAR community, including scientists and researchers, technical and non-technical staff, and industry development and commercialisation staff, was 5,400 as at 31 March 2016.

Our Achievements in FY2015

More SMEs, start-ups adopting technologies offered by A*STAR

Investment in R&D has paid off: PM Lee

Government committed to investing in biomedical R&D: DPM Teo

PM Lee: Fusionopolis Two to bring manufacturing to next level

尚达曼：在人力资源有限情况下
应运用科技提供高效医疗护理

Biomedical sciences' next frontier, here at home

Potential cancer drug a 'Singapore baby': Don

Internet of Things technology helps firm save money, time

An optimist's view of technology

Cities power the way into new epoch

Rise in investments into collaborative R&D efforts

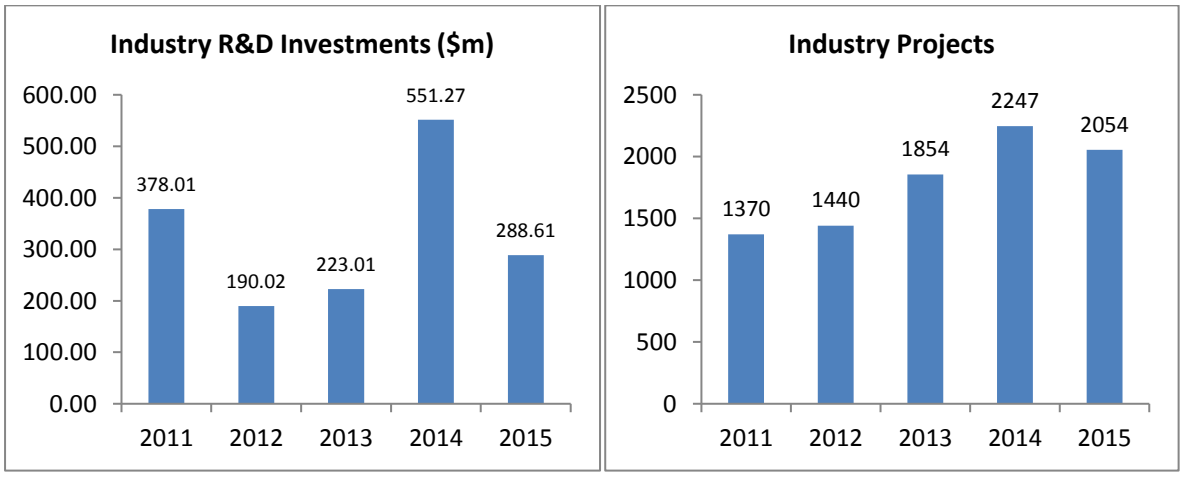
Brave new (bioengineered) world

Spurring cross-disciplinary innovation

As an open economy with significant domestic resource constraints, Singapore has always prioritised Research, Innovation, and Enterprise (RIE) as a key driver of its economic success. Singapore's RIE ecosystem has matured significantly over the years, with both the public and private sector investing heavily in R&D to build competitive organisations. Singapore's Business Expenditure on R&D (BERD) reached an all-time high of S$5.2 billion in FY2014, a 16 percent increase over FY2013. Growing investments in R&D have also continued to spur the creation of high-value jobs. The number of Research, Scientists and Engineers (RSE) jobs has increased from 19,000 in 2004 to 33,000 in 2014, with 70 percent of these jobs currently held by locals.

Globally, Singapore continues to be recognized as a leader in RIE. In INSEAD's 2015 Global Innovation Index (GII), Singapore once again came in first in the South East Asia and Oceania region, and maintained its seventh position in the overall rankings. Singapore also moved up two ranks to be named the world's sixth most innovative economy in the Bloomberg Innovation Index 2016, ahead of countries like Finland and the United States. In turn, A*STAR has also been recognised as a key player driving RIE in Singapore, ranking third in the category of "Government Agencies" in the IEEE Spectrum's 2015 US Patent Power rankings, rising three positions from sixth in 2014, and coming in ninth in the 2015 Thomson Reuters' Top 25 Global Innovators (Government) Survey, above Max Planck and RIKEN.

Throughout FY2015, A*STAR continued to attract and deepen many partnerships with MNCs, such as Applied Materials, Coca-Cola, Delta Electronics, Fujitsu, GE Healthcare, Global Foundries, GlaxoSmithKline, Micron, Nestle, P&G and Roche. Despite challenging global economic conditions, A*STAR worked on over 2,000 industry projects in FY2015.

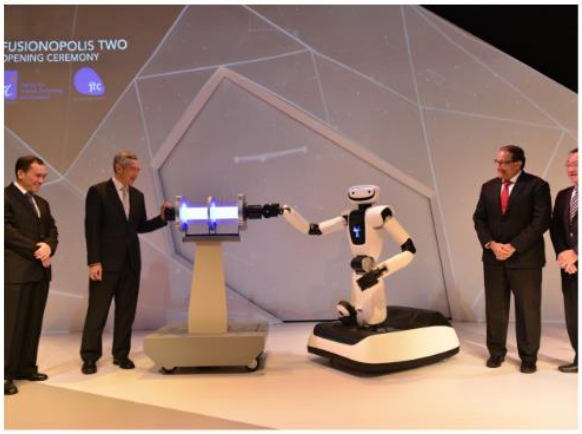


In FY2015, several A*STAR scientists received international recognition for their groundbreaking work. Prof Jackie Ying (IBN), Dr Khor Chiea Chuen (GIS), and Dr Nicolas Plachta (IMCB), among others, won prestigious international scientific awards. Dr Patrick Tan (GIS) won the President's Science Award 2015 for his

research in Asian cancer genomics. Dr Liu Jianjun (GIS) was named one of Thomson Reuters' 2015 Most Influential Scientific Minds, for his research in the fields of molecular biology and genetics. Dr Benjamin Tee (IMRE) was one of MIT Technology Review's Global "35 Innovators Under 35" last year. Researcher Peh Ruey Feng was a TR35 finalist in 2015 for the development of a device to improve hemodialysis treatment at End Stage Renal Disease (ESRD), produced through his start-up company, Advent Access Pte Ltd.

As our contribution to the celebrations marking Singapore's 50th anniversary, A*STAR, together with our public sector partners, embarked on Science@50 to commemorate the role that science, technology, and innovation have played in Singapore's development. Some of the events held as part of Science@50 included the inaugural Singapore Scientific Conference, the International Science Competition, the Science Jubilee Open House, and the Innovati50n mobile exhibition.

FY2015 was an especially significant year for A*STAR, with the opening of Fusionopolis Two (F2) by Prime Minister Lee Hsien Loong in October. With the opening of F2, almost all of A*STAR's research institutes have come together in the twin campuses of Fusionopolis and Biopolis. F2 also represents A*STAR's ongoing commitment to boost private-public sector collaborations, integrate research capabilities, and spur cross-disciplinary innovation and activity to further economic growth and improve lives.



Industry Engagement

As Singapore's leading Science and Technology organisation, A*STAR continued to bridge the gap between academia and industry in FY2015. Three key strategies have underpinned A*STAR's approach to industry engagement over the past year. First, A*STAR continued to anchor the presence of MNCs, facilitating the creation of good jobs, and high value investments to Singapore. Next, A*STAR remained focused on growing, and strengthening, local enterprises with the aim of helping them stay globally competitive. Finally, A*STAR played a significant role in the formation of several key industry consortia, further driving collaboration and innovation in key sectors such as high-value manufacturing.

Anchoring MNCs through R&D

In FY2015, A*STAR continued to anchor the presence of MNCs in Singapore through the forging of strategic partnerships and collaborations. These have significantly strengthened key industries that remain important to Singapore's economy, such as Electronics, Manufacturing, and Pharmbio.

Driving Advanced Manufacturing and Engineering

In October 2015, Applied Materials announced the opening of a new joint R&D laboratory with A*STAR. The five-year agreement included the opening of a S$150 million lab that will be located at Fusionopolis Two. The lab's research will focus primarily on developing advanced semiconductor technologies for use in future generations of logic and memory chips, found in smartphones and laptops. The collaboration with A*STAR marked the second time that Applied Materials has chosen to conduct product development and commercialisation activities outside its Santa Clara headquarters in the US.

Drug Development to Combat Infectious Disease

Visterra Inc., a clinical-stage biotechnology company based in Cambridge, MA, announced a collaboration with A*STAR's Drug Discovery & Development unit (D3) in May 2015, targeted at furthering the development of VIS513, a broadly neutralizing antibody for treating dengue fever. VIS513 was engineered using

Visterra's proprietary technology platform, and was designed to neutralise all four serotypes of the dengue virus. As part of the collaboration, D3 and Visterra are working together with infectious disease experts at Duke-NUS Graduate Medical School to generate the additional data needed to initiate clinical trials of VIS513 in Singapore.

Enhancing Digital Connectivity

Buoyed by the success of the first phase of the Baidu-I²R Centre (BIRC) in 2012, Baidu continued its alliance with the Institute for Infocomm Research (I²R) in 2015 through a joint laboratory agreement, extending the research scope to previously unexplored territories, such as natural language processing, human language technology, and robotics.

Raising Innovation Capacity of Local Enterprises

A*STAR recognises that Singapore's future rests on positioning local companies for greater growth. In FY2015, A*STAR intensified its efforts to engage with local enterprises, helping them upgrade their technological capabilities, improve their innovation capacity, and ultimately increase their productivity levels, with the eventual aim of giving local companies the competitive edge to become global industry leaders in their respective domains.

Innovations for the Financial Sector

Building on A*STAR and DBS's existing collaboration, a first-of-its-kind partnership was formed between DBS, National University of Singapore (NUS), and A*STAR's I²R to support the growing demand for specialised analytics talent across the region. In the three-year partnership, NUS Master's students will work on real banking challenges with data analytics experts from I²R, and professionals at DBS, at the DBS-I²R laboratory. The lab was established to allow DBS to leverage I²R's capabilities in developing new and innovative products and services for the local financial sector.

Enhancing Sports Performance

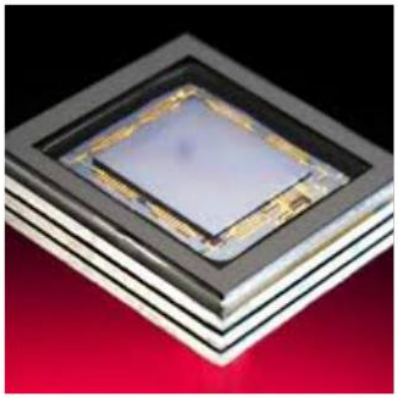
9 Degrees Freedom is a spinoff that licensed I²R's gap-funded sports analytic technology to develop QLIPP, a tennis performance sensor. In December 2015, QLIPP received certification from the Federal Communications Commission (FCC) and Bluetooth®, validating that it is not only safe to use, but will also deliver a

seamless user experience. The device achieved close to 90% of its crowdfunding target in two weeks, and at the close of 2015, had generated funding of over US$80,000, almost triple its initial target of US$30,000, through the sale of more than 1,000 units.

Safer Alternatives in Prenatal Diagnostics

In June 2015, A*STAR's Institute of Microelectronics (IME) announced that it was collaborating with local healthcare diagnostics company, INEX Innovations Exchange, in the development of non-invasive prenatal diagnosis (NIPD) technology. This technology can provide more genetic information about unborn babies to enable early diagnosis of aneuploidy[1], hence providing a safer diagnostic alternative to conventional methods which carry the risk of miscarriage. INEX is in the midst of setting up a NIPD facility in Singapore. Currently, the Southeast Asian market remains largely untapped, and by partnering with IME, INEX plans to become a dominant player in the growing prenatal diagnostics market in this region.

Creating Value through Industry Consortia




Over the past year, A*STAR has facilitated the creation of several industrial consortia, targeted at driving R&D and improving industry capabilities in new types of high-value manufacturing. These consortia group industry and research partners with similar technology needs together, enabling the mutual sharing of resources and expertise, while catalysing and accelerating the adoption of emerging technologies amongst the members of the consortia.

Electronics Manufacturing

In November 2015, IME launched six consortia with a total of 42 industry members, all targeted at developing and expanding electronics manufacturing technologies and capabilities. One of these was the Micro-Electro-Mechanical Systems (MEMS) Consortium III, launched with nine industry partners, including LG Electronics and Applied Materials. This consortium seeks to develop industrial grade sensors that can address market needs, for wide applications in various industries such as the automotive and indoor navigation industries.

[1] Aneuploidy is the presence of an abnormal number of chromosomes in a cell, e.g. the presence of 45 or 47 chromosomes when 46 is expected in a human cell.

Chemicals Manufacturing

The Innovative Processing for Specialties and Pharmaceuticals (iPSP) consortium, led by the Institute of Chemical and Engineering Sciences (ICES), added a new member to its ranks in 2015, MSD International GmbH (Singapore Branch), one of the top five leading pharmaceutical companies in the world. This consortium brings together various players from the pharmaceutical and specialty chemicals industries, to address the need for greater industry access to emerging next-generation manufacturing technologies. These technologies can potentially provide quantum improvements in cost, quality, environmental impact, and process robustness in high value chemicals manufacturing processes. Other iPSP members include pharmaceutical players Pfizer, Glaxo Smith-Kline (GSK) and Siemens, technology leaders such as Hellma Analytics, Mettler Toledo and Novozymes, and leading academic institutions NUS and Newcastle University International Singapore (NUIS).

Food Packaging Manufacturing

The Institute of Materials Research and Engineering (IMRE) has launched a two-year project entitled “Active Barrier Packaging” under the “Industrial Coating and Packaging Consortium” (ICAP II). The 5 companies participating in ICAP II are Mitsui Chemicals Asia Pacific, Ltd, Toyo Ink SC Holdings Co., Ltd, Dou Yee Enterprises (S) Ptd Ltd, Dai Nippon Printing Co., Ltd, and Piaget Chemicals & Manufacturing Ptd Ltd. The new active packaging is intended for the food packaging market, and will not only protect perishables, but can also be coupled to other IMRE technologies such as a sensor to accurately indicate the freshness of the packaged meat, fish or poultry.

Commercialisation Activities – Bringing R&D to the Market

In FY2015, A*STAR continued to achieve more commercialisation outcomes in terms of licensing and spin-offs. A*STAR's small and medium enterprise (SME) friendly licensing framework continued to facilitate easy access to A*STAR's IP assets. Local spin-offs generated and incubated by A*STAR in FY2015 also have good growth prospects in Singapore and beyond, having demonstrated successful market validation for their products and services.

High Value Spin-Offs

More Effective Disease Detection

Formed in 2015, One BioMed is a spinoff from A*STAR's IME that develops in-vitro diagnostic platforms to address global health needs for decentralised, point-of-care (POC) diagnostic testing. The company's first flagship product was an integrated diagnostic device that can quickly detect infectious diseases based on a unique silicon biophotonic technology platform. In addition to working with Tan Tock Seng Hospital clinical collaborators to develop a prototype device for diagnosing tuberculosis, One BioMed is also collaborating with A*STAR's Institute of Molecular and Cell Biology (IMCB), NUS and Nanyang Technological University (NTU) to develop POC diagnostic systems for bladder cancer biomarker detection.

Cosmetics Product Development

Vesiderm Pte. Ltd. is an A*STAR spin-off founded by Dr Lim Sai Kiang in June 2015. Vesiderm recently licensed the Institute of Medical Biology (IMB)'s liposome technology to develop, manufacture and sell liposomes for cosmetic use. The company is currently negotiating with other international cosmetics brands to commercialise the product.

Treating Renal Disease

Advent Access is an A*STAR spin-off that focuses on creating a device to improve hemodialysis treatment at End Stage Renal Disease (ESRD). While hemodialysis is the main choice of treatment for ESRD – a rapidly growing and financially crippling chronic disease – a major culprit of costly hemodialysis treatment and poor outcomes is vascular access and complications. Named av-Guardian, the device enables patients to draw blood safely, affordably and independently. Advent Access

is founded by researcher Peh Ruey Feng, whose work in this area earned him a spot as a TR35 finalist in 2015.

Technology Licensing for New Products & Services

Improving Quality Control

Wavelength Opto-Electronic (S) Pte Ltd., a 10-year-old local SME in the laser and image optics market, licensed the Singapore Institute of Manufacturing Technology (SIMTech)'s Vacuum Laser Calorimetry system in 2015 to expand its product and service offerings. Such systems are specialised for highly precise absorption coefficient measurement of CO2 laser optics, a means of quality control for laser optic manufacturers. Since the calorimeter was implemented in production lines, the company's annual sales have increased by more than 20%

Broadening Revenue Streams

A local RFID solution provider, Tunity Technologies Pte Ltd, licensed SIMTech's software packages in 2015 for RFID-based item management and inventory tracking. This technology complements its existing license of another of SIMTech's technologies for the capture of RFID-triggered events. Tunity will further develop the software packages into a cloud-based solution platform to target the retail and logistics verticals. With an expanded portfolio of RFID-based solutions, Tunity will be able to broaden its revenue streams from both existing and new clients.

Enhancing Business Effectiveness and Developing New Products

A*STAR's engagement with Wangi Industrial Pte Ltd first started through the OMNI Programme, a joint effort between WDA and A*STAR's SIMTech to help SMEs in the manufacturing and service sectors enhance business efficiency and effectiveness. Through this programme, SIMTech helped Wangi to reduce manhours by 42% and material wastage by 47%. A*STAR's Nanoimprint Foundry and Wangi also worked on a successful two-year collaboration project. The Foundry helped Wangi develop a hard anti-scratch, anti-reflective glass panel incorporating imprinted nanostructures with improvements of up to 98.4% transmission on glass. This glass can be used in consumer products, industrial goods and also in the aerospace sector.

Making a Difference for Singapore through Public-Public Partnerships

Aside from its economic mission, A*STAR continues to uphold its commitment to engage in R&D that can ultimately make a difference to the lives of ordinary Singaporeans. In FY2015, A*STAR embarked on various partnerships and projects with government agencies and other public sector organisations that promise significant societal benefits in the long-run.

Singapore's First Cancer Drug Candidate

Singapore's first publicly-funded drug candidate, ETC-159, advanced into Phase 1 clinical trials in July 2015. This drug targets a number of cancers, including colorectal, ovarian and pancreatic cancers, which contribute to a significant proportion of Singapore's cancer burden. ETC-159 was discovered and developed through a collaboration between A*STAR's Experimental Therapeutics Centre (ETC) and D3, and Duke-NUS Graduate Medical School.

Improving Maritime Technologies

In the face of increasingly complex challenges, A*STAR and MPA collaborated in maritime R&D to enhance the competitive edge of Singapore's ports and its operations. MPA will leverage the capabilities of all research institutes under A*STAR's Science and Engineering Research Council (SERC) to promote multidisciplinary R&D projects in maritime technologies between the Government, academia, and industry. The work will cover R&D in areas such as communications technologies (satellite, terrestrial, and wireless modes of communication) robotics, environment technology, and modelling, simulation and visualization technologies.

Collaborating for New Cancer Therapies

The National Cancer Centre Singapore (NCCS) entered into a partnership with A*STAR's IMCB in August 2015 with the aim of developing new cancer therapies. In total, eight principal investigators from both institutes are involved in the collaboration. This collaboration seeks to leverage on NCCS' clinical expertise and IMCB's capabilities in human biology and oncology research.

Realisation of Singapore's Car-lite Vision

A*STAR and Land Transport Authority (LTA) jointly worked on the Singapore Autonomous Vehicle Initiative (SAVI) to explore the feasibility of having autonomous vehicles (AVs), such as driverless buses, for a mass transport service that operates on fixed routes and scheduled timings. By marrying the joint capabilities of both organisations, the team took only nine months to bring its AV from developmental stages to public trials at one-north. This achievement opens up the possibilities of a new mobility system for intra-town travel in future residential developments, using a network of customised and demand-responsive shared vehicles, and also brings Singapore close to realising its Smart Nation and car-lite vision.

Recognition and Awards

With five winning entries, A*STAR was the biggest winner for the third consecutive year at the IES Prestigious Engineering Achievement Awards 2015. The IES Prestigious Engineering Awards is an annual award presented by the Institution of Engineers Singapore (IES) that recognises outstanding engineering achievements.

A*STAR also strengthened its international profile in international surveys, for example, coming in fifth in the 2015 World Intellectual Property Organization (WIPO) Patent Cooperation Treaty (PCT) Top 30 Government and Research Institutions.

A*STAR's scientists also brought international recognition to A*STAR by winning several prestigious international and local scientific awards in FY2015:

International Awards

Prof Jackie Ying

Prof Ying, Executive Director of the Institute of Bioengineering and Nanotechnology (IBN), won the inaugural Mustafa Prize "Top Scientific Achievement" Award for her outstanding achievements in the work of nanostructured materials and systems, nanostructured biomaterials and miniaturised biosystems for various applications. The Mustafa Prize recognises leading researchers of the Organisation of Islamic Cooperation (OIC) member states, as well as Muslim research from around the world. The OIC is the second largest inter-governmental organization in the world after the United Nations.

Dr David Townsend

Dr David W. Townsend, Director of the A*STAR-NUS Clinical Imaging Research Centre (CIRC), was awarded the prestigious Paul C. Aebersold Award 2015 by the Society of Nuclear Medicine and Molecular Imaging (SNMMI). The award recognises outstanding achievements in basic science applied to nuclear medicine, and was first presented in 1973. Dr Townsend began his work on PET instrumentation development in the early eighties; designing and building the first rotating partial ring PET scanner using block detectors. Dr Townsend's contributions to 3D PET imaging have been invaluable in improving the signal-to-noise of reconstructed PET images

without increasing the amount of detector material, which to a large extent determines cost. As a result, the impact on the overall cost-effectiveness of PET as a clinical tool has been substantial.

Dr Benjamin Tee

Dr Benjamin Tee, an A*STAR Scholar and also a Singapore-Stanford Biodesign (SSB) Fellow, was the only Singaporean named in MIT Technology Review's Global "35 Innovators Under 35" list in 2015. He was lauded for his research on electronic skin sensors that could potentially make prosthetic limbs as sensitive as human ones. This annual list highlights young people whose work can potentially change the world. Notably, previous honourees include Google founders Larry Page and Sergey Brin.

Dr Khor Chiea Chuen & Dr Nicolas Plachta

Two A*STAR scientists clinched the esteemed 2015 EMBO Young Investigator Award: Dr Khor Chiea Chuen, Group Leader at the Genome Institute of Singapore (GIS) and one of the first few recipients of A*STAR's NSS (MBBS-PhD) scholarships; and Dr Nicolas Plachta, Senior Principal Investigator at IMCB. They are two of only five award winners outside Europe, alongside 21 other winners worldwide. This award recognises young, promising researchers under 40 who have established their first labs in Europe or in EMBO cooperation countries over the past four years.

Dr Liu Jianjun

Dr Liu Jianjun, Deputy Director and Senior Group Leader at GIS, was the only scientist from Singapore to be named in the fields of molecular biology and genetics as one of Thomson Reuters' 2015 Most Influential Scientific Minds. Dr. Liu's main research interest is to understand the genetic basis of human disease susceptibility and inheritance. Focusing mainly on complex disease phenotypes, his lab pursues collaborative research to discover genetic variants that influence disease susceptibility, progression and treatment outcomes, by employing both hypothesis-driven and hypothesis-free strategies for genetic analysis.

Singapore Awards

Dr Patrick Tan

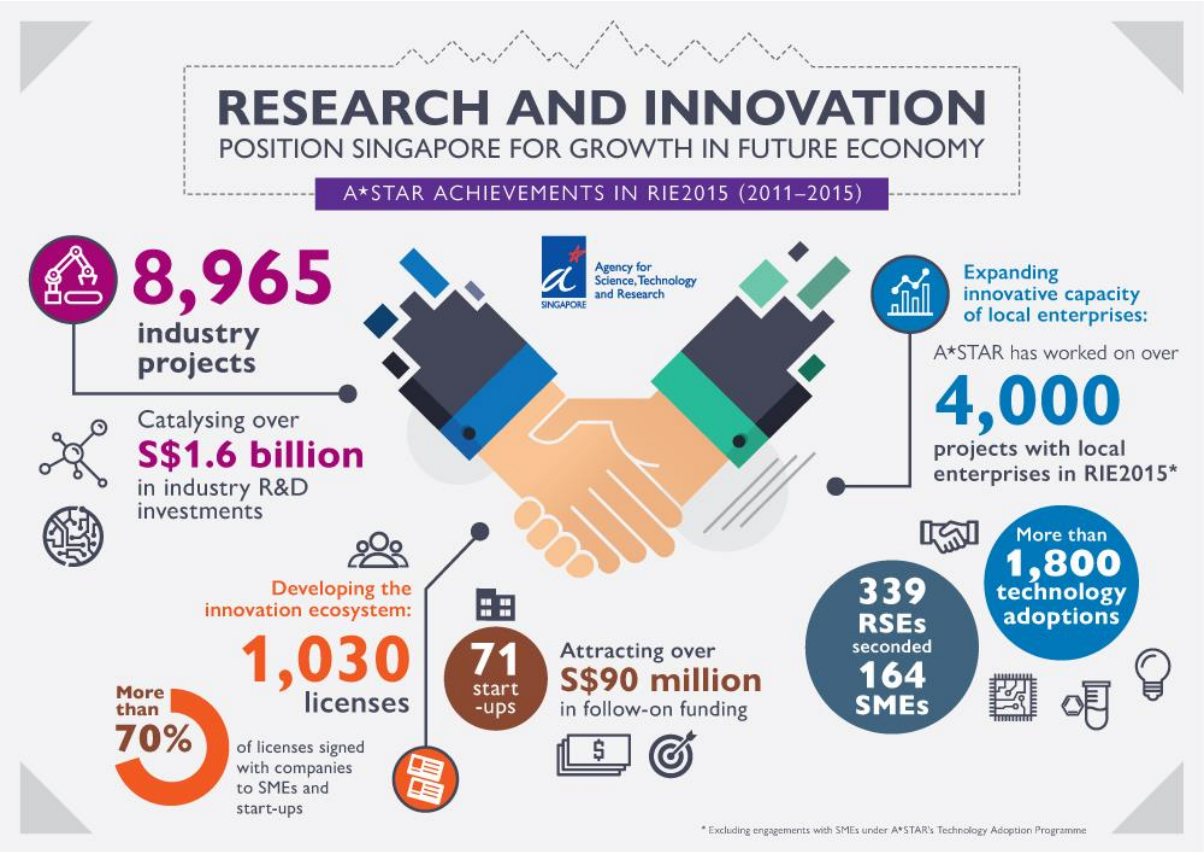
Dr Patrick Tan, Senior Group Leader, GIS, was awarded the President's Science Award 2015 for his research in Asian cancer genomics. The President's Science Award is one of the President's Science and Technology Awards given out in recognition of significant achievements in science and technology in Singapore.

Dr Yvonne Tay & Dr Wan Yue

A*STAR scholars Dr Yvonne Tay (AGS (NUS) recipient) and Dr Wan Yue (NSS (BS-PhD) recipient and GIS Fellow) were amongst four awardees to receive the Young Scientist Award on 16 September 2015. The Award, presented by Mr S. Iswaran,

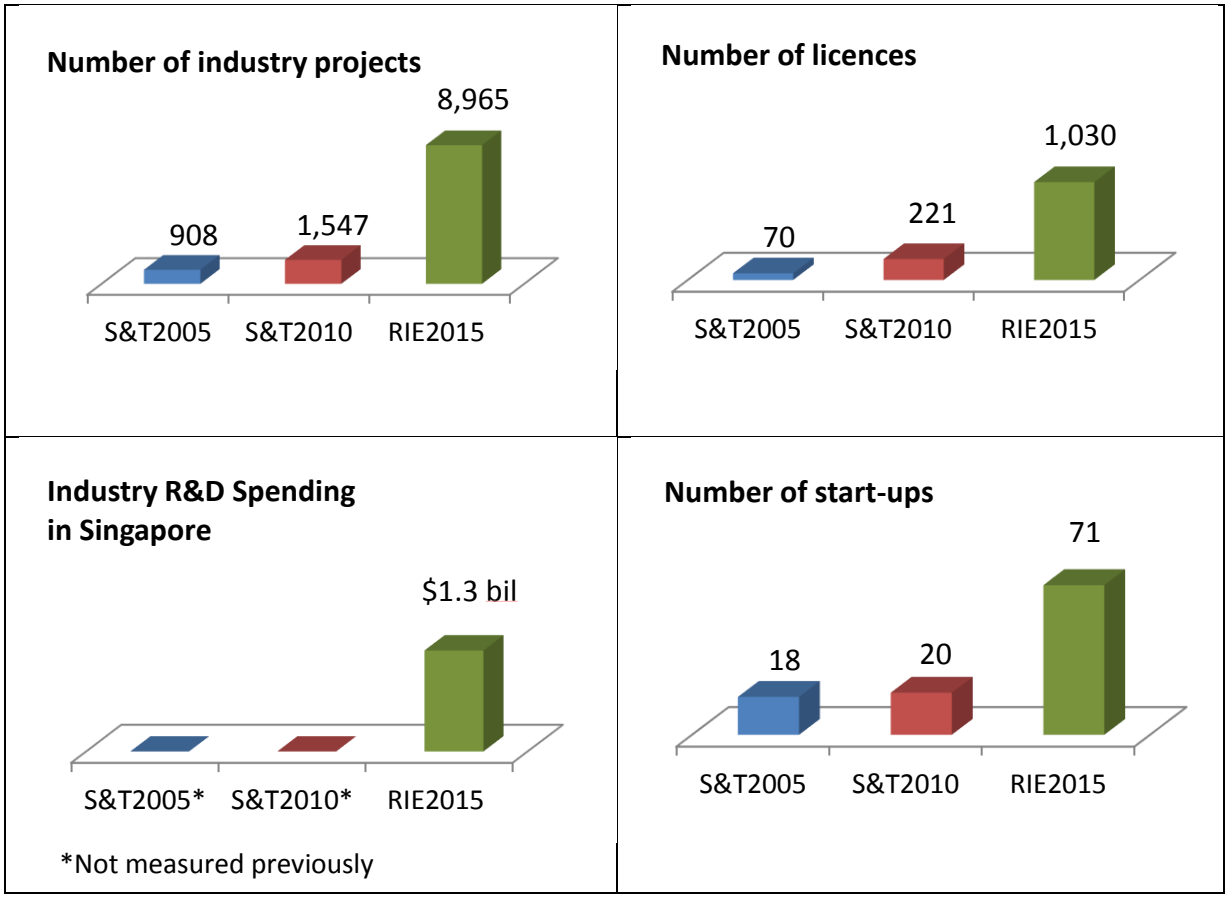
then-Minister, Prime Minister’s Office and Second Minister for Home Affairs and Trade & Industry, recognises young researchers aged 35 and below, who are actively engaged in R&D in Singapore, and who have shown great potential to be world-class researchers in their fields of expertise.

RIE2015 Achievements



2015 marked the end of RIE 2015 (2011-2015). Across tranches, A*STAR significantly exceeded previous targets. Overall, A*STAR undertook 9,000 industry projects, almost six times more than the previous tranche, and catalysed more than S$1.63 billion in industry R&D investments.

2015 also coincided with a slowdown in global economic growth. Despite this, A*STAR did well, surpassing targets in partnering with companies and delivering innovative technologies, driving innovation, and seeding start-ups for value creation. These resulted in the creation of new clusters such as food and nutrition, and good jobs, enhancing Singapore's reputation as a knowledge-based country.



55% of A*STAR's industry projects in RIE2015 were with MNCs. These span the Chemicals & Materials, Electronics, Engineering, Infocomms & Media, Biologics, Food & Nutrition, Personal Care, Pharmaceuticals, and Medtech industries. More importantly, by forming partnerships across Singapore's RIE ecosystem, A*STAR has been key to supporting the growth of industry sectors that are critical to Singapore's economy, and in seeding new growth areas that will contribute to Singapore's continued economic prosperity.

One such new area is the Food and Nutrition cluster. A*STAR's efforts to capitalise on this growing market has resulted in the emergence of a new innovation cluster, with MNCs expanding their R&D and manufacturing facilities here, creating opportunities for companies along the value chain. BERD for Food and Nutrition increased from S$49.2m in 2009 to S$217.8m in 2014. A*STAR also worked closely with public agencies to advance food product innovation, raised the competitiveness of local enterprises, and strengthened Singapore's position as the major food and ingredients R&D and supply chain hub in Asia.

In RIE 2015, A*STAR intensified its efforts to help SMEs upgrade their capability, productivity and competitiveness through technology transfer and adoption. To date, more than 1,800 technology adoptions have taken place through the Technology Adoption Programme (TAP), which was launched in 2013, benefiting some 1,100 local enterprises. Our simplified licensing model eliminated the complexity of

intellectual property rights agreements, making it easy for SMEs to adopt new technologies and attain productivity gains. Another 200 SMEs also benefited from the Growing Enterprises for Technology Upgrade (GET-Up) Programme, which aims to boost the global competitiveness of local SMEs by seconding A*STAR researchers to assist them with technology roadmapping.

71 start-ups were established in RIE2015. These starts-ups attracted more than S$90 million in follow-on funding, and one-third of these already have revenue-generating products.

A*STAR's efforts in R&D also improves lives in Singapore and beyond. Our first publicly-funded drug candidate, ETC-159, entered first-in-man clinical trials, paving the way for advancements in cancer therapeutics. We have also partnered other government agencies to address needs at the national level, such as working with LTA to develop driverless cars.

A strong Singaporean talent base is important to sustain a country's R&D efforts over the long term. Since A*STAR's inception, we have built a pipeline of over 1,400 Singaporean PhD and postdoctoral talents through a variety of scholarships and fellowships. As of 2014, there were over 9,500 PhD-qualified RSEs in Singapore in both the public and private sectors, of which about 60% were Singaporean Citizens and PRs. A*STAR scholarships and fellowships are awarded to the most promising and committed young talent, and the pool of A*STAR scholars entering our eco-system will significantly enrich and add to the intellectual richness of Singapore's R&D landscape.


A stellar showing by science and tech agency

A*Star has not only helped SMEs stay competitive but also got start-ups running

A*Star surpasses 5-year targets; industry R&D spend exceeds S$1.6b

Agency is involved in 8,965 industry projects – against a target of 1,726 – and has 1,030 licensing agreements over the period

Singapore R&D landscape

A*Star achievements in RIE*2015 (2011-2015)

8,965 industry projects

1,030 licences

Expanding innovative capacity of local enterprises:

Collaborations with Industry

Computing and Information Technology

Over the past five years, A*STAR's research institutes have worked closely with Fujitsu, one of the world's top providers of information technology equipment and services. In 2012, A*STAR's Data Storage Institute (DSI) signed an RCA with Fujitsu Limited to jointly research hybrid drive storage systems involving the use of hybrid hard disk drives (HDD) in an enterprise-grade disk storage system.

On 15 October 2014, Fujitsu, A*STAR and Singapore Management University (SMU) announced the establishment of an Urban Computing and Engineering Centre of Excellence in Singapore. This represents a combined effort to use high performance computing methods to develop solutions for sustainable urban operations, such as crowd mobility and transport engineering, with researchers using Singapore as a living lab to simulate a new generation of solutions to real urban issues.

In 2015, IME and Fujitsu, through Sumitomo Corporation Kyushu, collaborated on the development of through-silicon via (TSV) of bonded device wafer for logic and memory computing applications. This collaboration leveraged IME's capabilities in through-silicon via–last for 3D integrated circuits heterogeneous integration.

Healthcare and Pharmaceuticals

A*STAR and Chugai have enjoyed a close collaborative relationship over the past five years. In 2012, Chugai established a second R&D facility in Singapore where a 60-man R&D unit worked on antibody engineering. Chugai deepened this partnership in 2015 by expanding its presence here, and pledging to invest S$476m in total by 2021 into the Chugai Pharmabody Research Pte Ltd (CPR) in Biopolis.

A*STAR and GE Healthcare also announced the establishment of a joint fund to co-develop the next generation of medical technologies, in areas such as patient monitoring, computed tomography, and magnetic resonance imaging. The five-year Master Research Collaboration Agreement (MRCA) was signed on 8 December 2014.

Aerospace

A*STAR's Aerospace Programme supports Singapore's vision to be a leading aviation hub through its activities in innovative research and development, with the aim of driving innovation critical to the development of Singapore's aerospace industry. Pre-competitive research carried out through the consortium built Singapore's mindshare with leading aerospace original equipment manufacturers (OEM) and enhanced Singapore's standing as a global aviation hub. Consequently, this has strengthened Singapore's value proposition for aerospace engineering, manufacturing, and MRO (Maintenance, Repair and Overhaul) activities. Launched in 2007 with four founding members, the A*STAR Aerospace Consortium now has 15 members, with Airbus coming on board in 2014. The consortium includes the leading airframe, engines & component OEMS, specialist materials companies, as well as leading MRO service providers. The two largest local enterprises in the aerospace industry, SIA Engineering Company and ST Aerospace, are also members of the consortium. To date, the A*STAR Aerospace Programme has undertaken more than 100 multi-disciplinary projects.

Advanced Materials

The nanoimprint foundry, led by IMRE, was launched in 2013, and aims to bridge the gap between lab-based nanotechnologies and real-world products. The foundry brings together nanotechnology suppliers and manufacturers including Toshiba Machines Co Ltd, EV Group, NTT Advanced Technology Corporation, NIL Technology ApS, Kyodo International Inc., micro resist technology GmbH, Nanoveu Pte Ltd, and Solves Innovative Technology Pte Ltd, to speed up productisation of nanoimprinting, which imbues ordinary surfaces with unique properties for sectors like consumer care, biomedical devices, optics, filtration, displays and maritime.

New Growth Areas – Food and Nutrition, Consumer Care, Developmental Health, Future of Manufacturing

Food and Nutrition

In the burgeoning area of Food and Nutrition, Nestlé S.A. has undertaken a three-year Framework Research Agreement with A*STAR as of 22 January 2014. This umbrella agreement allows all of A*STAR's research institutes to collaborate with Nestlé's affiliates globally. Nestlé further strengthened its presence in Singapore with the opening of the Nestlé Food Science and Nutrition (NFSN) Hub at Proteos, Biopolis, on 3 December 2014. The hub is part of Nestlé's open innovation efforts to facilitate research project collaborations with A*STAR, complementing its 120-FTE R&D Centre in Jurong.

Three leading players in the Food and Nutrition sector also opened R&D facilities in Singapore recently — Abbott Nutrition, DSM Nutritional Products and Fuji Oil Asia. In 2014, together with the National University Health System, the Clinical Nutrition Research Centre (CNRC) was opened to undertake research across the food industry value chain. The new centre is the first in Asia to house both research and clinical capabilities under one roof. Capabilities range from the early exploratory science of foods to understanding the nutritional impact of developed food products. CNRC conducts studies in research areas such as nutrition in women, children and the elderly, and body weight control, to understand the causes of metabolic diseases such as diabetes and obesity. These studies will aid in the development of products, and the formulation of diets that can reduce the risks of these diseases. In addition, such research promotes public education of how to enhance one's nutrition in food systems, promoting a change in eating habits, which will have an impact on health outcomes.

Consumer Care

In consumer care, P&G and A*STAR have forged a strategic partnership, evident in the numerous collaborative tie-ups over the past five years. Since the signing of the first MRCA in September 2010, A*STAR and P&G have jointly worked on more than 16 project collaborations. In 2014, Deputy Prime Minister Tharman Shanmugaratnam officially opened the Singapore Innovation Centre (SgIC). The largest private research facility in Singapore, this S$250m centre employs 500 people, and houses research for hair, skin, home care, personal health, and grooming products. Expanding on the earlier MRCA, P&G also signed a new S$60m agreement with A*STAR. This collaboration will span five years of partnerships with Singapore's network of research institutes, medical institutions and institutes of higher learning, and will combine P&G's insights in consumer behaviour with A*STAR's state-of-the-art knowledge in multi-disciplinary sciences.

Developmental Health

A*STAR's Singapore Institute for Clinical Sciences (SICS), KK Women's and Children's Hospital (KKH), the National University Health System (NUHS) and the National University of Singapore (NUS), embarked on Growing Up in Singapore Towards healthy Outcomes (GUSTO), Singapore's largest and most comprehensive birth cohort study. Supported by the National Research Foundation (NRF) under its Translational and Clinical Research (TCR) Flagship Programme, this study tracks over 1,000 pregnant women and their offspring till age 9 to deliver critical findings on developmental health. Outcomes of the study aim to address national needs to reduce the healthcare burden caused by diseases such as diabetes and obesity, which are prevalent in Singapore.

Future of Manufacturing

As a key pillar of Singapore's economy, manufacturing accounted for nearly 20% of nominal GDP in 2015. Yet, the nature of manufacturing is changing and the government is investing in advanced manufacturing technologies to ensure that the sector is well positioned for the future.

Alongside additive manufacturing and robotics, remanufacturing has emerged as a key technological platform in recent years, In January 2015, A*STAR formally launched the Advanced Remanufacturing and Technology Centre (ARTC), a public-private collaboration between A*STAR, NTU and industry partners. ARTC is Asia's first centre for test-bedding and developing remanufacturing, and seeks to bridge technological gaps in the adoption of advanced remanufacturing processes. The centre currently has 38 member companies consisting of industry leaders and SMEs. It provides a platform for providers and companies along the supply chain, for example, equipment makers and materials suppliers, to work with users who set technical demands.

A major player in Singapore's aerospace industry, Rolls Royce accounts for over 15% of the country's aerospace output and plays an active role in this partnership. ARTC has been working with Rolls-Royce to jointly develop a suite of manufacturing and repair capabilities for Aerospace, Land and Sea products and components.

ARTC is also working with IHI Corporation, a comprehensive engineering company providing solutions for both land and sea, in developing manufacturing processes for high productivity machining and precision finishing technologies of both machinery and aerospace components.

Working with Local Enterprises to Enhance Competitiveness through Technology Adoption



A*STAR's Growing Enterprises with Technology Upgrade (GET-Up) programme leverages on the technical capabilities of A*STAR's research institutes to upgrade SMEs, through the secondment of our researchers, provision of technical advisory services, and support in technology roadmapping.

As of 31 March 2016, a total of 535 companies have benefitted from the GET-Up Programme, with 636 of A*STAR's RSEs seconded to 347 companies since the launch of the T-Up Scheme in 2003.

One company which has benefited from the GET-Up Programme is Trilogy Technologies Pte Ltd. With the assistance of a T-Up secondee from I²R, Trilogy Technologies built up its in-house capabilities in mobile applications and wireless devices using Bluetooth Low Energy and RFID. In addition, Trilogy also successfully developed a shopping cart that provides for an enhanced interactive consumer shopping experience. Using a proximity sensor, the tablet mounted on the shopping cart automatically plays the promotional video clip associated with a nearby promotional item, while a RFID sensor at the shopping cart keeps a record of all the items placed inside the cart. The information collected by the shopping cart can then be analysed by FMCG manufacturers to glean insights into consumer behaviour. Trilogy has developed and sold a demo unit of the shopping cart to a MNC in the FMCG industry.

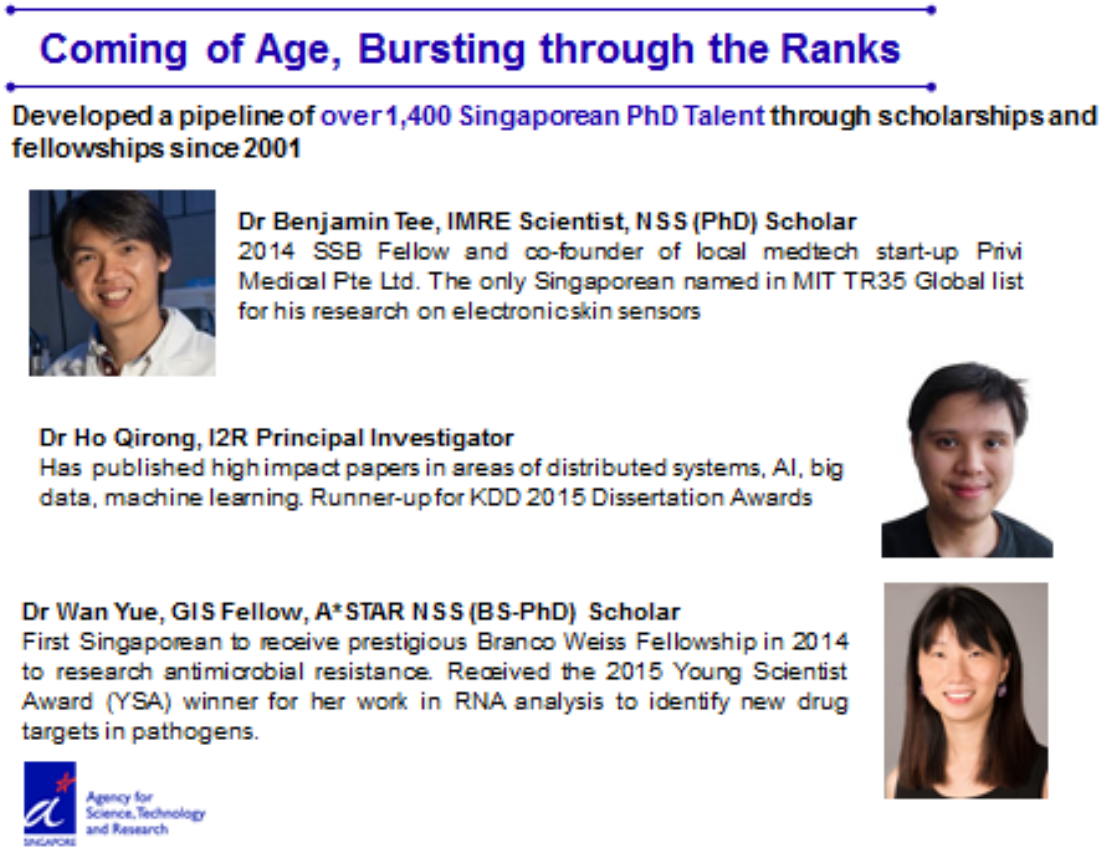
Since 2013, A*STAR has also been spearheading the S$51 million Technology Adoption Programme (TAP) to provide platform technology solutions to SMEs, so as to help them boost their productivity and move up the value chain. TAP introduces a team of experienced intermediaries from A*STAR's research institutes, SPRING's SME Centres, as well as Productivity Centres and Centres of Innovation, to link companies up with solution providers from the public and private sectors. As of 31 March 2016, 1,170 companies have achieved 1,877 adoptions of new technologies that have gone a long way in improving their productivity.

FOSTA is one such company that has benefited through TAP. FOSTA is a high tech fiber optic sensing instrumentation and monitoring company in the building and

construction industry. The company monitors noise and vibration levels at construction sites to ensure that they remain within safety limits. Previously, workers had to manually retrieve data at the construction site, and return to their office to generate reports. This posed a potential safety hazard when the noise and vibration levels exceed safety limits, as data collected was not timely enough to generate the required alerts. In 2013, FOSTA approached A*STAR to develop a solution for capturing data readings for vibration and noise levels on-site. Through TAP, I^2R developed an IoT-based monitoring system which facilitates machine-to-machine communications over the Internet, and allows for real-time, remote access to on-site information. With this system, workers are no longer required to be physically on-site, and timely reporting is achieved through the automated collection of data. In 2015, FOSTA achieved manpower savings of nearly 90% and reduced processing time by 50% across its 40 worksites.

Creating a Global Nexus for Scientific Talent

Undergirding Singapore's research and innovation efforts is a pool of scientific talent. A*STAR has been instrumental in creating a vibrant, dynamic and cosmopolitan R&D ecosystem in Singapore, with an overall talent strategy focused on developing a strong core of Singaporean scientists, complemented by a rich diversity of international researchers. In RIE 2015, A*STAR awarded 469 scholarships and fellowships to develop a pipeline of Singaporean PhD/postdoctoral talent, and attracted 341 international PhD students through its international awards.



A*STAR also hosted various eminent scientists during RIE 2015 through its Visiting Investigatorship Programme. This programme aims to advance research and innovation at A*STAR by leveraging on the expertise of world renowned experts to develop local capabilities, and groom local talent, in key strategic areas. Some key VIs include Nobel Laureate Professor Thomas C. Südhof from Stanford University, a leading authority in the field of neurological disorders; Professor Tomaso Poggio from Massachusetts Institute of Technology, one of the pioneers of computational neuroscience; Professor Gregory Vardine from Harvard University, whose research specialties lie in the emerging areas of chemical biology and peptide therapeutics; Professor Zhao Huimin from University of Illinois at Urbana-Champaign, one of the world's foremost experts on the development and applications of synthetic biology tools to address societal challenges; and Nobel-prize winning stem-cell researcher Dr Shinya Yamanaka, who specialises in iPS Cell Research and regenerative medicine.

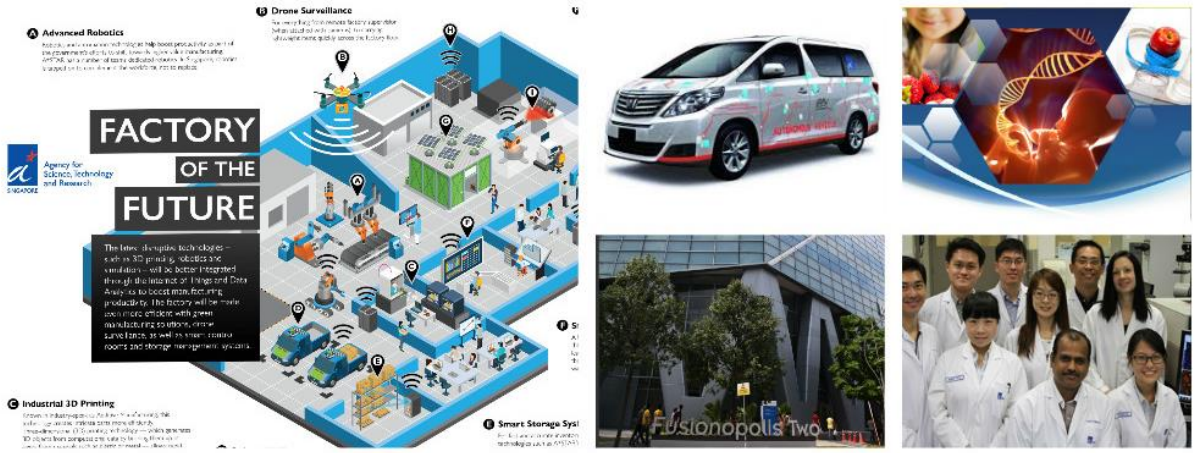
A*STAR's Achievements in RIE 2015

A*STAR has exceeded all of our Key Performance Indicators for the RIE 2015 tranche. In certain areas such as the number of industry projects, we have exceeded the RIE 2015 target by as much as 515%. KPI achievements for both FY2015 and RIE 2015 are summarised below.

Category	RIE 2015 KPIs	FY2015 Achievement Cumulative (% achieved)	RIE2015 Achievement Cumulative (% achieved)	RIE2015 Target
Public R&D	Industry funding received ($mil)	64.56	301.87 (118%)	$255 mil
	No. of industry projects	1,883	8,508 (515%)	1,651
	No. of Translational and Clinical Research (TCR) projects	87	362 (155%)	234
	IAF Industry R&D spending ($mil)	224.06	1329.05 (160%)	$830 mil[2]
	IAF Industry projects	171	457 (609%)	75
Innovation & Enterprise	No. of RSEs from RIs seconded to industry (GET-Up only)	73	339 (123%)	275
	No. of licenses (overall)	205	1,030 (193%)	535[2]
	No. of licenses or spin-offs arising from completed Gap Funded projects	50	273 (142%)	192[2]
	No. of licenses or businesses facilitated by IPI[3]	*The performance of this indicator is tracked and reported to the IPI steering committee*		80
Talent	No. of PhD postgraduates trained or being trained by the RIE2015 talent budget	154	816 (105%)	780
	No. of PhD postgraduates who work in Singapore upon graduation	*Lag KPIs which are tracked beyond 2015 due to the lengthy period required to train a PhD/postdoc student.*		399
	No. of PhD postgraduates who work in Singapore within a 5-year window upon graduation			399

[2] 5-year targets have been revised upwards following an increase in budget.
[3] National initiative administered by A*STAR. KPI achievement is monitored by and reported to the IPI Steering Committee and the RIE Standing Committee on Innovation & Enterprise.

The Future



Developed economies have chosen to focus on Research, Innovation and Enterprise (RIE) to sustain economic competitiveness, and to transform and drive manufacturing up the value chain through the adoption of advanced technologies. Singapore's RIE system was developed with a view to transform Singapore into a knowledge-based, innovation-driven economy.

In January 2016, Prime Minister Lee Hsien Loong announced that the government would commit S$19 billion to RIE over the next five years. RIE 2020 will focus on four domains that mirror Singapore's major R&D investments, national challenges and economic opportunities: advanced manufacturing and engineering (AME), health and biomedical sciences (HBMS), services and digital economy (SDE), and urban solutions and sustainability (USS).

A*STAR's achievements in RIE 2015 demonstrate our ability to deliver valuable outcomes through our science and technology, translate research into solutions that address national challenges, build up innovation and technology capacity in companies, and drive economic growth through value creation. We are well placed to contribute to all four domains in RIE 2020, particularly to AME and HBMS.

We will intensify our efforts in RIE 2020. In the coming year and throughout the next five years, we will sustain the development of industry-relevant capabilities, and strengthen public-private partnerships. We will deepen and broaden engagements with multinational companies and local enterprises to catalyse the growth of further innovative capacities in the private sector.

A*STAR will also support SMEs to become more productive and competitive. We will work closely with other government agencies to ensure that SMEs receive the assistance needed to focus on innovation-lead growth that will position them well for Singapore's future economy.

To drive the formation of new enterprises, we will facilitate the success of more A*STAR start-ups, guiding them through the process of licensing and commercialisation, and helping accelerate their time to market.

As we continue our emphasis on R&D that brings about good economic outcomes and societal benefits, and is focused on national priorities, A*STAR will step up its role in integrating research performers and collaborators from across the ecosystem. We will contribute to building a robust and diverse research base and innovation workforce for the entire innovation ecosystem. We will sustain our talent strategy of developing a strong Singaporean core to be complemented by a rich diversity of international researchers.

Much of the RIE activity will take place within the one-north area, home to over 400 leading companies, with 16 world-class public research institutes and five institutes of higher learning and corporate universities, and 41 incubators with over 700 start-ups which collectively create over 40,000 jobs. The area is a fertile ground for innovation and test-bedding, and growing ideas and partnerships amongst organisations, research institutes and start-ups. The maturing ecosystem has spawned many collaborative projects in the biomedical sciences, infocomms, the physical sciences, and engineering, and we can expect to see many more in the coming years.