

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

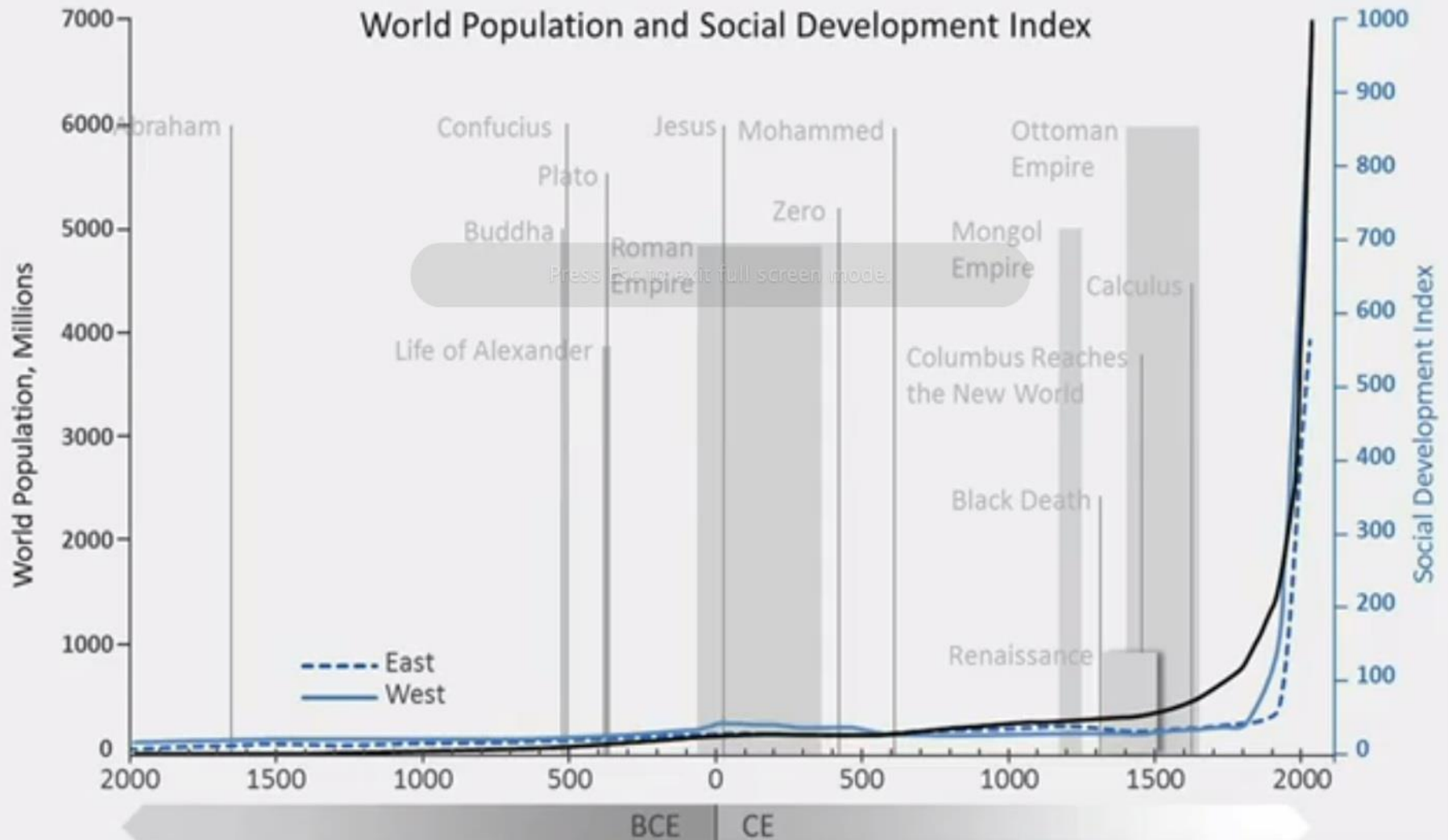
Dr. Raj Thampuran  
Managing Director  
Agency for Science,  
Technology & Research  
(A\*STAR)

25 January 2016



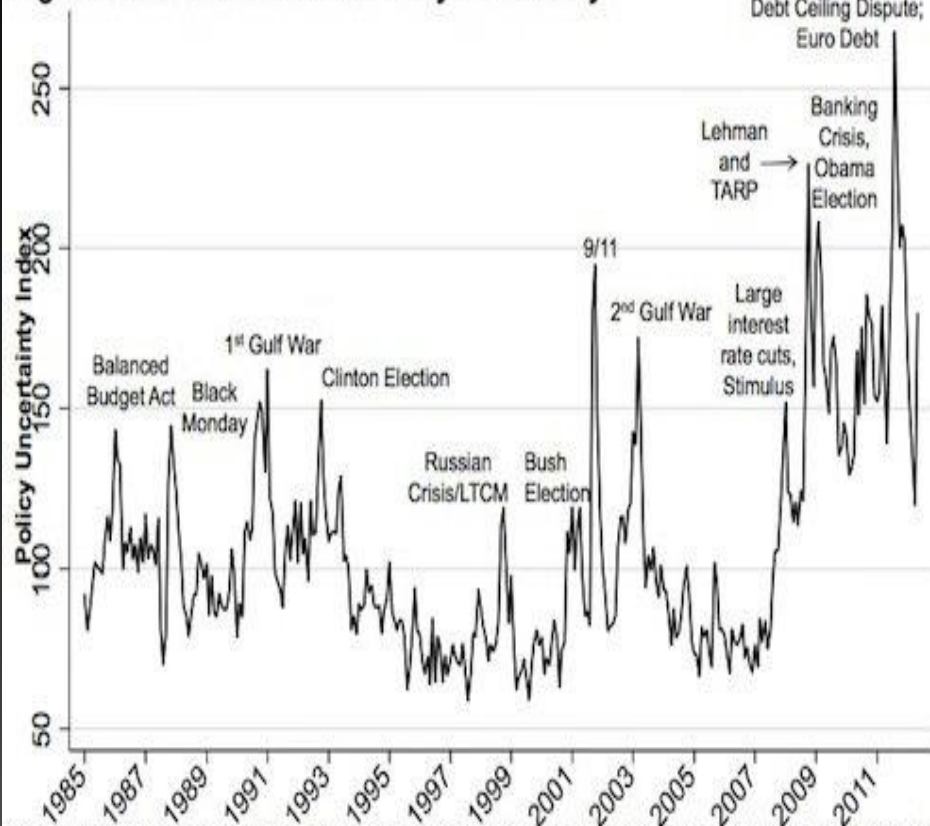
# Technology and Civilization

Andrew McAfee: Are droids taking our jobs?



# Economic Trends: Uncertainty the New (Re) Normal

Figure 1: Index of Economic Policy Uncertainty

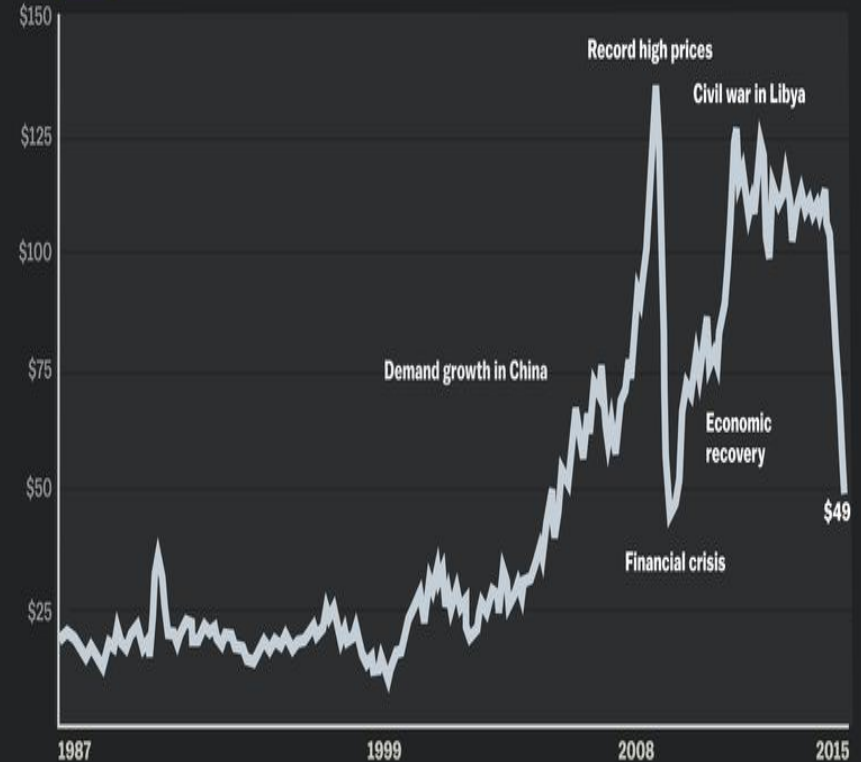


Notes: Index of Policy-Related Economic Uncertainty composed of 4 series: monthly news articles containing uncertain or uncertainty, economic or economy, and policy relevant terms (scaled by the smoothed number of articles containing 'today'); the number of tax laws expiring in coming years, and a composite of IQ ranges for quarterly forecasts of federal, state, and local government expenditures and 1-year CPI from the Phil. Fed Survey of Forecasters. Weights: 1/2 News-based, 1/5 tax expirations, 1/5 CPI disagreement, 1/5 expenditures disagreement after each index normalized to have a standard-deviation of 1. News query run Jun 4, 2011. Index normalized mean 100 from 1985-2009. Data at [www.policyuncertainty.com](http://www.policyuncertainty.com)



## Oil prices since 1987

BRENT CRUDE PRICE PER BARREL - EIA & NASDAQ AS OF JAN. 23, 2015





# Economic Trends: Global Megatrends

**Population Boom**



**Ageing population**



**Urbanisation**

**1.3 million**  
**migrating to towns**  
**and cities every**  
**week** for the next  
**20 years**



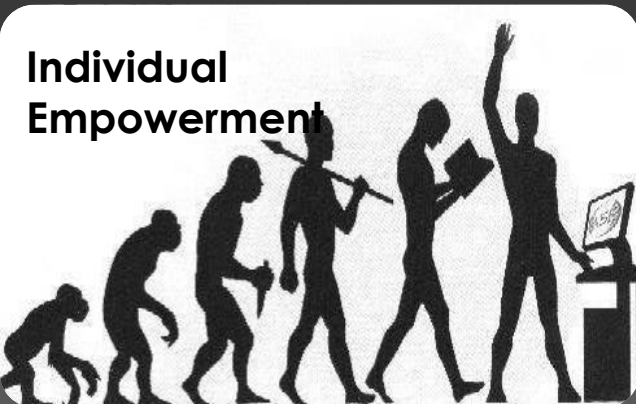
**Rise of the Digital World**



**Mass Customisation**



**Individual Empowerment**



**Resource Scarcity**



**Economic Instability**



# Developed Economies have recognized that R&D and Innovation are imperative for competitiveness

*“Every dollar we invested to map the human genome returned \$140 to our economy... Now is not the time to gut these job-creating investments in science and innovation. **Now is the time to reach a level of research and development not seen since the height of the Space Race.**”*

- President Barack Obama, State of the Union Address 2013



*“The current low levels of investment in R&D in the UK ... will compromise our ability to compete effectively in the knowledge economy. To address this ... we must not only continue to **sustain and grow our investment in our world leading science base, but extend this to our support for innovation.**”*

– Hauser Review of the Catapult Network , 2014



*“Investment in R&D is part of the solution to exit from the economic crises in Europe”*

– EU Horizon 2020





# The Twin Engines of Innovation and Industrialisation



*Economic growth*



*Multiplier Effect to  
the Services Sector*



*Increase in Productivity*



*Higher quality of living*



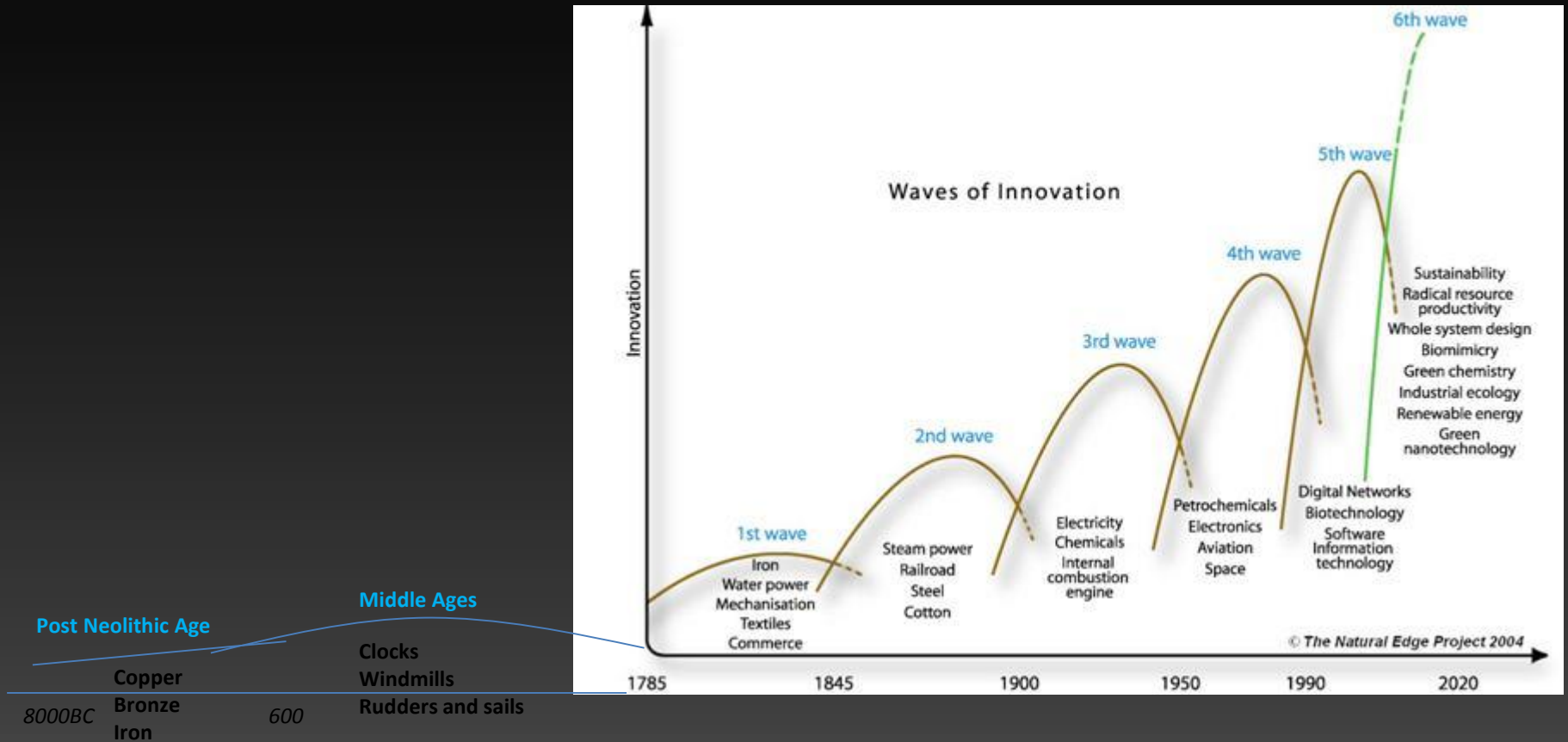
*Better Jobs; Higher  
income*



# Open Innovation: Public-Private Partnerships

- Schumpeterian Approach:
  - Develop new technologies and bring them to market = competitive advantage of companies
- A Corpus of Literature on Theory of Firms
  - Open Innovation (Chesbrough 2003)
  - Complexities of innovation and knowledge recombination has led to increased permeability of organisational boundaries
- Benefits to Companies
  - Improved efficiency through scale economics
  - Access to innovation that does not reside in the focal company
  - Arbitrage on R&D that is riskier or further in the horizon
  - Closer to the market innovations

# Waves of Innovation



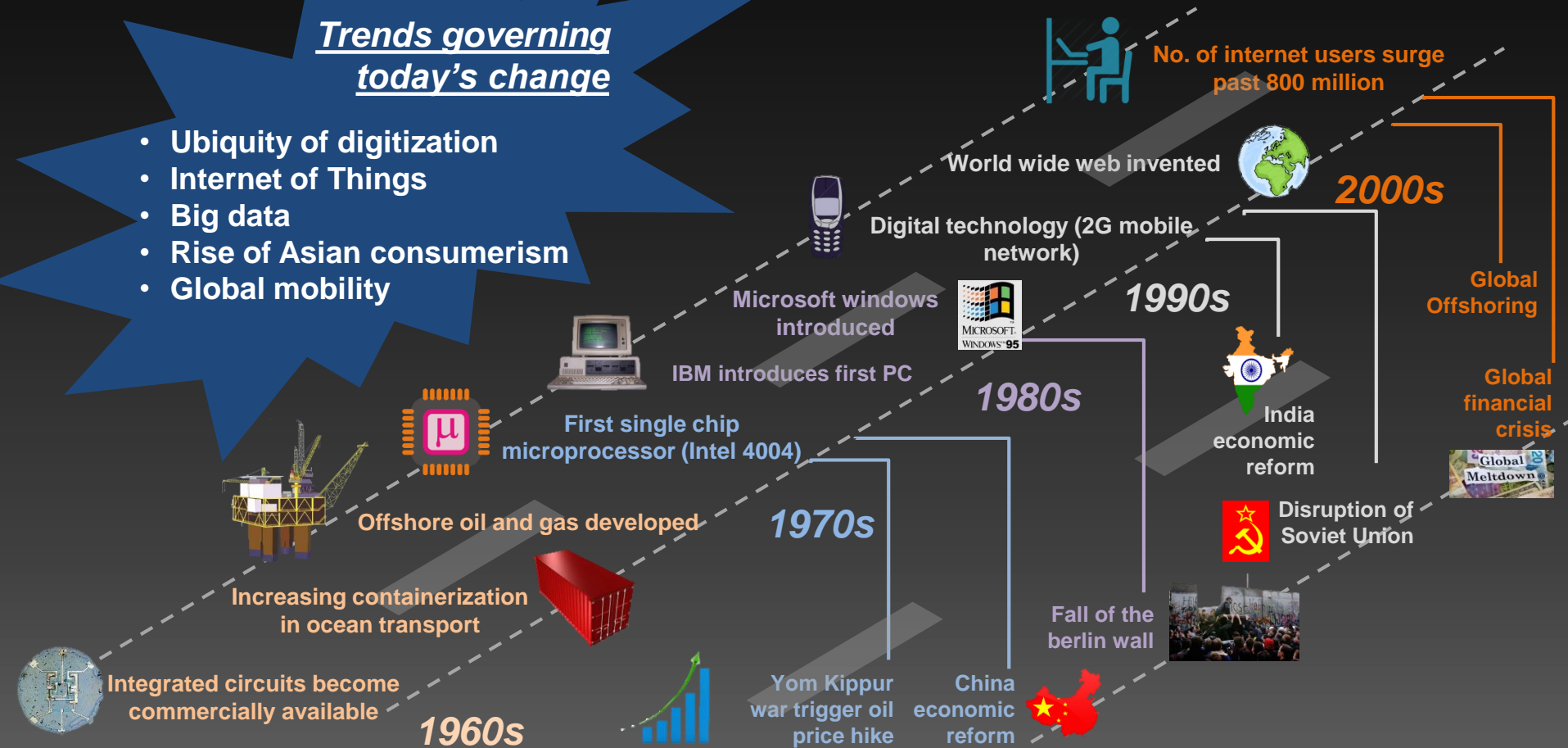


# Why the perpetual need to change?

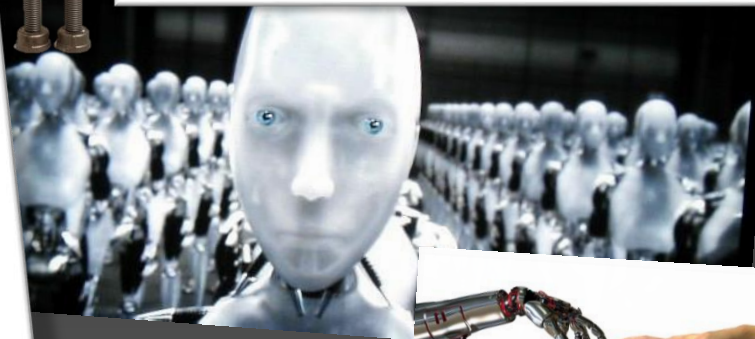
*As an open economy, fast paced industrial evolution is a consequence of rapid changes in technological trends*

## Trends governing today's change

- Ubiquity of digitization
- Internet of Things
- Big data
- Rise of Asian consumerism
- Global mobility



# When Your Boss Wears Metal Pants



# Business Innovation: Companies in Non-Traditional Sectors

## Open Innovation & Diversification

*Open Innovation • Collaboration • Cross-Discipline • Cross-Application*

**New Apple Health Technology Prepares to Do Battle With Samsung**

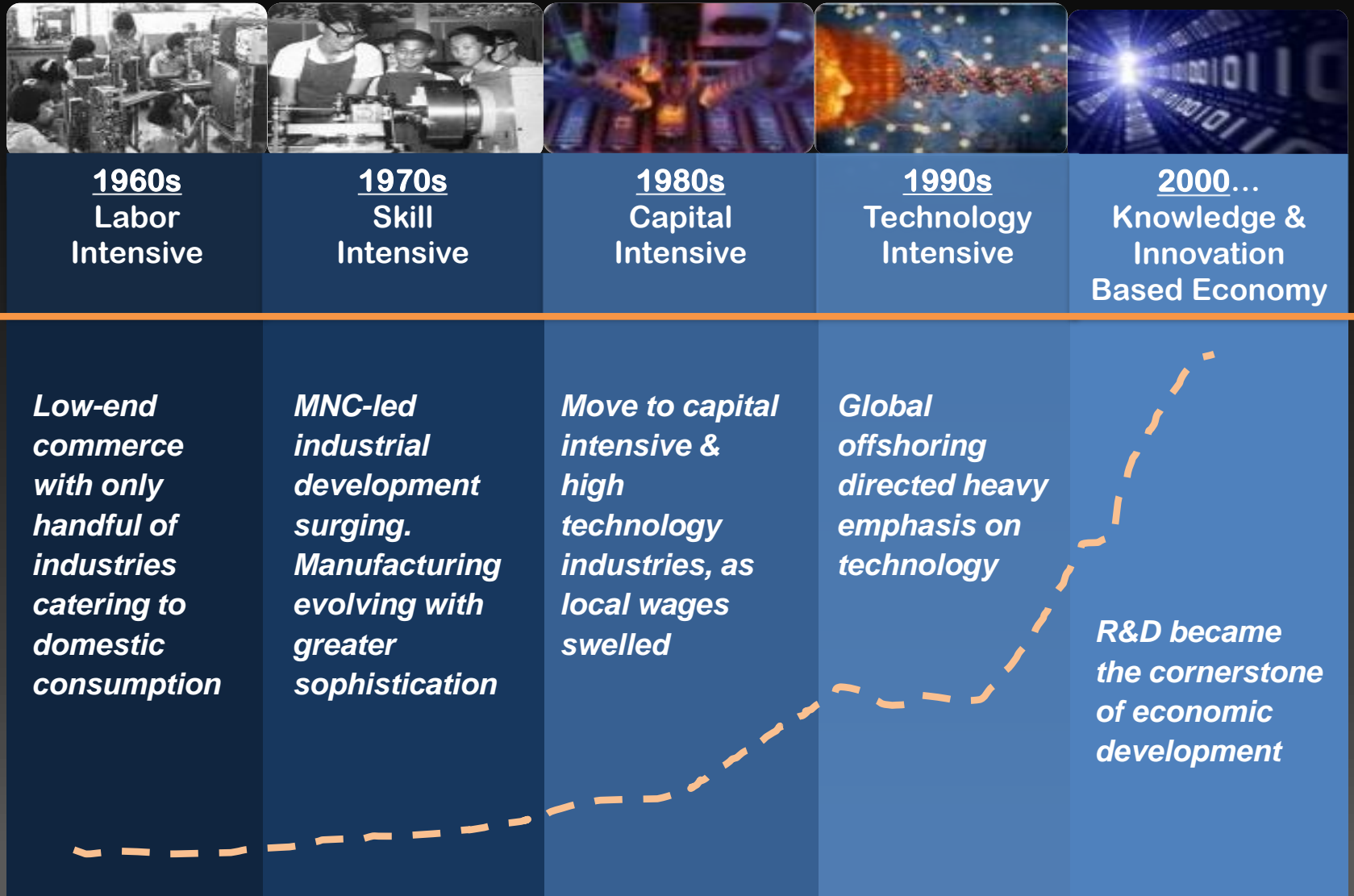


Johnson & Johnson Seeks Patent on Electronic Contact Lenses

Google[x] searches for ways to boost cancer immunotherapy



# Transformation of Singapore's economy





# A Coordinated National R&D Framework

Research, Innovation  
& Enterprise Council



Lee Hsien Loong  
Chairman, RIEC  
Prime Minister of Singapore

Ministry of  
Health



Ministry of  
Education



Ministry of  
Trade & Industry



NATIONAL  
RESEARCH  
FOUNDATION



Agency for  
Science, Technology  
and Research

EDB  
singapore



SPRING  
singapore  
Enabling Enterprise

Hospitals

Polytechnics  
& Universities

A\*STAR  
Research  
Institutes

Corporate Labs

FUNDING AGENCIES &  
MINISTRIES

RESEARCH  
PERFORMERS

# Our Government's R&D commitment

1991



Lee Hsien Loong,  
DPM  
Launch of  
NSTB  
9<sup>th</sup> Sept 1991

"Our target is for total R&D expenditure to reach 2% of GDP by 1995. This means increasing research spending by 25% per year over the next 5 years..."

...The government will allocate up to \$2billion to support research and development over the next 5 years."

2010



Lee Hsien Loong,  
Prime Minister  
4<sup>th</sup> RIEC  
Meeting  
17<sup>th</sup> Sept 2010

"Singapore's long term aim is to be among the most research intensive, innovative and entrepreneurial economies in the world. Increasingly, intellectual capital will be critical for our next phase of economic development."

Hence, the government will allocate S\$16.1 billion to support research, innovation and enterprise activities in the next 5 years."

2016



Lee Hsien Loong,  
Announcement  
of RIE 2020  
plan  
8<sup>th</sup> Jan 2016

"RIE (Research, Innovation & Enterprise) will continue to be important to secure our future. It contributes significantly to the economy and creates opportunities and jobs. It supports national initiatives like Smart Nation, Skills Future ... under the Committee of Future Economy"

... Therefore, for the RIE 2020 Plan, we are committing S\$19 billion, 18 % more than the previous plan and the spending will be about 1% of GDP

# RIE in Singapore

## Research Innovation Enterprise

5-year S&T Plans

National  
Technology  
Plan  
(1991-1995)  
**S\$2 bn**

National  
Science &  
Technology Plan  
(1996-2000)  
**S\$4 bn**

Science &  
Technology  
Plan 2005  
(2001-2005)  
**S\$6 bn**

Science &  
Technology  
Plan 2010  
(2006-2010)  
**S\$13.9 bn**

Research,  
Innovation &  
Enterprise Plan  
(2011-2015)  
**S\$16.1 bn**

Research,  
Innovation &  
Enterprise Plan  
(2016-2020)  
**S\$19 bn**



Ensure excellent science and impact by supporting the best ideas across disciplines, encouraging collaboration, and investing strategically in both curiosity-driven and mission-oriented research



Renew our knowledge base and ensure responsiveness to pursue new opportunities and technology developments



Create value from our R&D investments by engaging the private sector, including LLEs and SMEs, to build their capacity for innovation and technology adaptation, as well as leveraging S&T to address our national needs

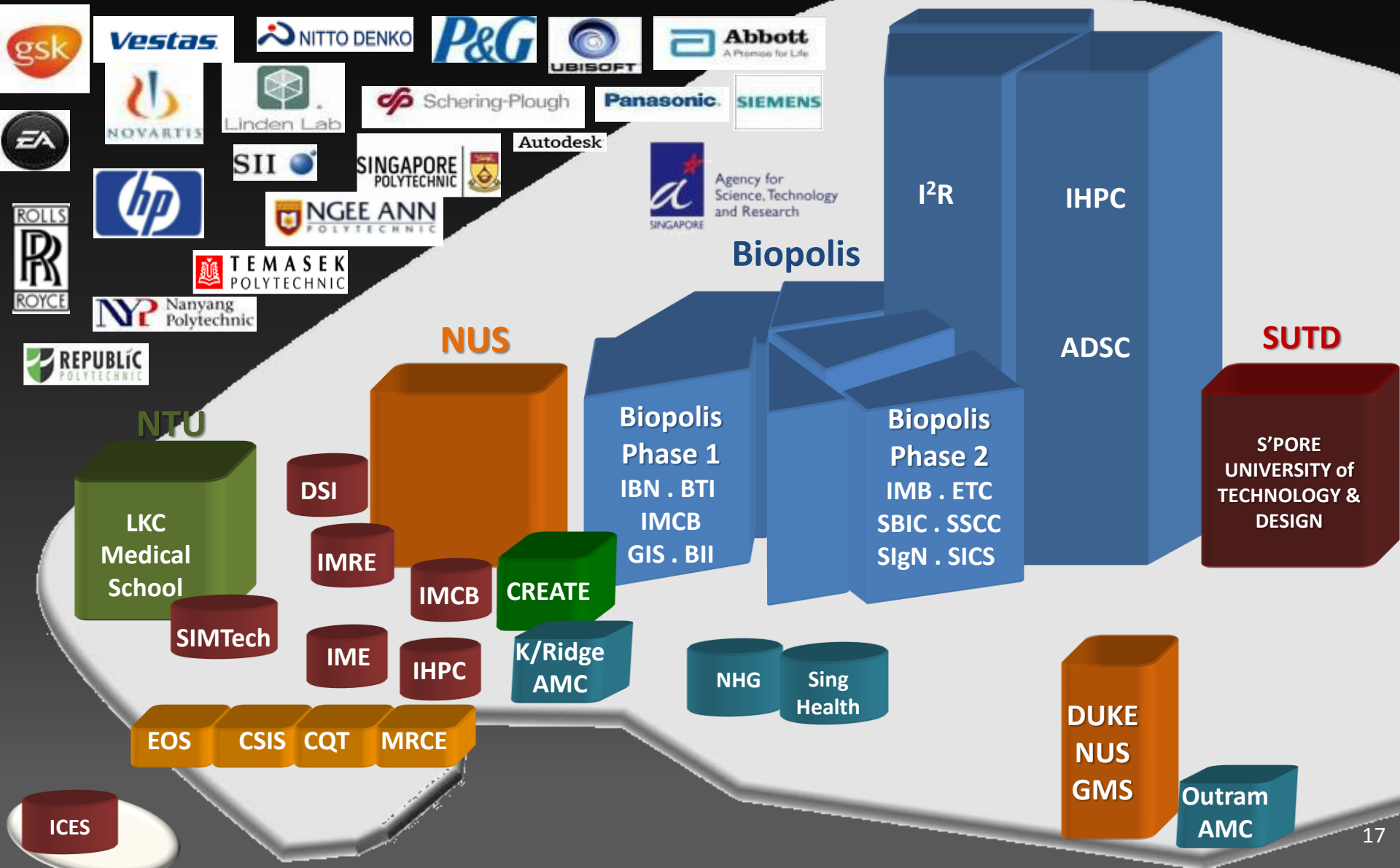


Sustain a robust and diverse research base and innovation workforce in the private and public sector, built around a strong Singaporean core but also leveraging international talent to strengthen our team.

# Singapore's Growing R&D Landscape

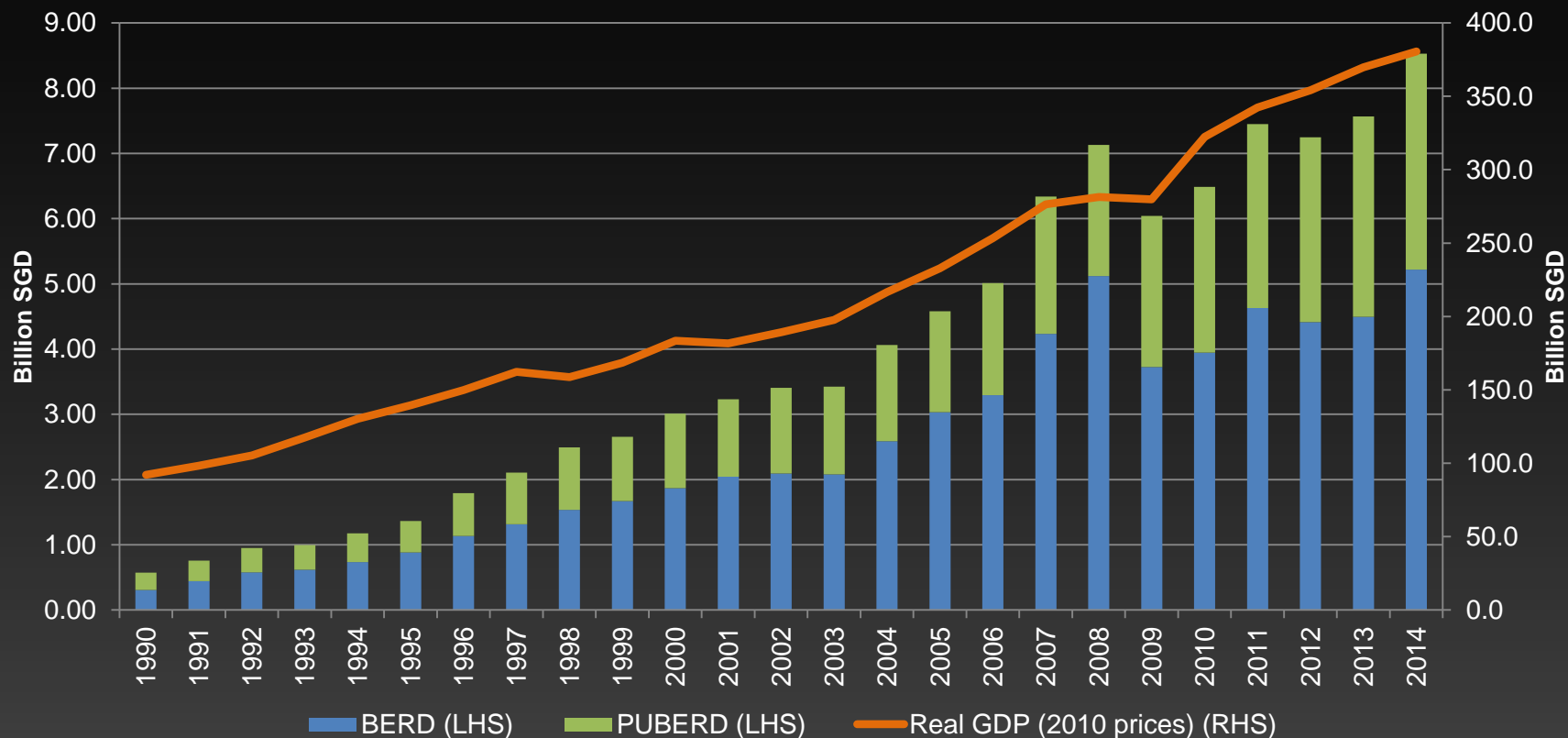
2005-2010

Fusionopolis



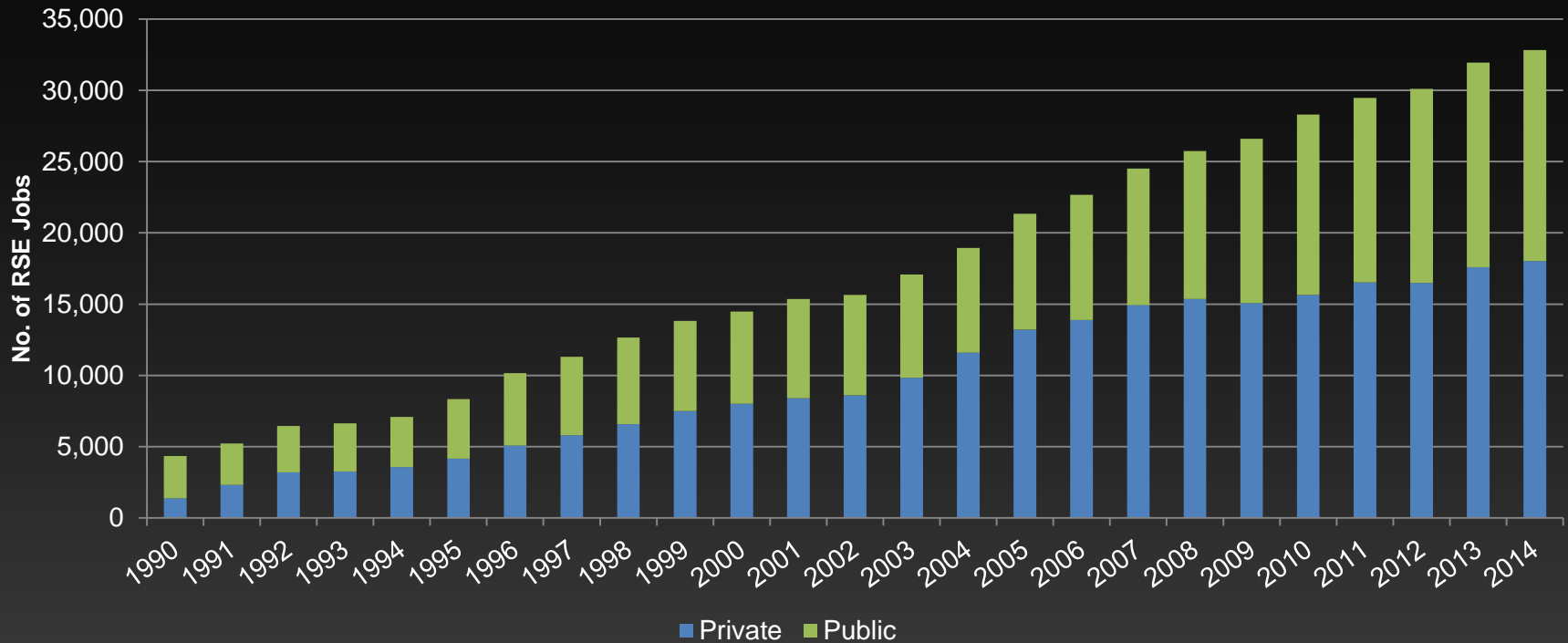


# Growth of R&D Expenditure



Expenditure on R&D	1990	2014	CAGR
Business expenditure on R&D (BERD)	\$0.31B	\$5.22B	12.5%
Gross expenditure on R&D (GERD)	\$0.57B	\$8.53B	11.9%

# Growth of RSE Jobs



Research Scientists and Engineers (RSEs)	1990	2014	CAGR
Private Sector RSEs	1,363	18,026	11.4%
Public Sector RSEs	2,966	14,809	6.9%
Total RSEs	4,329	32,835	8.8%

# The World and A\*STAR

- A\*STAR conducted a series of study visits to benchmark ourselves against successful research-intensive economies in 2013-2014.
- We found that these countries often have a **mission-oriented Science & Technology Organisation (STO)** to help bridge the gap between academia and industry.
- **A\*STAR has placed itself on the map of world-class STOs around the world.** Countries such as the UK, US and Israel have all looked to A\*STAR as a successful model of a mission-oriented entity that can translate research excellence into impact.



*"...Innovate UK lacks the public kudos and political power of more famous technology agencies, such as DARPA in the United States, Finland's TEKES or **Singapore's A-STAR**.... In the venerable world of public sector organisations, Innovate UK is still a youngster, with much to prove."*

**-Guardian article by Stian Westlake, ED Policy at Nesta**

# Singapore's Lead Government Agency for Economic Oriented R&D: **A\*STAR**

21

**Biomedical  
Research  
Council  
(BMRC)**

**Joint  
Council  
Office  
(JCO)**

**Science &  
Engineering  
Research  
Council  
(SERC)**

**ETPL**

**A\*STAR  
Graduate  
Academy**

**10 Research  
Units**

**8 Research  
Units**

**Commercialisation**

**Scholarships**

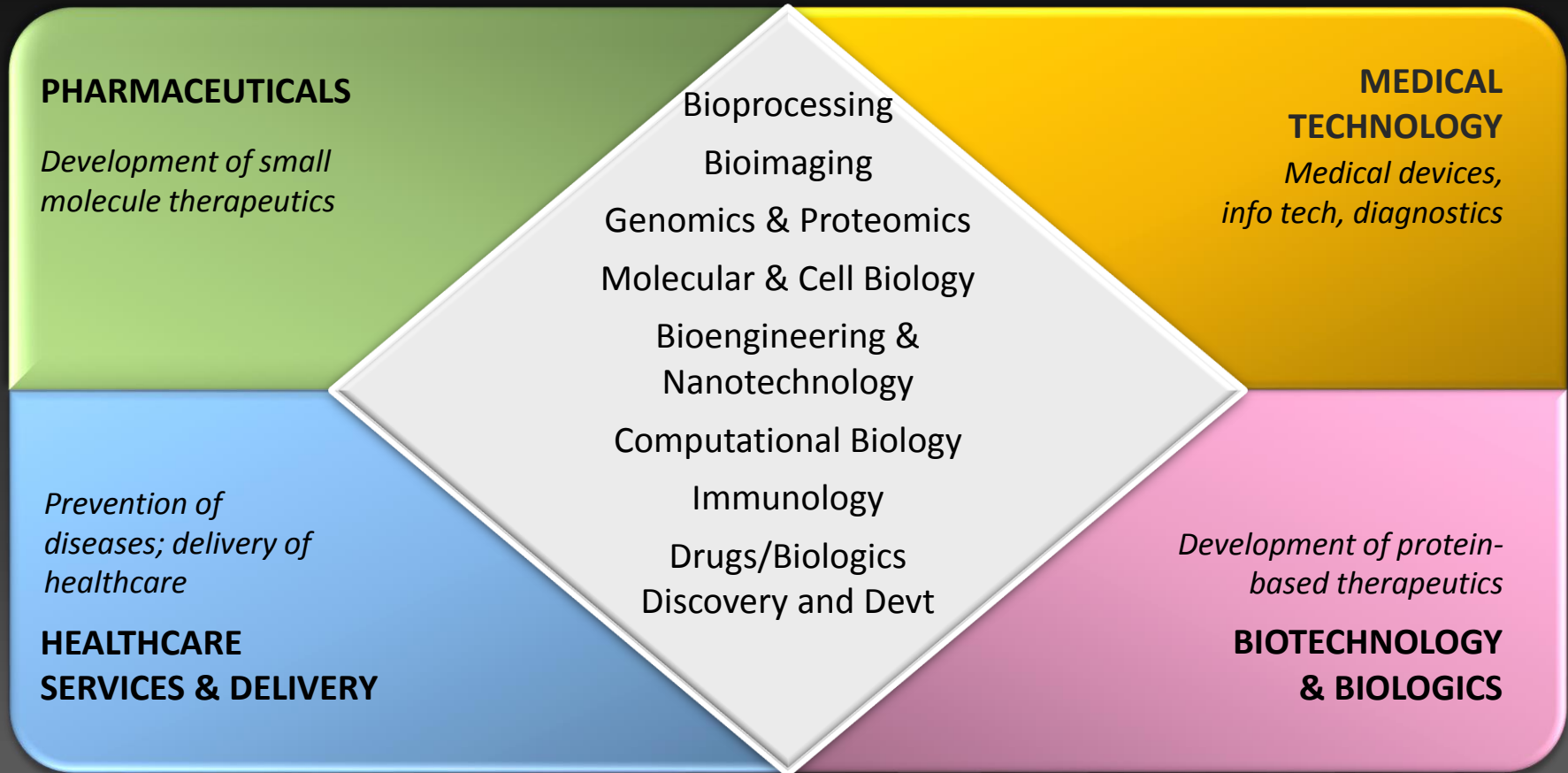
**>5,400 Staff**

**>4,400 Researchers, Engineers and Technical Support Staff**  
**>40% of whom come from 60 countries**



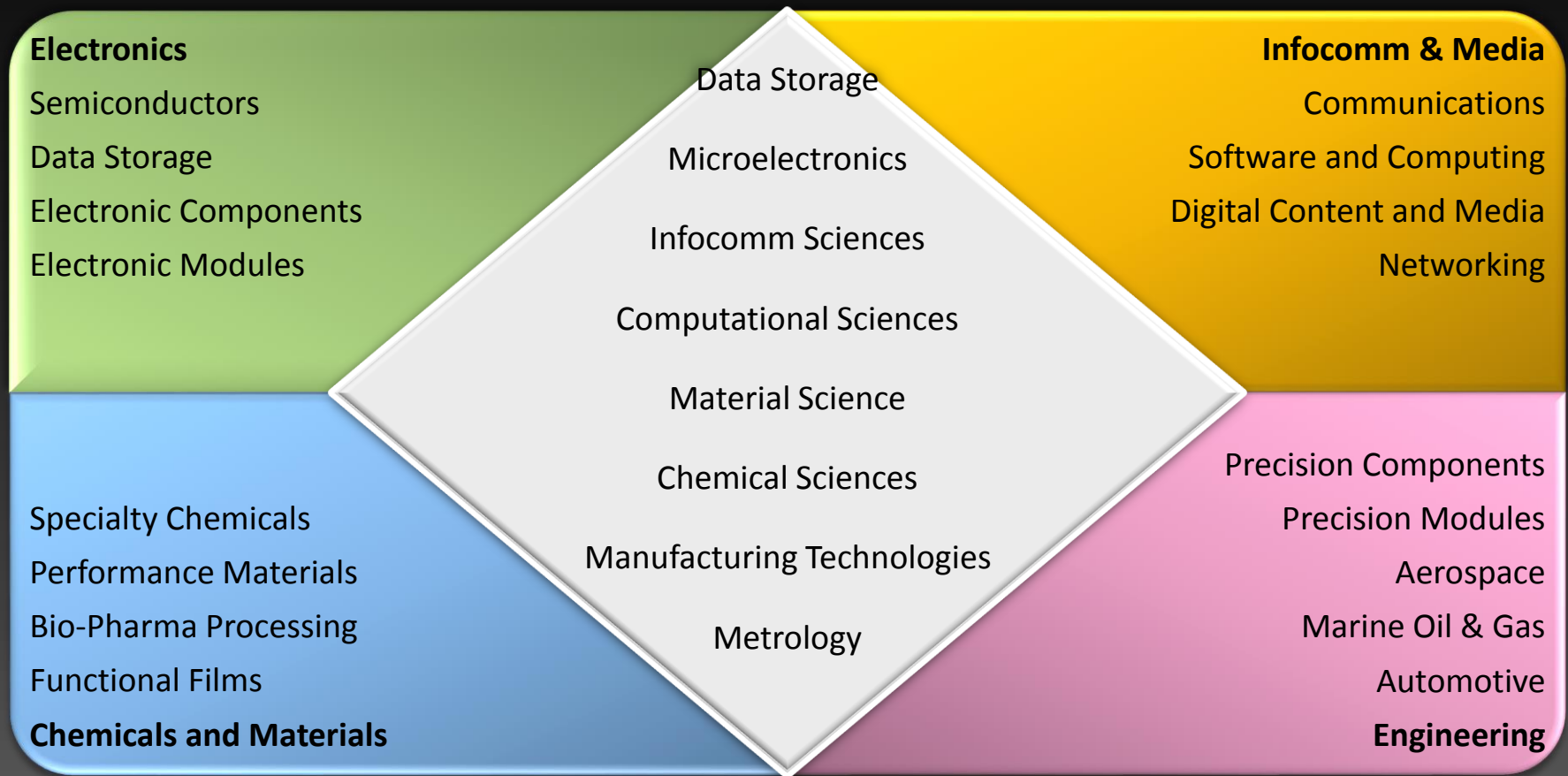
# Biomedical Research Council

Creating economic value for Singapore through delivering excellent science; building world-class research infrastructure; growing our research talent base and enhancing public-private partnerships

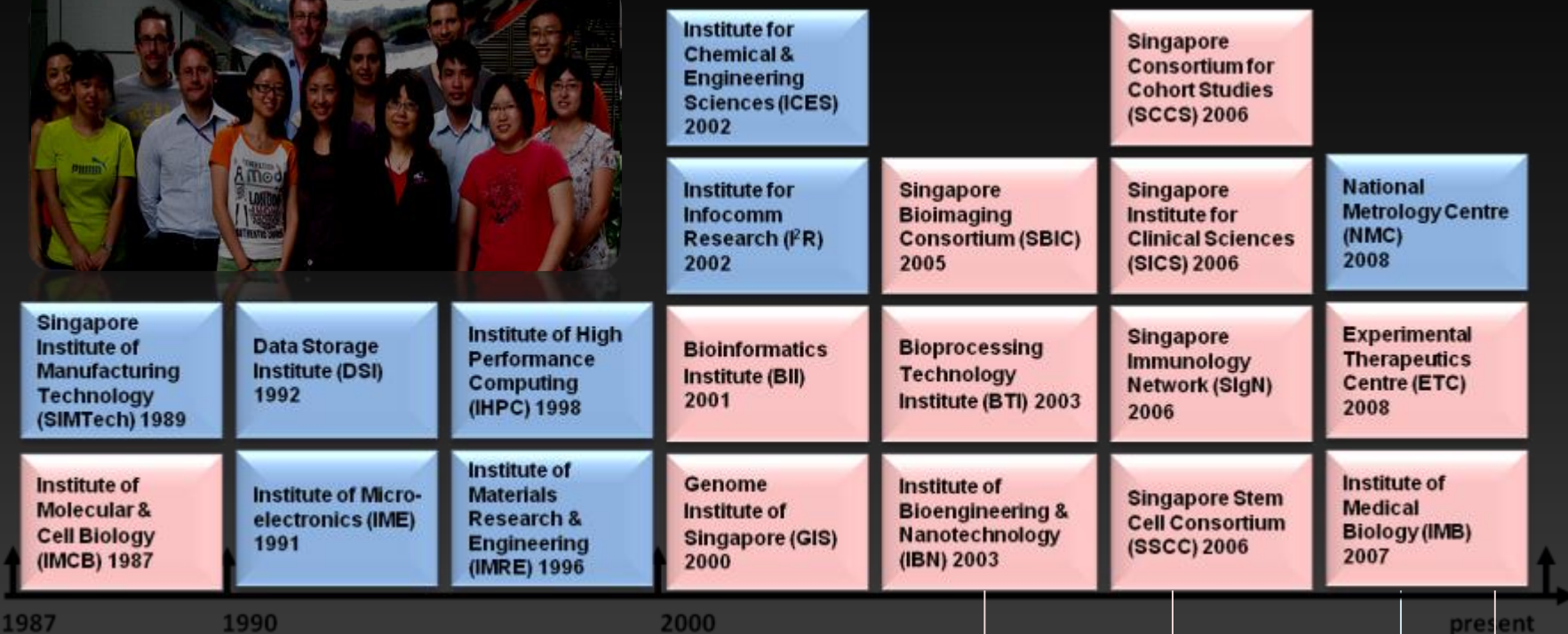


# Science & Engineering Research Council

**Supporting a wide spectrum of leading edge science and engineering R&D capabilities and nurturing talent for innovation and industry development**



# Evolution of R&D Performers in A\*STAR



Biopolis  
Phase I  
(2003)

Biopolis  
Phase II  
(2006)

Fusionopolis  
Phase I  
(2008)

Biopolis  
Phase III  
(2011)

Biopolis  
Phase IV  
(2013)

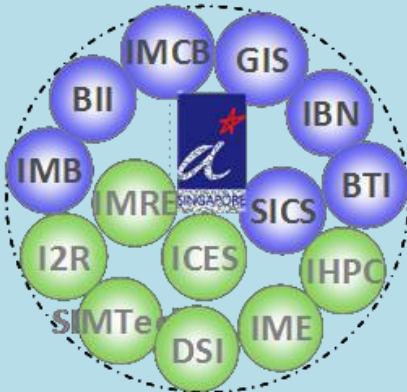
Fusionopolis  
Phase II-V  
(2015)

Biopolis  
Phase V  
(TBC)

# A\*STAR: INNOVATION CAPITAL

(1) Sustained  
Knowledge Creation

**Research  
Performers**



Ris, IHLs, Hospitals,  
Corporate Labs

(2) Growing Innovation Capital

**Innovation Capital**

**Integrating for Impact**  
**Clustering for Competitiveness**

**Gearing for Growth**

**Partnering for Productivity**

**Seeding for Surprises**  
**Shaping for Success**

**Enterprises**

**MNCs and  
GCCs**

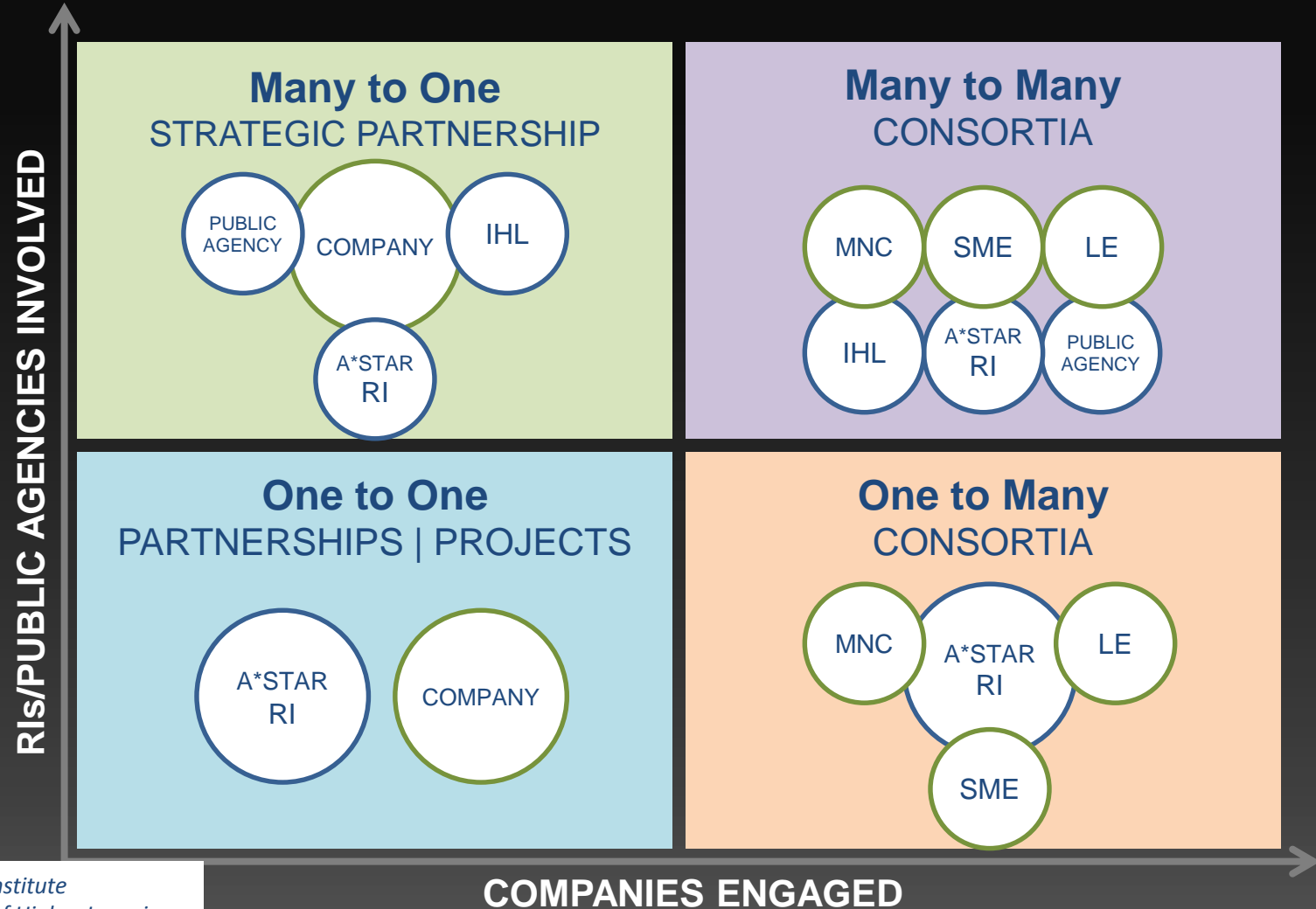
**SMEs**

**Start-Ups**

(3) Attract and Develop Talent

(4) Funding

# Industry Engagement



*RI: Research Institute*  
*IHL: Institute of Higher Learning*  
*MNC: Multi-National Company*  
*LE: Local Enterprise*  
*SME: Small & Medium Enterprise*

# Industry Engagement

## One to One ENGAGEMENTS

*Building partnerships  
with companies in  
targeted research areas*



Setting up a center of Excellence in Advanced Packaging in Singapore



Collaboration on compressing genome data



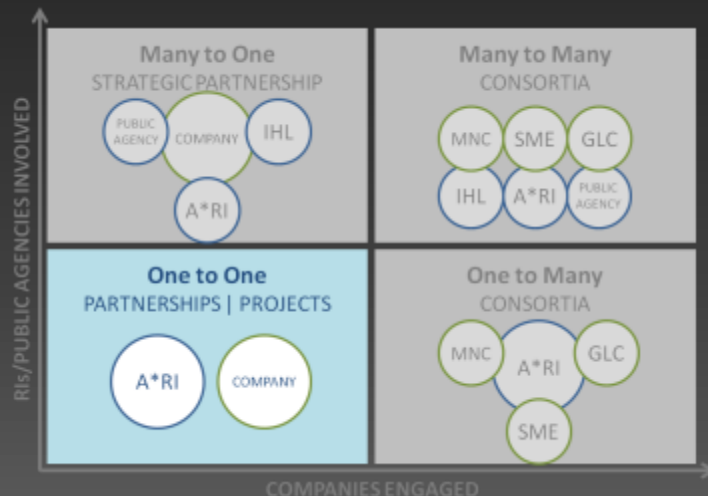
Joint lab: Baidu-I<sup>2</sup>R Research Centre

**Arkray's 1<sup>st</sup> R&D centre outside Japan**

*\$9.1 million investment  
5-year partnership*



**Partnering for better diagnosis**  
Novel detection kits for infectious diseases

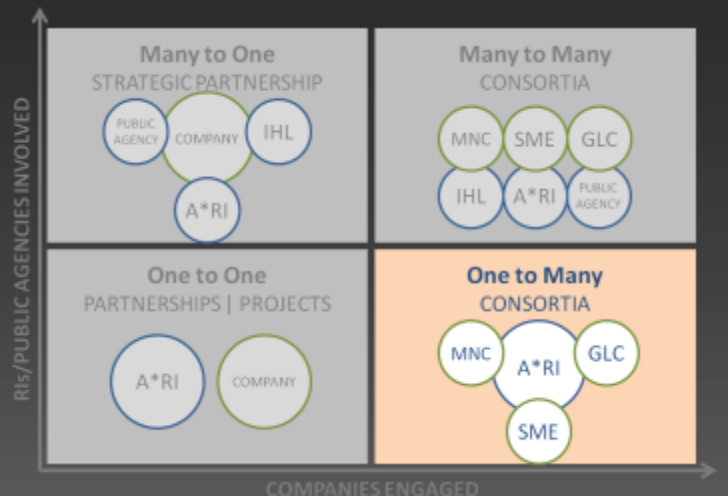




# Industry Engagement

## One to Many CONSORTIA

*Leveraging an RI to bring companies together to collaborate on common research areas*



## Industrial Consortium on Nanoimprint

To demonstrate applications of nanoimprint technology and develop roll-to-roll nanoimprinting



## Innovative Processing of Specialties and Pharmaceuticals (iPSP)

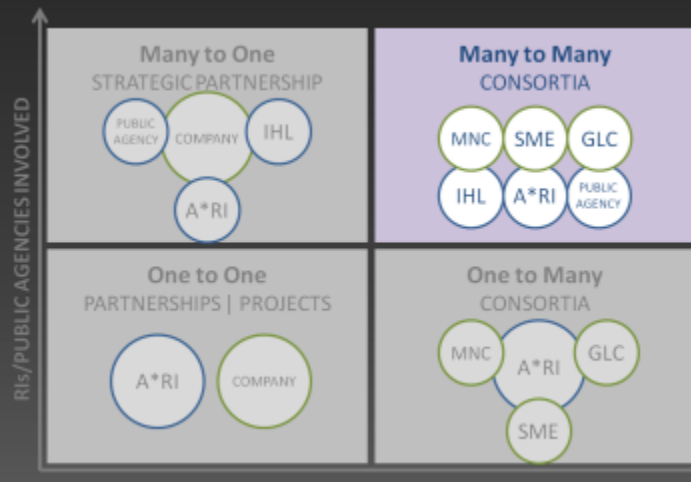
Providing access to next generation manufacturing technologies



# Industry Engagement

## Many to Many CONSORTIA

*Creating effective platforms for both public and private sectors to collaborate*



## EpiGen Consortium



3 Countries  
6 Member institutes  
30 Principal Investigators  
200 Scientists  
Multiple industry Collaborators



## Aerospace Consortium

To drive innovation and sustain competitiveness of local aerospace industry through R&D

### R&D Focus

- Computational Modelling & Dynamics
- Advanced Materials
- Manufacturing Processes & Automation
- Inspection & NDT
- Information & Communication

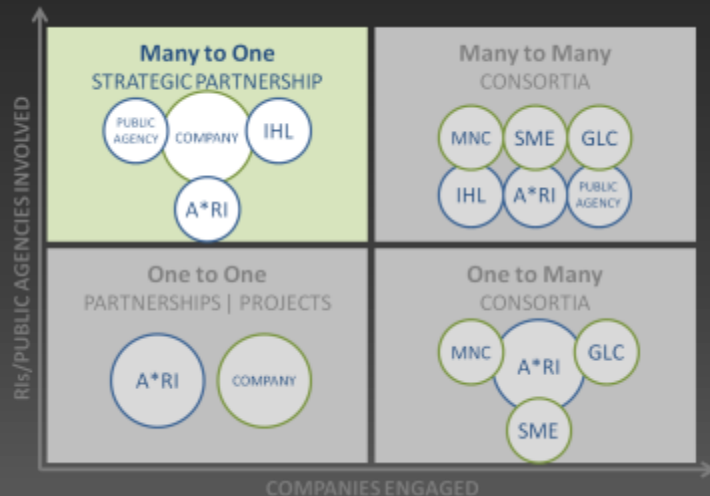


# Industry Engagement

## Many to One

STRATEGIC PARTNERSHIPS

*Integrating scientific capabilities across disciplines for impact*



## A\*STAR-Lloyd's Register Master Research Collaboration



5-year MRCA in innovations and solutions for the Energy and Maritime sectors

## A\*STAR – P&G MRCA



**\$250 million, 32,000 sqm facility**  
**500-man Singapore Innovation Centre**  
**MRCA renewal in Aug 2013**  
 Beauty and grooming, health and well-being & household care

# Growing the Innovation Capacity of Local Enterprises: **Large Local Enterprises**

## New Joint Labs



## Growing LLEs in the M&O Sector



### Deepwater Ocean Basin

- Non-profit, national infrastructure to support R&D and manpower training in M&O, involving public & private sectors
- To support LLEs such as **Sembcorp** and **Keppel** in Marine & Offshore R&D

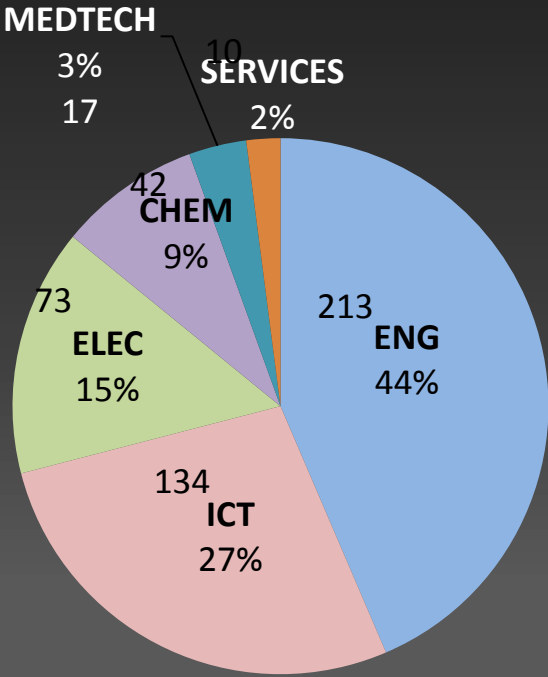
### *Other Examples of LLE collaborations:*



# Growing the Innovation Capacity of Local Enterprises: Enhancing SMEs Competitiveness

## Growing Enterprises for Technology Upgrading (GET-Up)

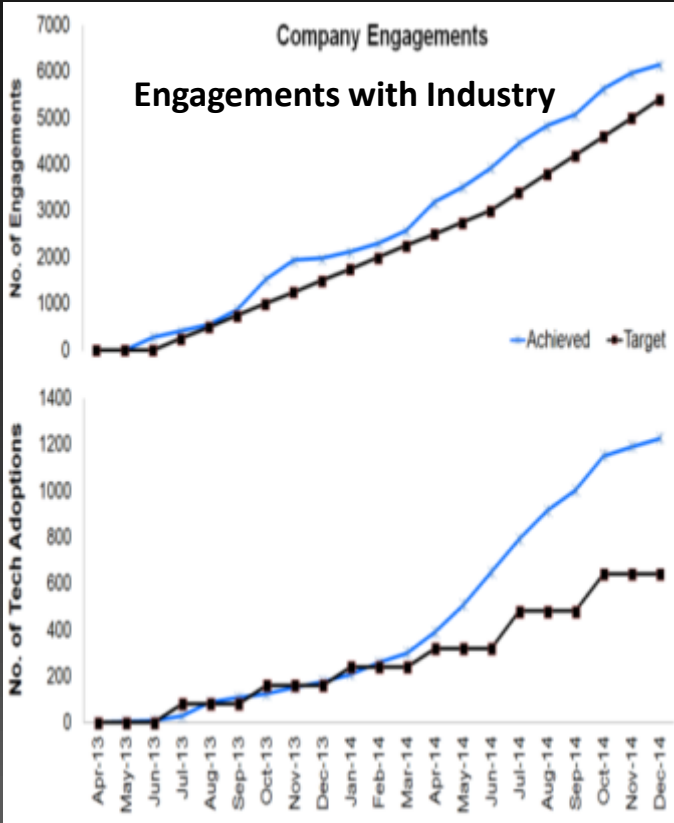
From 2002 to 2014: 491 Coys have benefited from GET-Up



Breakdown by Industry Sector

## Technology Adoption Programme

**300%**  
Increase in No of Proj with SMEs since FY11

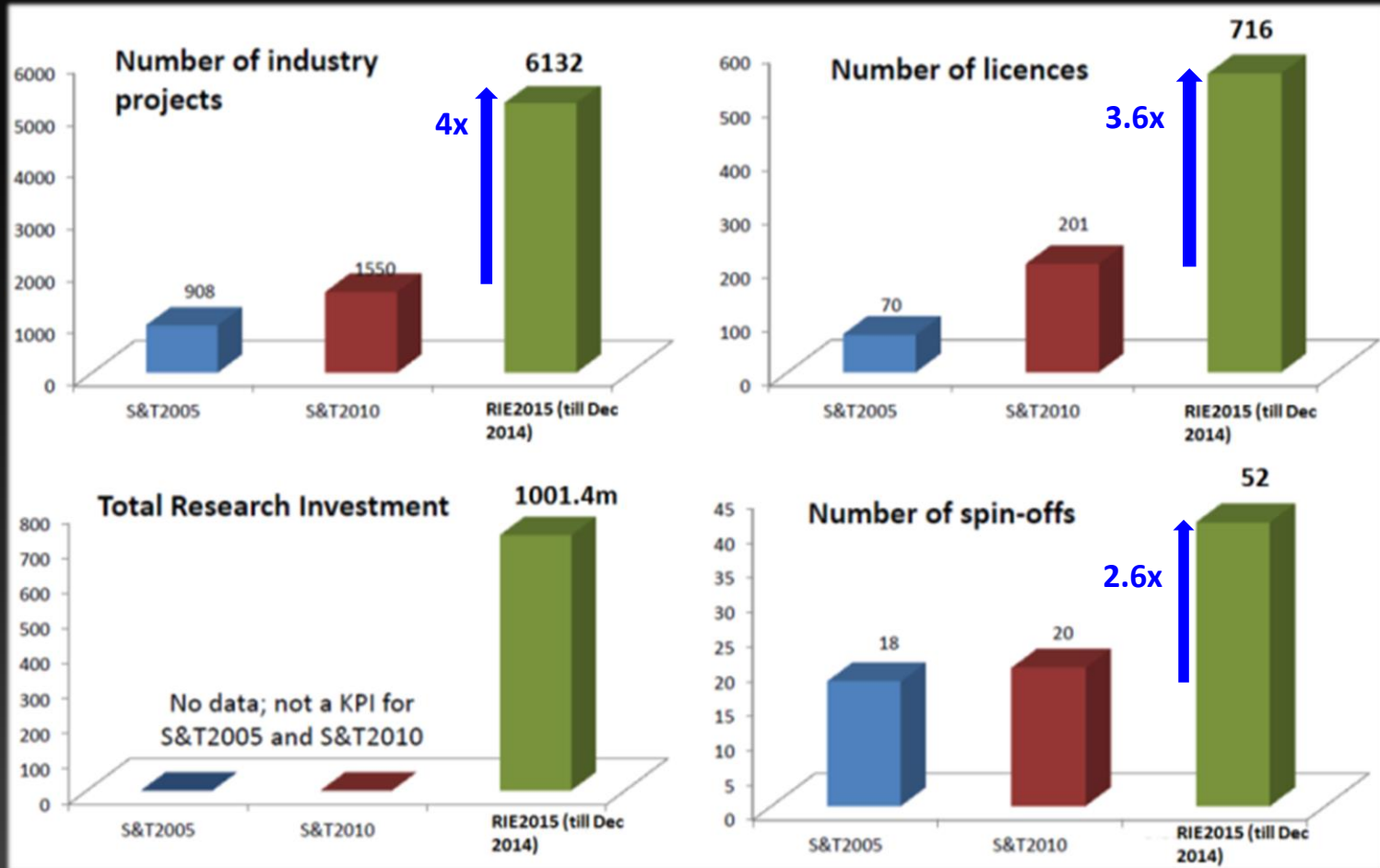


9,000

1,150



# Economic Impact



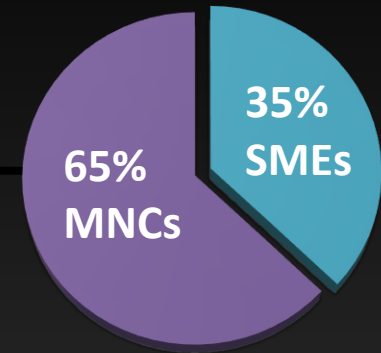
**A\*STAR works with 92 out of 112 companies that contribute 80% to Private Sector R&D investments in Singapore**



# Singapore's Lead Government Agency for Economic Oriented R&D

>1,700

INDUSTRY PROJECTS A YEAR  
5 INDUSTRY PROJECTS A DAY



>2,800

PAPERS  
PUBLISHED A  
YEAR

>200

LICENSES A YEAR  
4 LICENSES A WEEK

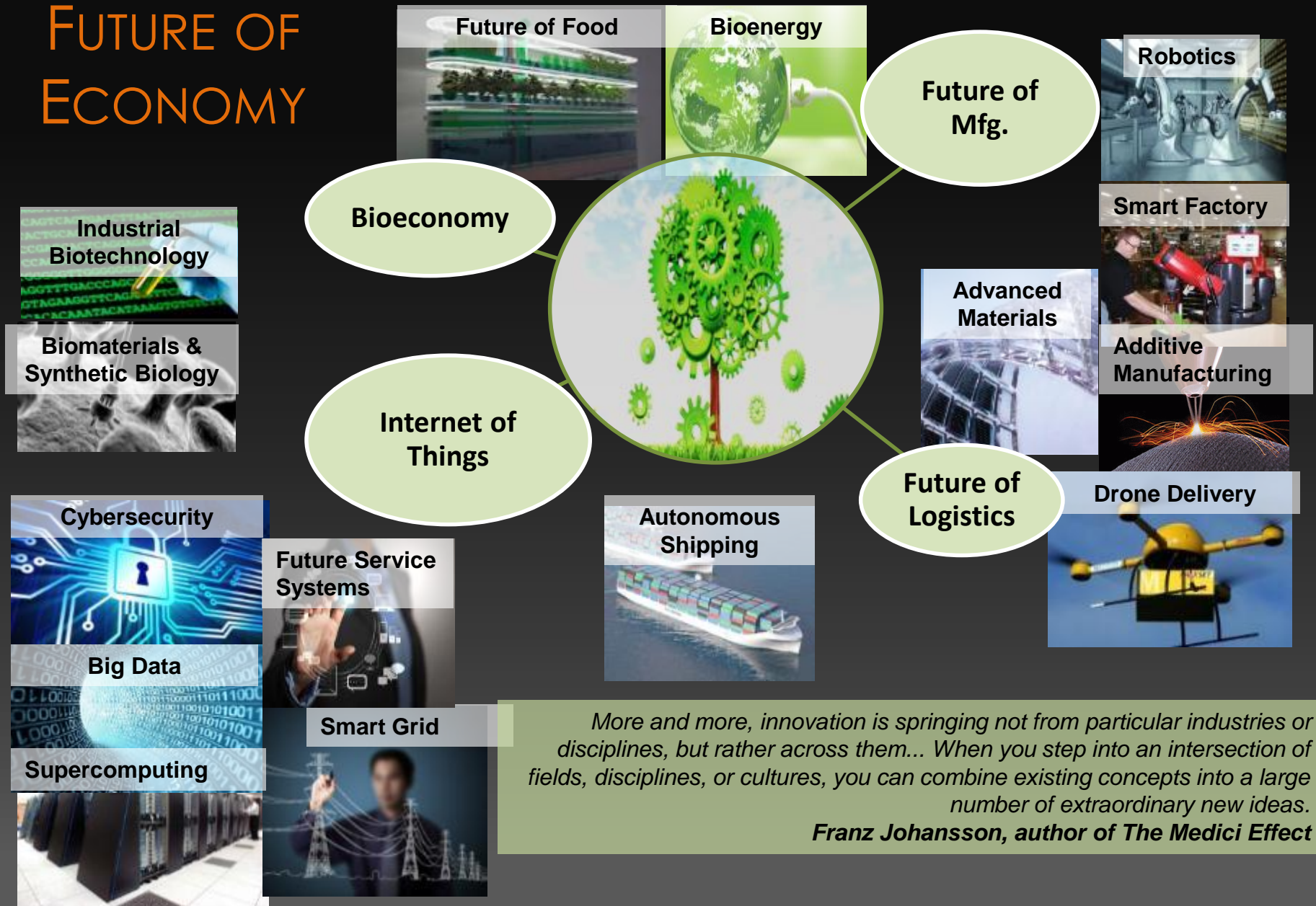
>13

START-UPS A  
YEAR

>290

PATENTS FILED  
A YEAR

# FUTURE OF ECONOMY





# TALENT AT A\*STAR

**CREATING GROWTH, ENHANCING LIVES**



Agency for  
Science, Technology  
and Research

# A\*STAR GRADUATE ACADEMY

Global Nexus for Scientific Talent

## Supporting Early Career Development for Young PhDs

- Post-doc opportunities at top institutions & corporate laboratories around the world
- Conducive scientific career development environment at A\*STAR
- Multiple career pathways at A\*STAR and beyond



## Sustaining Singaporean PhD Talent Flow

A\*STAR Undergraduate & PhD Scholarship Programmes



## Building a Robust & Diverse Talent Pool

Awards & Attachments for International Students



## Promoting Science to Young People & Building a Pipeline of R&D Talent

A\*STAR Science Awards & Youth Science Programmes





# A\*STAR GRADUATE ACADEMY

Nurturing a Pipeline of >1,300 Singaporean PhD Talent

**A\*STAR has awarded more than 1,300 Scholarships  
to develop Singaporean PhD talent since 2001**

**Over 450 scholars have completed their PhD/postdoctoral training & are  
contributing to Singapore's Research, Innovation and Enterprise (RIE) ecosystem**

Assoc Prof Karen Crasta  
Lee Kong Chian School of Medicine,  
Nanyang Technological University (NTU)  
A\*STAR International Fellowship Recipient



Dr Yar Kar Peo  
Principal Engineer, ST Electronics  
National Science Scholarship (PhD) Recipient

Dr Jonathan Loh Yui Han  
Principal Investigator, Institute of  
Molecular & Cell Biology (IMCB)  
A\*STAR Graduate Scholarship Recipient



Dr Seah Kwang Hwee  
Patent Examiner, Intellectual Property  
Office of Singapore (IPOS)  
A\*STAR Graduate Scholarship Recipient

# A\*STAR GRADUATE ACADEMY

Building a Robust & Diverse Talent Pool



Strengthening  
International Linkages



*Opportunities for Graduate & Pre-Graduate students from around the world*

## Singapore International Graduate Award (SINGA)

- Partnership between A\*STAR, NUS, NTU and SUTD
- Full PhD scholarships for over 170\* international students

## A\*STAR Research Attachment Programme (ARAP)

- Over 175 international students provided with PhD research opportunities at A\*STAR Research Institutes under joint supervision of A\*STAR scientists and overseas universities

## Singapore International Pre-Graduate Award (SIPGA)

- Short-term research attachments at A\*STAR Research Institutes for over 550 students in the later years of their Bachelors' or Masters programmes

*Data as of 30 April 2015*

*\*Over 560 awardees across A\*STAR, NTU and NUS*



# A\*STAR'S SCIENTIFIC LEADERSHIP



(First Row: L to R) – **Prof .Raj Thampuran**, MANAGING DIRECTOR; **Dr Sydney Brenner**, SENIOR FELLOW AND SCIENTIFIC ADVISOR TO A\*STAR CHAIRMAN; **Sir David Lane**, CHIEF SCIENTIST; **Sir George Radda**, CHMN, BMRC; **Sir John O'Reilly**, CHMN, SERC; **Prof Edward Holmes**, SENIOR FELLOW; **Prof Judith Swain**, SENIOR FELLOW; **Prof Andy Hor**, SENIOR FELLOW, **A/P Tan Sze Wee**, ED SERC; **Dr Benjamin Seet**, ED BMRC

(Second Row: L to R) - **Prof Lam Kong Peng**, ED BTI; **Prof Birgitte Lane**, ED IMB; **Prof Jackie Ying**, ED IBN; **Prof Ng Huck Hui**, ED GIS; **Prof Hong Wanjin**, ED IMCB; **Prof Laurent Réna**, ED SigN, **Prof Alex Matter** CEO ETC; **A/P Chong Yap Seng**, ED SICS; **Prof Patrick Cozzone** ED SBIC

(Third Row: L to R) – **Prof Kwong Dim Lee**, ED IME ; **Dr Thomas Liew**, ED NMC; **Dr Lim Ser Yong**, ED SIMTech; **Dr Keith Carpenter**, ED ICES; **Prof Alfred Huan**, ED, IHPC; **Dr Lee Shiang Long**, ED I<sup>2</sup>R; **Dr Tan Yong Tsong**, Covering ED DSI; **Dr Tan Geok Leng**, SENIOR FELLOW



# INFRASTRUCTURE AT A\*STAR

**CREATING GROWTH, ENHANCING LIVES**



Agency for  
Science, Technology  
and Research

# One-North

Singapore's biomedical and engineering research hubs are located at One-North



# FUSIONOPOLIS

Singapore's science & engineering research hub at One-North



Infrastructure  
and scientific  
platform to fuse  
and to synergize  
the knowledge  
for different  
domains

Bringing  
together public  
and private R&D  
activities



Fusionopolis

- 10,400 employees
- 312,000 sqm (GFA)



# BIOPOLIS

Singapore's biomedical research hub at One-North

Home to 53 BMS  
companies & growing



## Phase 1 to 5

- 5,600 employees
- 335,000 sqm (GFA)



**Thank you**