IEEE World Forum on Internet of Things

IEEE 4th World Forum on Internet of Things
05-08 February 2018 – Singapore
http://wfiot2018.iot.ieee.org/vert4-industrial-iot/program/

IoT, Big Data, AI, Materials Informatics and Circular Economy

Professor Seeram Ramakrishna, *FREng*

Chair of Circular Economy Taskforce, National University of Singapore

Member, World Economic Forum's Committee on Future of Production- Sustainability

Member, Smart Manufacturing Technical Committee, Singapore

A World's Most Influential Scientific Mind (Thomson Reuters & Clarivate Analytics)

http://www.europeanbusinessreview.com/smart-manufacturing/

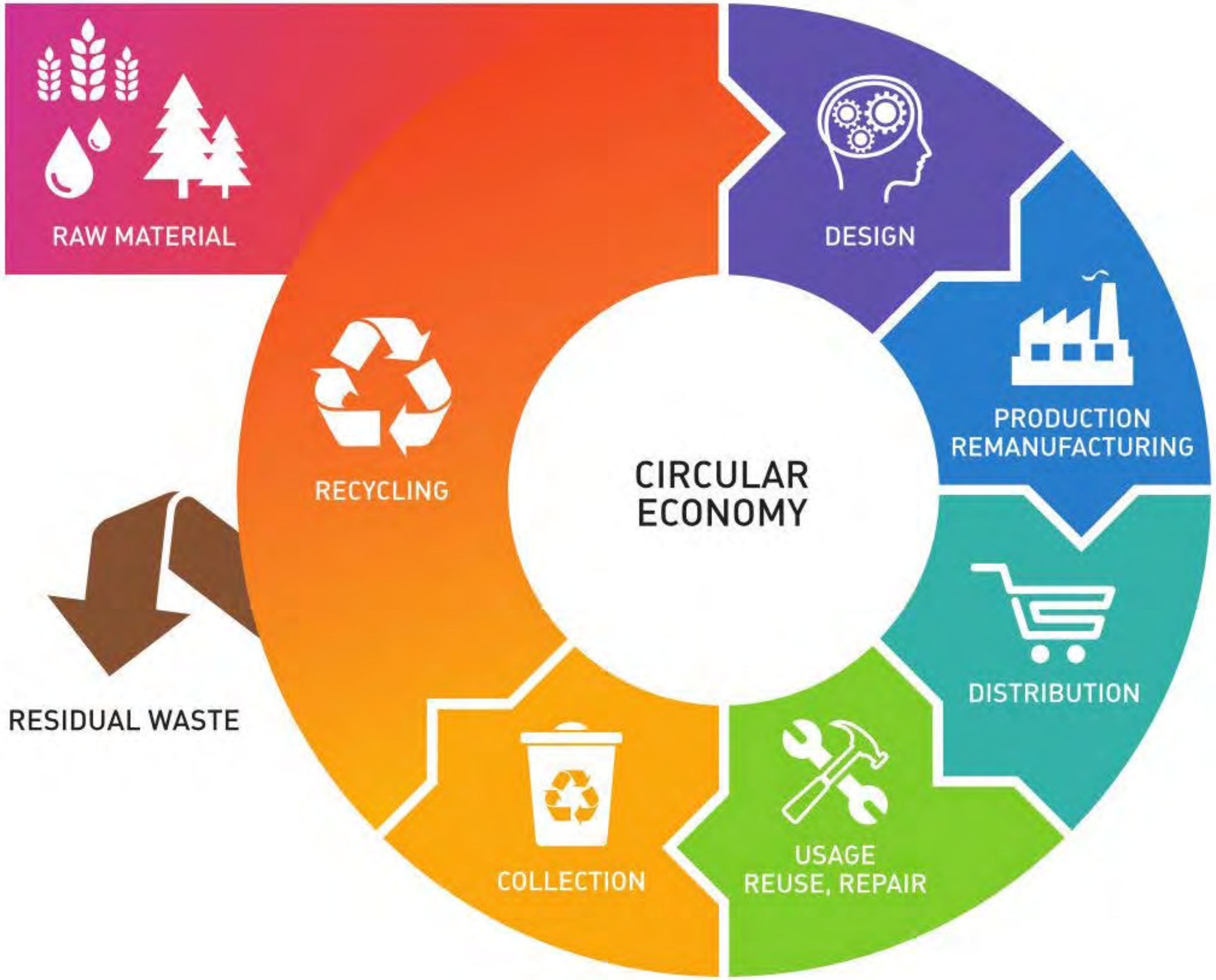

CleanEnviro
Summit
Singapore
Transforming Tomorrow's Cities
with Clean Environment Solutions
8-12 July 2018 | Sands Expo & Convention Centre | Marina Bay Sands, Singapore
www.cleanenvirosummit.sg


How can a country like singapore that imports most of its resources and products really apply circular economy or smart manufacturing ?
26 votes
Anonymous
CleanEnviro
Summit
Singapore
Organised by
National
Environment
Agency

A member of World Economic Forum (WEF)'s Committee on Future of Production- Sustainability

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD



Source: World Economic Forum

Researcher:

- A World's Most Influential Scientific Mind (Thomson Reuters)
- Highly Cited Researcher by Clarivate Analytics (~1000 journal papers, 73,000 citations; ~127 H-index)
- Five start-up companies and marketed products
- Fellow of UK Royal Academy of Engineering, and Singapore Academy of Engineers
- Fellow of ASME, AIMBE, BSE, AAAS, ASM, IMechE, IMMM, NAE, and IES

Education:

- PhD (University of Cambridge)
- The General Management Program (Harvard University)

Global Professional:

- Founder, Global Engineering Deans Council (www.gedc.org)
- Vice-President, International Federation of Engineering Education Societies (IFEES)
- World Economic Forum (WEF)'s Committee on Future of Production- Sustainability
- Advisor to the Governments, Corporations and think-tanks around the world

Academic Leadership Experience:

- Vice-President (Research Strategy), NUS
- Dean, NUS Faculty of Engineering (& Vice-Dean & Sub-Dean)
- Founding Director, NUS Enterprise
- Director, NUS Industry Liaison Office
- Founding Director NUS Nanoscience & Nanotechnology Initiative
- Founding Director, NUS Bioengineering Initiative
- Founding Chairman, Solar Energy Institute of Singapore (SERIS)
- Mentor, Nuclear Energy Research & Education Study Group

We are living in interesting times !


MORNING!
MORNING!
MORNING!


Robot Suitcase
CES
2016
© YouTube/Cowa Robot

In October 2017, the robot (Sophia) became a Saudi Arabian citizen, the first robot to receive citizenship of any country

(Sophia_(robot)

Tech Industry

World's GDP ~ $78 trillion

GAFA: $3 trillion
Google, **A**pple, **F**acebook and **A**mazon

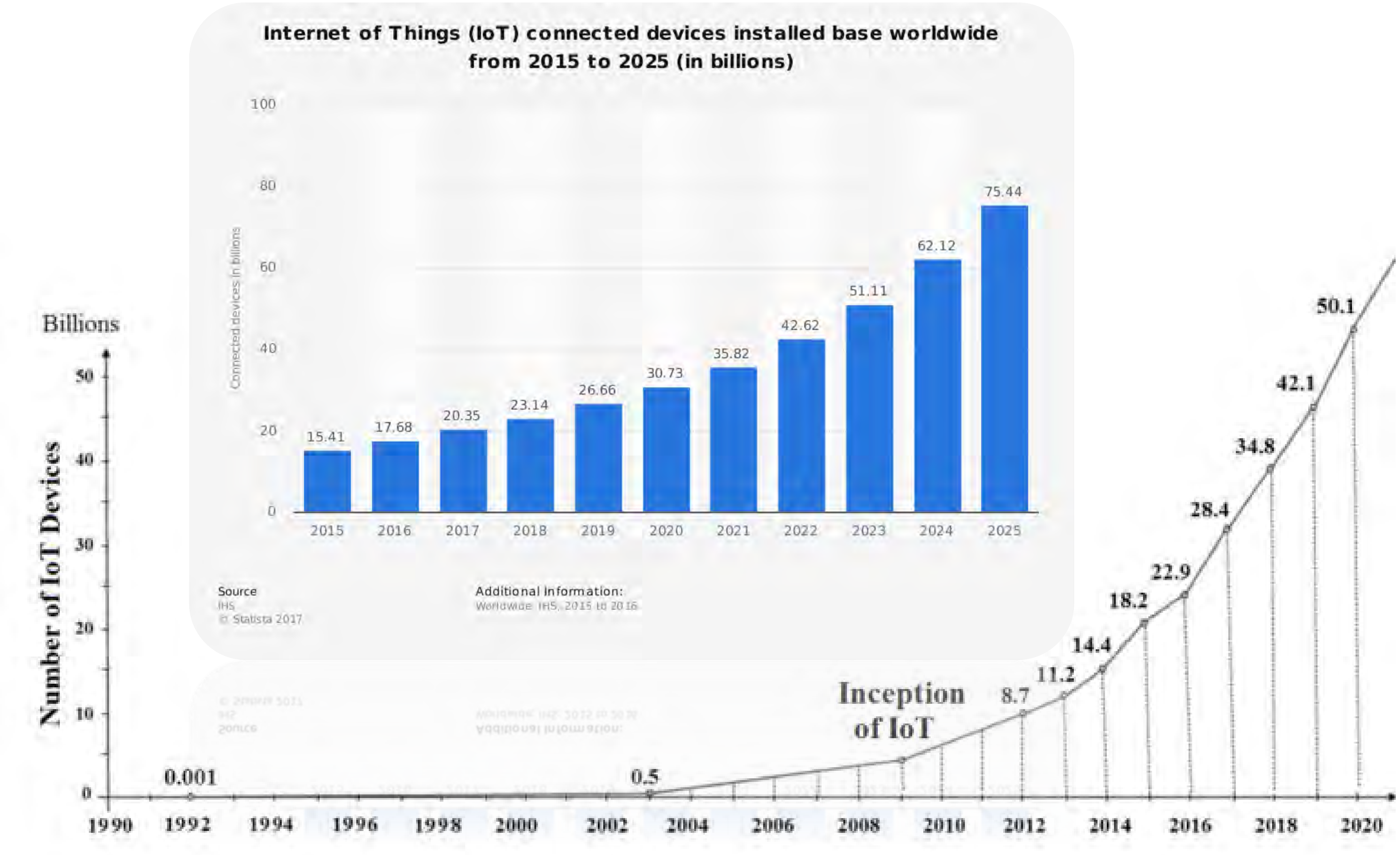
BAT: $1.5 trillion
Baidu, **A**libaba and **T**encent

Trending Technologies	
Social & Mobile	Mainstream
Cloud Computing	Scaling
Big Data & Analytics	Scaling
IOT, Internet of Things	Emerging
Block-chain	Emerging
AI, Artificial Intelligence	Nascent
VR, Virtual Reality	Nascent
Robotic Process Automation	Nascent
3D Printing	Nascent

Only 15 economies out of 191 economies have GDP above $1 trillion

http://statisticstimes.com/economy/countries-by-projected-gdp.php

Trend in growth in IoT (1990-2020)



Kashif Naveed et al. Technology in Society (2017), https://doi.org/10.1016/j.techsoc.2017.11.003

IoT in Textiles Industries

Zara now designs and stock an outfit in its stores around the world in 20 days!

Concept to store: Four steps over 21 days

The secret to Zara's success in fast fashion lies in its responsive, data-driven supply chain.

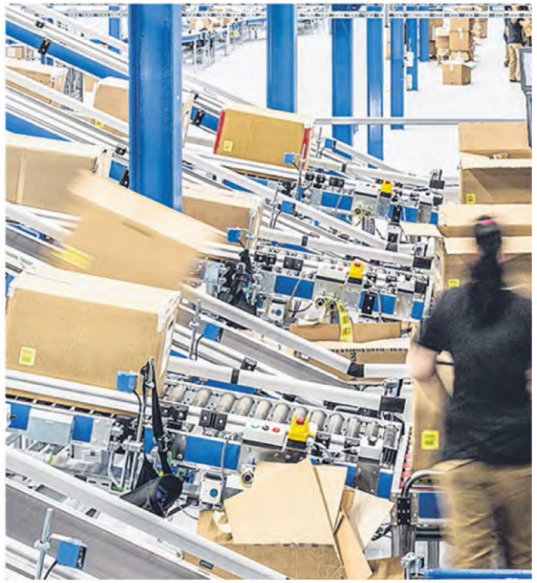
The brand has 2,213 outlets in 93 markets and e-commerce stores in 41 of them. The individual outlets operate like feedback portals, feeding information daily on product sales, returns and trends to Zara's headquarters in La Coruna, Spain.

In this hub of activity, market analysts digest the data and relay it to designers and the commercial team. Production is quickly halted for designs that are not selling well, while successful designs are tweaked to fit trends, keeping stocks and wastage low.

1 Based on feedback from market analysts, global trends are identified and new designs (above) created daily. Designers sit next to commercial teams, which allows for quick discussions about costing and design. Crucial decisions on style, colour and fabric as well as estimates of manufacturing costs can be made in a few hours, allowing resources to be committed quickly for production.

Crucial decisions about style, colour and fabric, as well as estimates of manufacturing costs, are often made between design and commercial teams (left) in a few hours, allowing resources to be committed quickly for production.

2 Once a design is finalised, pattern-makers quickly create a prototype (above), which can then be tweaked for fit. When the green light is given, specifications are sent to cloth-cutting machines in Zara factories – mainly in Spain, but also in countries such as Portugal, Morocco and Turkey – where they are stitched and assembled. The trendiest items are manufactured closest to Spain, so that total production time can be usually capped at two or three weeks.



3 Zara stores make orders twice weekly – before and after the weekend. Items are shipped (above) with the price labels tagged and most items hung on hangers, allowing stores to replenish stocks quickly. Shipping takes up to 36 hours for European stores and 48 hours for the rest of the world.

Zara by numbers

1975
Year founded

$15.7 billion
Brand value according to Forbes

2,213 Zara stores in 93 countries

313 Zara outlets in Spain

193 Zara outlets in China

128 Zara outlets in France

78 Zara outlets in the US

4 The quick turnaround time means Zara stores continually look fresh. At the headquarters, there are mock-up stores for Zara Women, Men, Kids and Home, where stylists plan storefront displays and coordinate looks so similar trends can be displayed together. This information is relayed to stores around the world so their store facades look similar.

Items are also styled and photographed in-house (left) so the e-commerce experience is seamless across different markets.

PHOTOS: ZARA STRAITS TIMES GRAPHICS

IoT Example No. 3: Rolls-Royce

Rolls-Royce, which manufacturers not only luxury cars but also aircraft engines, offers an IoT example that involves capturing data about engine performance. Planes using Rolls-Royce engines can wirelessly and automatically send information about flight plans, weather, technical logs and even fuel usage back to employees so they can track potential problems and schedule replacement of parts, such as fuel pumps, before they go bad. Capturing and analyzing this data can also tell Rolls-Royce which factors impact plane fuel efficiency, including weather and maintenance – they can then share this information with their customers.

Applying machine learning algorithm to IoT

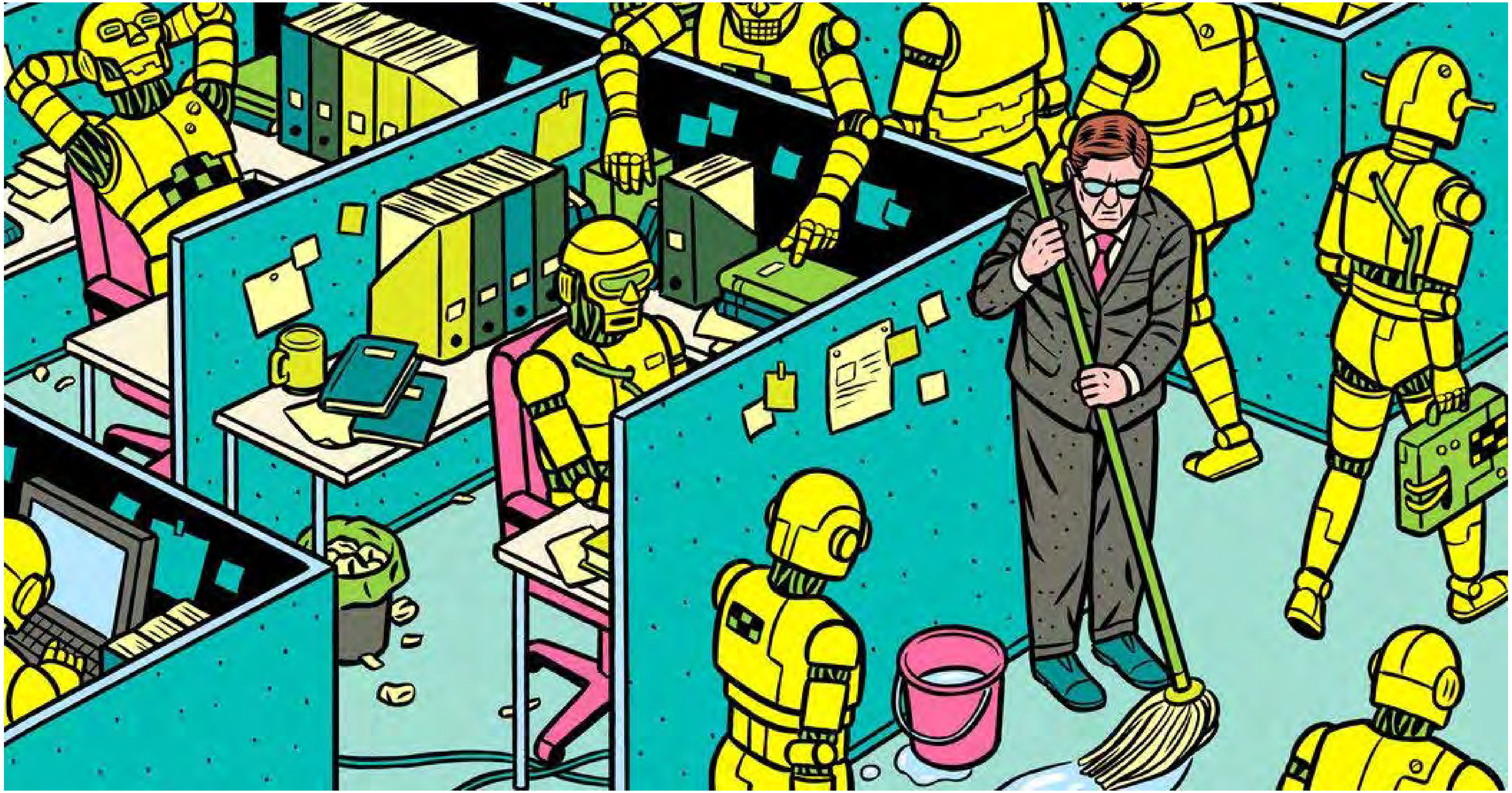
Machine learning Algorithm	IoT, Smart City use cases	Metric to Optimize
Classification	Smart Traffic	Traffic Prediction, Increase Data Abbreviation
Clustering	Smart Traffic, Smart Health	Traffic Prediction, Increase Data Abbreviation
Anomaly Detection	Smart Traffic, Smart Environment	Traffic Prediction, Increase Data Abbreviation, Finding Anomalies in Power Dataset
Support Vector Regression	Smart Weather Prediction	Forecasting
Linear Regression	Economics, Market analysis, Energy usage	Real Time Prediction, Reducing Amount of Data
Classification and Regression Trees	Smart Citizens	Real Time Prediction, Passengers Travel Pattern
Support Vector Machine	All Use Cases	Classify Data, Real Time Prediction
K-Nearest Neighbors	Smart Citizen	Passengers' Travel Pattern, Efficiency of the Learned Metric
Naive Bayes	Smart Agriculture, Smart Citizen	Food Safety, Passengers Travel Pattern, Estimate the Numbers of Nodes
K-Means	Smart City, Smart Home, Smart Citizen, Controlling Air and Traffic	Outlier Detection, fraud detection, Analyze Small Data set, Forecasting Energy Consumption, Passengers Travel Pattern, Stream Data Analyze
Density-Based Clustering	Smart Citizen	Labeling Data, Fraud Detection, Passengers Travel Pattern
Feed Forward Neural Network	Smart Health	Reducing Energy Consumption, Forecast the States of Elements, Overcome the Redundant Data and Information
Principal Component Analysis	Monitoring Public Places	Fault Detection
Canonical Correlation Analysis	Monitoring Public Places	Fault Detection
One-class Support Vector Machines	Smart Human Activity Control	Fraud Detection, Emerging Anomalies in the data

M.S. Mahdavinejad et al. Machine learning for Internet of Things data analysis: A survey, 2017, https://doi.org/10.1016/j.dcan.2017.10.002

Emerging **industrial revolution (Industry 4.0)** characterized by a confluence of new technologies, from Internet of Things (IoT), machine learning, cloud computing, big data analytics, artificial intelligence (AI), sensors, robots, 3D printing, wearables, to mind-technologies, biotechnology and nanotechnology will transform production systems, business models, economic growth, employment, and sustainability.

http://www.europeanbusinessreview.com/smart-manufacturing/

Humans will be paid based on how well they will work with digital technologies!



https://en.wikipedia.org/wiki/Martin_Ford_(author)

Singapore in 2065

Expect smart technologies, healthcare innovations and upgraded infrastructure

AS A professor at the National University of Singapore, it is natural for me to imagine Singapore in 2065. By then all my mentees would be basking in the glory of their mentees, and I would be 100 if I am still alive. It is a gamble for anyone to predict the future. Yet we cannot resist! How Singapore will be in 2065 depends very much on how the world turns out to be, and which innovations Singapore absorbs along the way.

Like Singapore, Moore's Law – which predicted the future of integrated circuits, the heart of computing and smart devices – turned 50 this year. The co-founder of Intel Gordon Moore famously made an empirical observation in 1965 about how the number of transistors that could fit on a single silicon chip would double every two years thereby increasing computing power and speed. Intel's latest chip offers 3,500 times more computing performance, is 90,000 times more energy efficient and costs about 60,000 times less compared to its first generation chip. We now have personal computers, smartphones and the Internet. By 2065 I wish to see more technologies using this law which will lower the cost of living and make rapid improvements in living standards.

Fifty years from now, economic growth facilitated by innovations in finance, commerce and political governance will enable people around the world to be glocal (i.e. global as well as local) in their mindsets and workplaces. They would be more concerned about the sustainability of the world for future generations, influenced by clean water shortages and undesirable consequences caused by climate change. How will these end points impact Singapore in its transformation to 2065?

SEERAM RAMAKRISHNA

According to Emporis, which lists the world's top skylines, Singapore with 4,562 tall buildings is ranked third behind New York (6,091) and Hong Kong (7,794). I imagine that by 2065, Singapore's skyscrapers will increase and be three times taller than the current ones with automated carpark systems and smart home appliances. They will be smarter and enable us to find the nearest and cheaper carparks, efficiently water green spaces, ensure security, save energy and handle waste with robots.

Lush green spaces in Singapore will grow and be recognised the world over for their uniqueness. Singapore will turn waste into a resource, and even export it to the world. Carbon footprinting of products and services will become the vogue, and building materials and construction methods reimagined to lower the carbon footprint.

Singapore will be monitoring polluting particles and gases to facilitate higher standards of healthy, urban living. Finance and international trading aspects of the economy will grow further. All electric transportation will go mainstream and information sent to our smartphones so we can share rides and find cost-effective parking spots and dining places. Drones will deliver food, groceries and purchases where and when we need them. Urban farming and nutritious diets will be favoured by Singaporeans. E-shopping will be the new normal. We will have our energy needs met at least up to a quarter by renewable sources.

Owing to our robust electricity system we may become the biggest data centre of the region and perhaps the world. We may be supplying clean water, clean energy and nutritious food to the region. We will be mitigating the rise of the sea level while leveraging on opportunities with the emergence of new shipping and trading routes via the Arctic.

The World Health Organisation expects that one in four people in the world will be above 65. As people pay more attention to health and well-being, they are likely to use more medicines and medical devices in addition to pursuing healthy lifestyles. As much as a quarter of our body weight is likely to be various medical devices! Aside from healthcare innovations, Singapore will have upgraded amenities, infrastructure (smart technologies-enabled walkways, building access, public transportation and roads), healthcare facilities, and opportunities for learning and skills upgrading.

Singapore in 2065 could be a key global node for finance, healthcare, sustainable technologies, dining, entertainment and space tourism. It will be a leading example of a livable city with high quality, smart infrastructure.

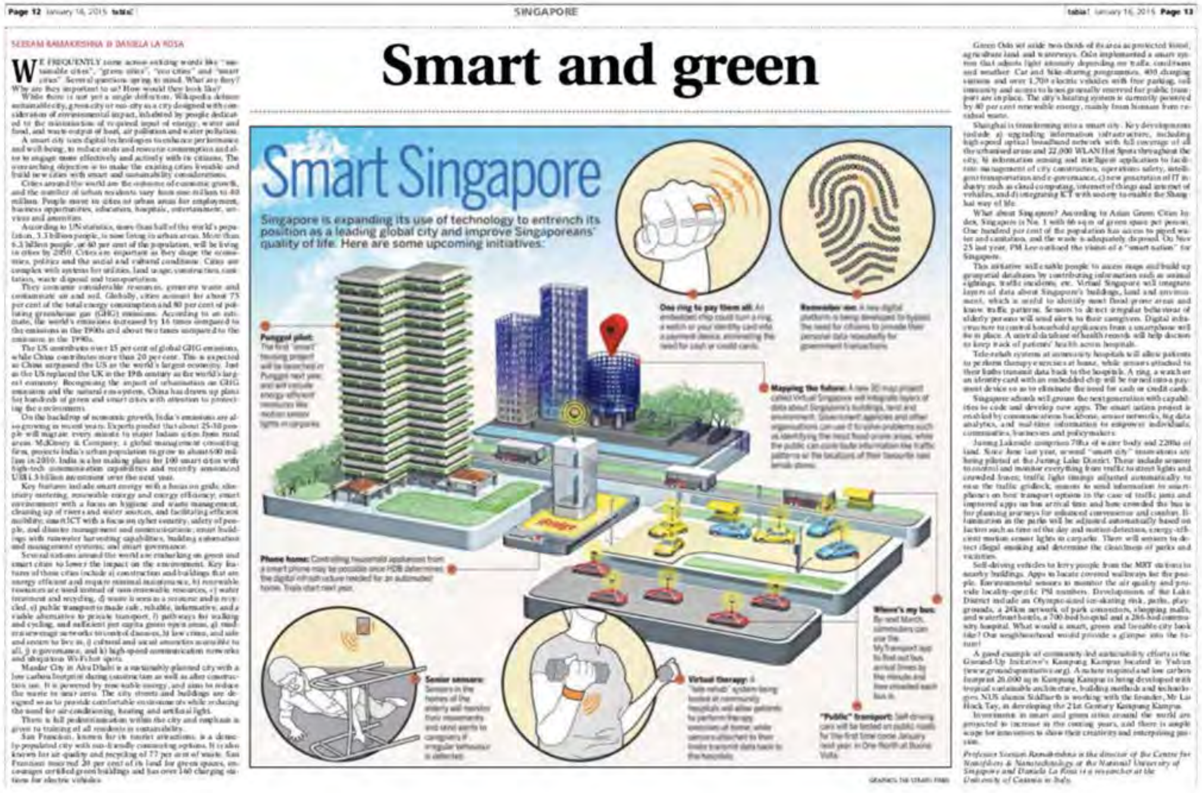
Professor Seeram Ramakrishna is the director of the Centre for Nanofibers & Nanotechnology at the National University of Singapore.

New Engineering Jobs in 2050
Co-Robot Engineers
Smart Electronics Engineers
Cyber Engineers
Virtual Reality Engineers
Organ/Tissue Engineer
Smart grid engineer
3D Printing or Additive manufacturing engineer
Digital manufacturing engineer
Machine/Human Interface Engineer
AI engineer or AI App Developer
Urban factory designers
Life Cycle Engineering Engineer or Green Engineer
Sub-terrain Engineers
Deep ocean engineers
IoT Engineers
Battery engineer
Electric vehicle engineer
Wind and Solar Power Engineer
Biologics Engineers
Urban Farmer
Food Engineer

New Engineering Jobs in 2100
Mind (Mentalist) engineer
Idea engineer
Brain engineer
Gene engineer
Synthetic Meat and Food Engineer
Food design engineer
Climate Engineer
Ozone Engineer
Space Traffic Engineer
Maintenance Engineer for Intelligent Machines
Urban farmer
Deep ocean engineer
Digital currency engineer
Biomedical Implants engineer
Wearables Engineer
Health Engineer
Medical Imaging Engineer
Media Engineer
Solutions Engineer
Medical Diagnostics Engineer

Smart Nation
SINGAPORE

to tackle transportation, security,
climate change, healthcare challenges



SINGAPORE

Smart and green

Smart Singapore

Singapore is expanding its use of technology to entrench its position as a leading global city and improve Singaporeans' quality of life. Here are some upcoming initiatives:

http://www.europeanbusinessreview.com/smart-manufacturing/

Singapore well positioned to gain from Industry 4.0

WEF lists it as among 25 leaders in advanced manufacturing

Chia Yan Min

Singapore is among the 25 countries best positioned to benefit from the rise of advanced manufacturing and smart factories, according to a new report from the World Economic Forum (WEF).

The report analysed 100 countries and economies to see how they might benefit from the Fourth Industrial Revolution – or Industry 4.0 – and the rapid rise of new manufacturing technologies.

Singapore was identified among 25 "leaders in manufacturing today that are also well positioned for the future of production".

The Republic came in second globally – after the United States – in the report's "drivers of production" ranking, which measures key enablers that help a country take advantage of Industry 4.0. It ranked 11th in the "structure of production" category, which measures the scale and complexity of a country's manufacturing sector.

Other countries in the top 25 include Japan, South Korea, Sweden, Germany, Denmark, Britain and the United States.

Leading countries have a first-mover's advantage, the report said, noting: "Those that most effectively push the frontier and convert readiness into actual transformation can reap tremendous benefits.

"True transformation is still nascent, but leading countries are at the forefront of designing, testing and pioneering emerging technologies. Many have developed government-led strategies to capitalise on the Fourth Industrial Revolution."

The 25 leading countries already account for over three-quarters of global manufacturing value-added, the report noted.

It added that Singapore's manufacturing capabilities "have evolved considerably, with strong competencies today in high-value areas of manufacturing such as research and development and product design".

But it also pointed out no country was fully ready, let alone harnessed the full potential of the Fourth Industrial Revolution in production.

Mr Lim Kok Kiang, assistant managing director of the Singapore Economic Development Board (EDB), said the Republic's strong showing reflects efforts to build an ecosystem to drive the adoption of advanced manufacturing among large and small firms here.

Leading countries have a first-mover's advantage, the report said, noting: "Those that most effectively push the frontier and convert readiness into actual transformation can reap tremendous benefits.

EDB launched a set of guidelines last November to help manufacturers build smart factories of the future. Called the Singapore Smart Industry Readiness Index, it was developed in partnership with German manufacturer TUV SUD.

"Transformation is a multi-year journey, and more needs to be done. It is important that we continue working closely with companies, trade associations and unions to improve our competitiveness and ensure our workforce is well equipped to support and enable the future of production," added Mr Lim.

chiaym@sph.com.sg

Leaders in advanced manufacturing

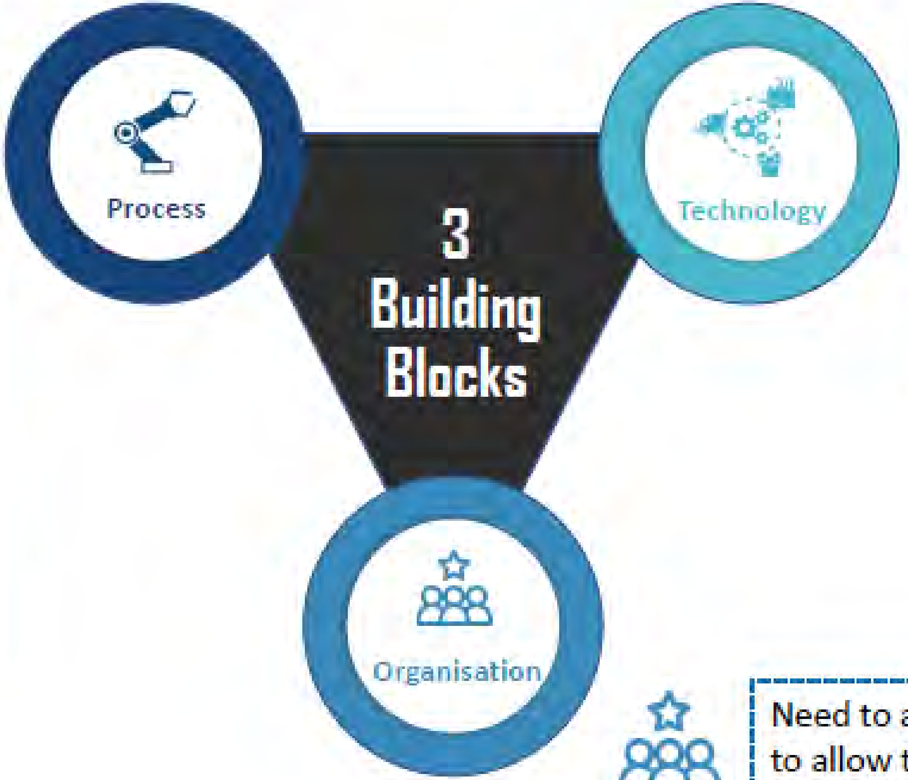
Country	Structure of production Score	Rank
Japan	8.99	1
South Korea	8.85	2
Germany	8.68	3
Switzerland	8.39	4
China	8.25	5
Czech Republic	7.94	6
United States	7.78	7
Sweden	7.46	8
Austria	7.46	9
Ireland	7.34	10
Singapore	**7.28**	**11**
Thailand	7.13	12
United Kingdom	7.05	13
Finland	7.00	14
Italy	6.99	15
Slovak Republic	6.98	16
Hungary	6.96	17
France	6.87	18
Poland	6.83	19
Malaysia	6.81	20
Slovenia	6.80	21
Mexico	6.74	22
Romania	6.61	23
Belgium	6.51	24
Israel	6.43	25

Source: WORLD ECONOMIC FORUM
STRAITS TIMES GRAPHICS

THE SINGAPORE SMART INDUSTRY READINESS INDEX

Catalysing the transformation of manufacturing

The Index: 3 Building Blocks



Process

Using technology to digitize a poorly-designed process will only result in a poorly-designed digital process. Conversely, applying technology to a well-developed process will compound the amount of improvement.

Under Industry 4.0, the concept of process improvements has expanded beyond efficiency enhancement of individual processes, to include integration of multiple processes.

Technology

A cornerstone of every major industrial revolution and remains a critical pillar for Industry 4.0.

Advanced automation & digital technologies are necessary to drive the convergence of cyber-physical systems

Organisation

Need to adapt organizational structures and processes to allow the workforce to keep pace.

2 critical elements:

(i) The people who make up the organization, and
(ii) The institutional systems that govern how the company functions

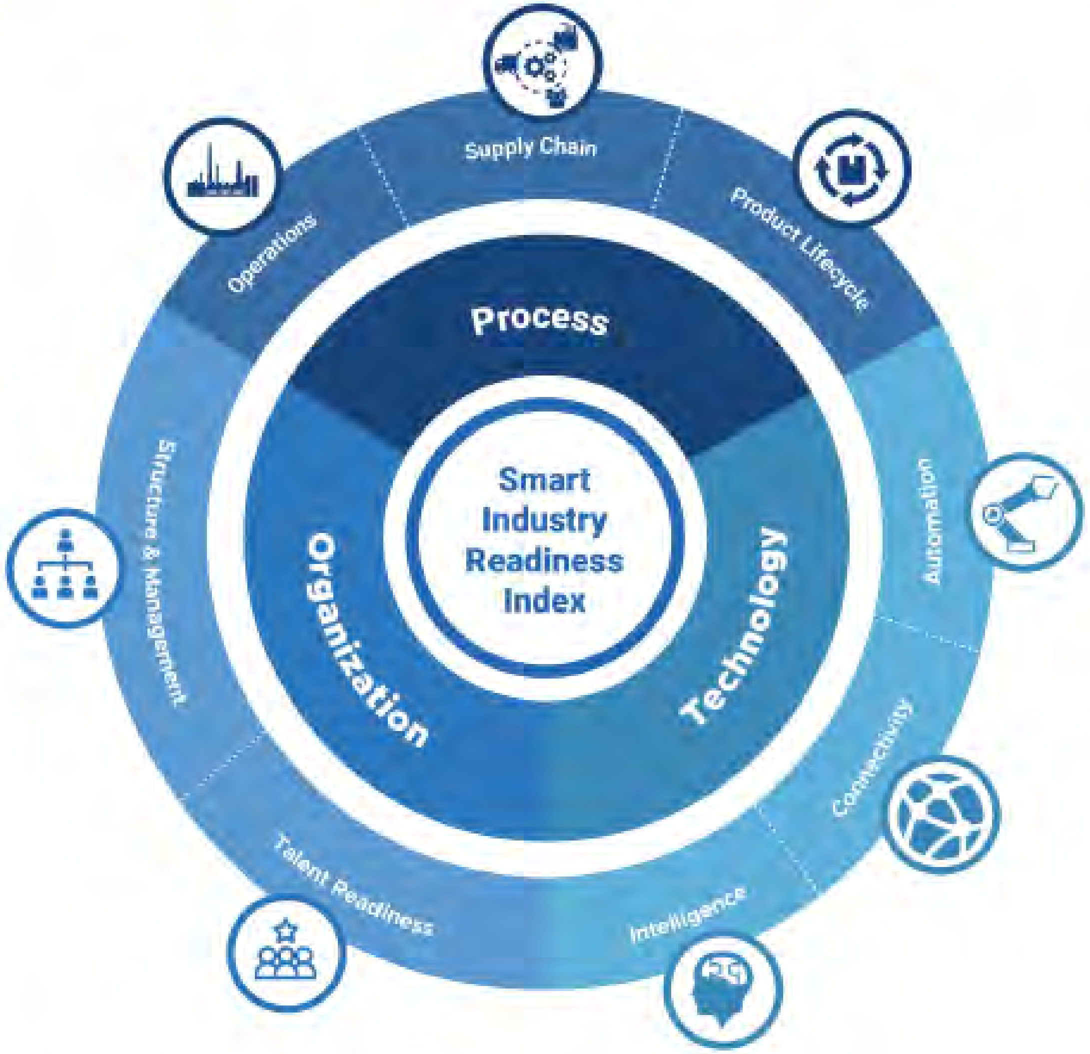
The Index: 8 Pillars

Operations
The planning and execution of processes which lead to the production of goods & services

Supply Chain
The planning & management of raw materials & inventory of a company's goods & services, from the point of origin to the point of consumption

Product Lifecycle
The sequence of stages that a product goes through, from its initial conceptualization to its eventual removal from the market

Automation
The application of technology to monitor, control, & execute the production & delivery of products & services



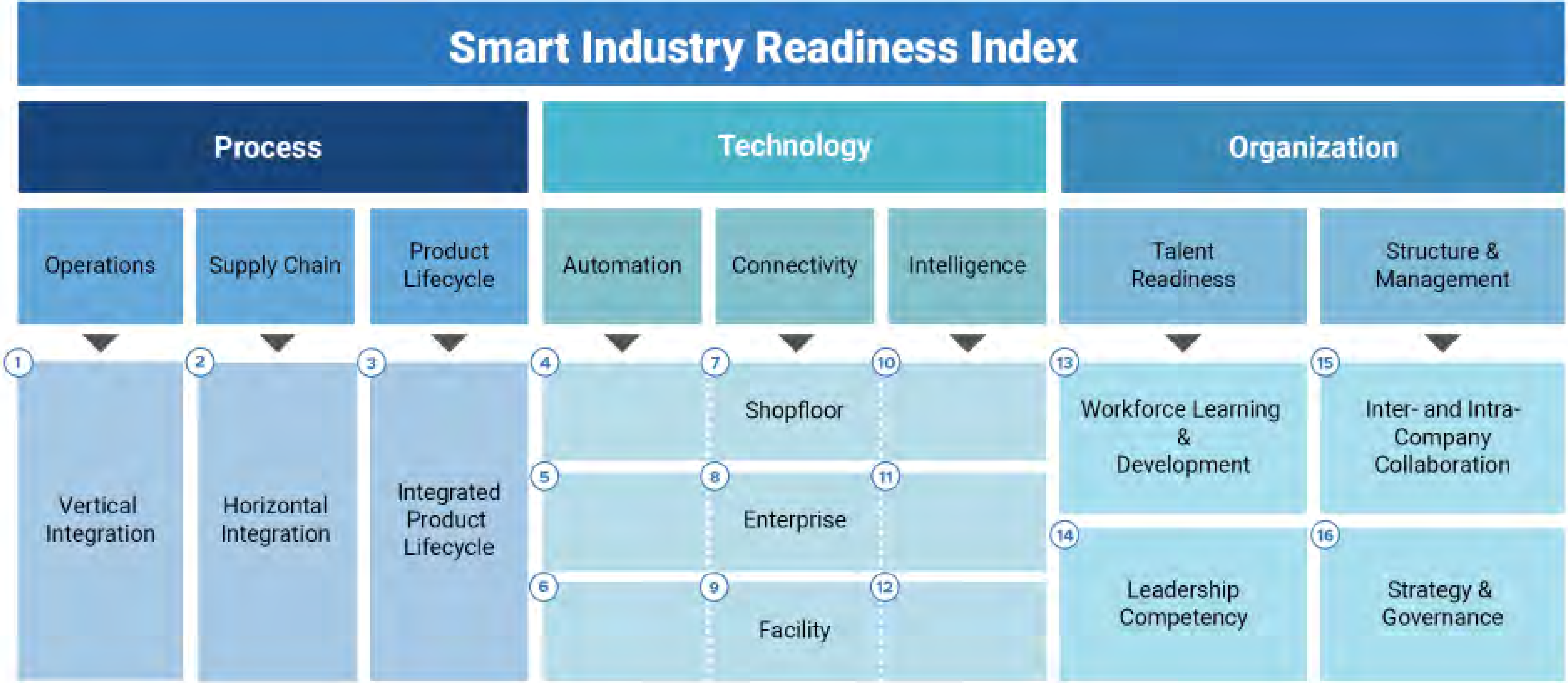
Connectivity
The state of interconnectedness between equipment, machines, & computer-based systems to enable communication & data exchange across assets

Intelligence
The processing & analysis of data collected, to diagnose problems & identify opportunities for improvement

Talent Readiness
The ability of the workforce to drive and deliver Industry 4.0 initiatives

Structure & Management
Strong leadership, supported by a clear strategy & governance framework, will enable firms to be more flexible, collaborative, & empowered to design & implement Industry 4.0 strategies effectively

The Index: 16 Dimensions



3 Dimensions under the Process Building Block

Operations

Supply-Chain

Product Lifecycle

1 Vertical Integration

Integration of processes & systems across all hierarchical levels of the automation pyramid within a facility

2 Horizontal Integration

Integration of enterprise processes across the organization and with other stakeholders along the value chain

3 Integrated Product Lifecycle

Integration of people, processes, and systems along the entire product lifecycle. This dimension also examines how data is collected, managed, and analyzed across the different stages

9 Dimensions under the Technology Building Block

Automation

Connectivity

Intelligence

4 | 7 | 10

Shop floor

Where the production and management of goods is carried out

5 | 8 | 11

Enterprise

Where the administrative work is carried out

6 | 9 | 12

Facility

Physical building and/or premises where the production area is located

4 Dimensions under The Organisation Building Block

Talent Readiness

13 **Workforce Learning & Development**

Strategy to develop the workforce's capabilities, skills and competencies to achieve organizational excellence

14 **Leadership Competency**

Readiness of the management to leverage the latest concepts and technologies for the company's continued relevance and competitiveness

Structure and Management

15 **Inter- and Intra-Company Collaboration**

Process of working together, both internally and with external partners, to achieve a shared vision and purpose

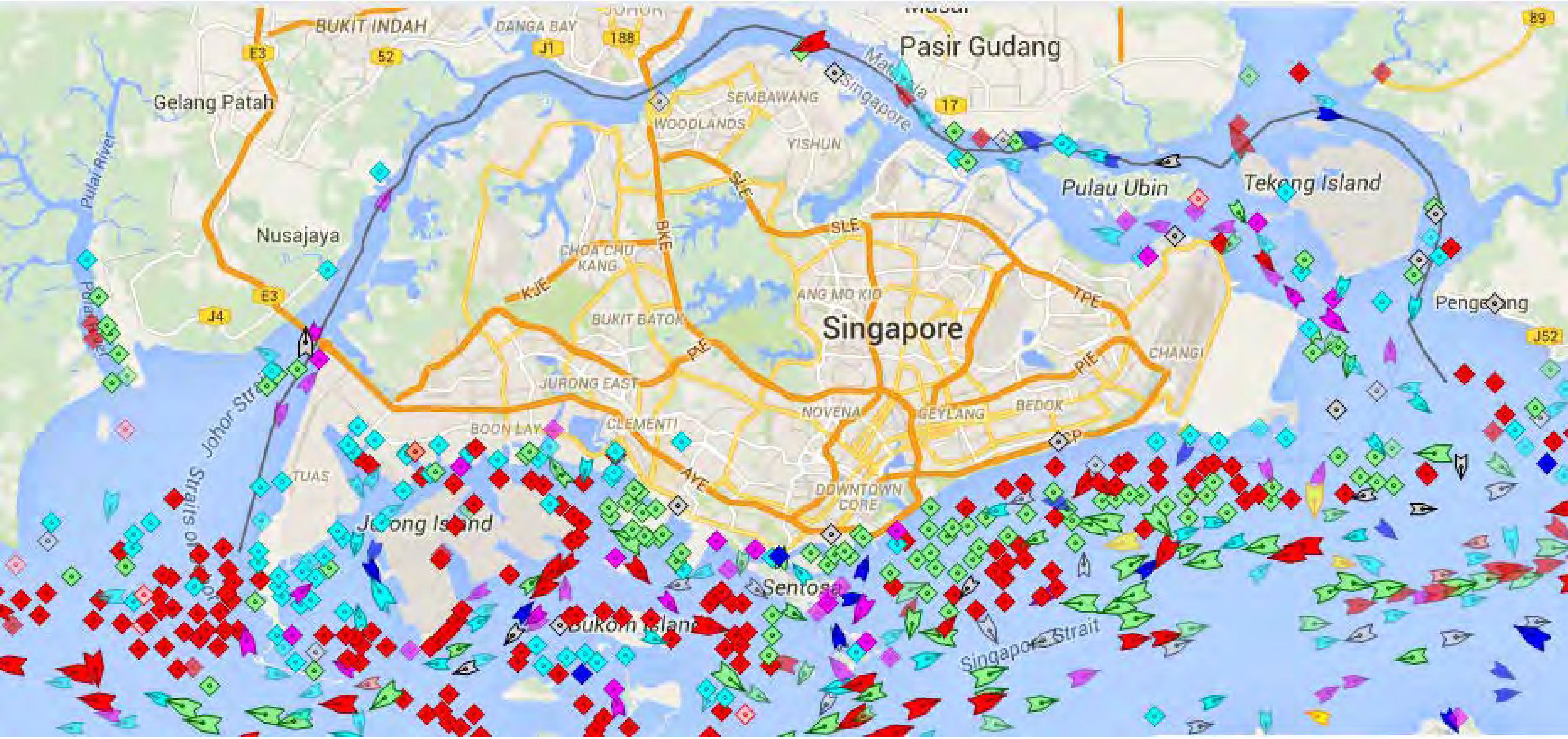
16 **Strategy & Governance**

Design & execution of a plan of action – which includes identifying priorities, formulating a roadmap, & developing a system of rules, practices & processes – to achieve a set of long-term goals

EVALUATE current state of facilities and the companies' readiness level

Process Building Block | Operations Pillar | Vertical Integration Dimension			
Vertical Integration is the integration of processes and systems across all hierarchical levels of the automation pyramid within a factory or plant within an end-to-end connected information thread.			
Band		**Definition**	**Description**
0	Undefined	Vertical processes are not explicitly defined.	Resource planning and technical production processes are managed and executed in silos, based on informal or ad-hoc methods.
1	Defined	Vertical processes are defined and executed by humans, with the support of analog tools.	Resource planning and technical production processes are managed and executed in silos, based on a set of formally defined instructions.
2	Digital	Defined vertical processes are completed by humans with the support of digital tools.	Resource planning and technical production processes are managed and executed in silos, by Operation Technology (OT) and Information Technology (IT) systems.
3	Integrated	Digitized vertical processes and systems are securely integrated across all hierarchical levels of the automation pyramid.	OT and IT systems managing the resource planning and technical production processes are formally linked; however the exchange of data and information across different functions is predominantly managed by humans.
4	Automated	Integrated vertical processes and systems are automated, with limited human intervention.	OT and IT systems managing the resource planning and technical production processes are formally linked, with the exchange of data and information across different functions predominantly executed by equipment, machinery and computer-based systems.
5	Intelligent	Automated vertical processes and systems are actively analyzing and reacting to data.	OT and IT systems are integrated from end to end, with processes being optimized through insights generated from analysis of data.

Marine Traffic



A glimpse into the future Tuas port

Held at Pasir Panjang Terminal Building 3 from Jan 10 to 17, PSA's Intelligent Port of the Future exhibition showcases its future port vision, as well as the transformation of jobs through technology and innovation. The Straits Times takes a look at the use of automation, data analytics, robotics and other applications that could be implemented at the future Tuas port.

FUTURE PORT

The current City Terminals (Tanjong Pagar, Keppel and Brani) and the Pasir Panjang Terminals will eventually be consolidated at a single location in Tuas.
The new Tuas port will be capable of handling the world's biggest ships, and will also be the largest automated container terminal globally, with a handling capacity of 65 million standard containers. It will be part of a greater ecosystem connecting various stakeholders in the logistics community, both digitally and physically.

FUTURE COMMAND CENTRE

A one-stop command platform where one operator can coordinate all automated port equipment, including Automated Rail-Mounted Gantry Cranes, Automated Guided Vehicles and Automated Quay Cranes.

SMART WEARABLES

PSA is working with ST Electronics to look at the use of smart wearables for various functions. Geofencing, together with location tracking, ensures staff going into unmanned areas will be safe from port equipment and machinery, while health-monitoring gadgets allow supervisors to monitor high-risk staff. The wearables can be used to relay instructions or provide information requested by the port specialist.

EXOSKELETON

Driven by a system of motors and linkages, the powered mobile attachment enables port specialists to perform strenuous and physically demanding motions — increasing productivity and reducing physical strain.

UNMANNED DRONES

A new breed of unmanned drones that operate autonomously in the air and on water will join the workforce. Working with on-ground Internet of Things sensor networks, drones can fulfil ship-to-shore and shore-to-ship deliveries. Drone inspections can help to minimise disruption as this means engineers can perform inspections at a safer distance, eliminating the risk factors.

ROBOTIC ARM FOR TWIST LOCK HANDLING

Currently, lashing specialists fix and remove twist locks during the container loading and discharging processes alongside the quay cranes. In the future, automatic platforms or robotic arms could be used instead – and lashing specialists will no longer need to work close to suspended heavy loads and equipment. Only a single operator is required to operate three or four robotic arm units in cases of exception or error handling.

AUTONOMOUS ENGINEERING TRANSPORTER

Sending spare parts to users via a transporter using preset navigation routes to the workshops will be a norm. Future models will be capable of navigating dynamic traffic conditions to send or return spare parts to worksites.

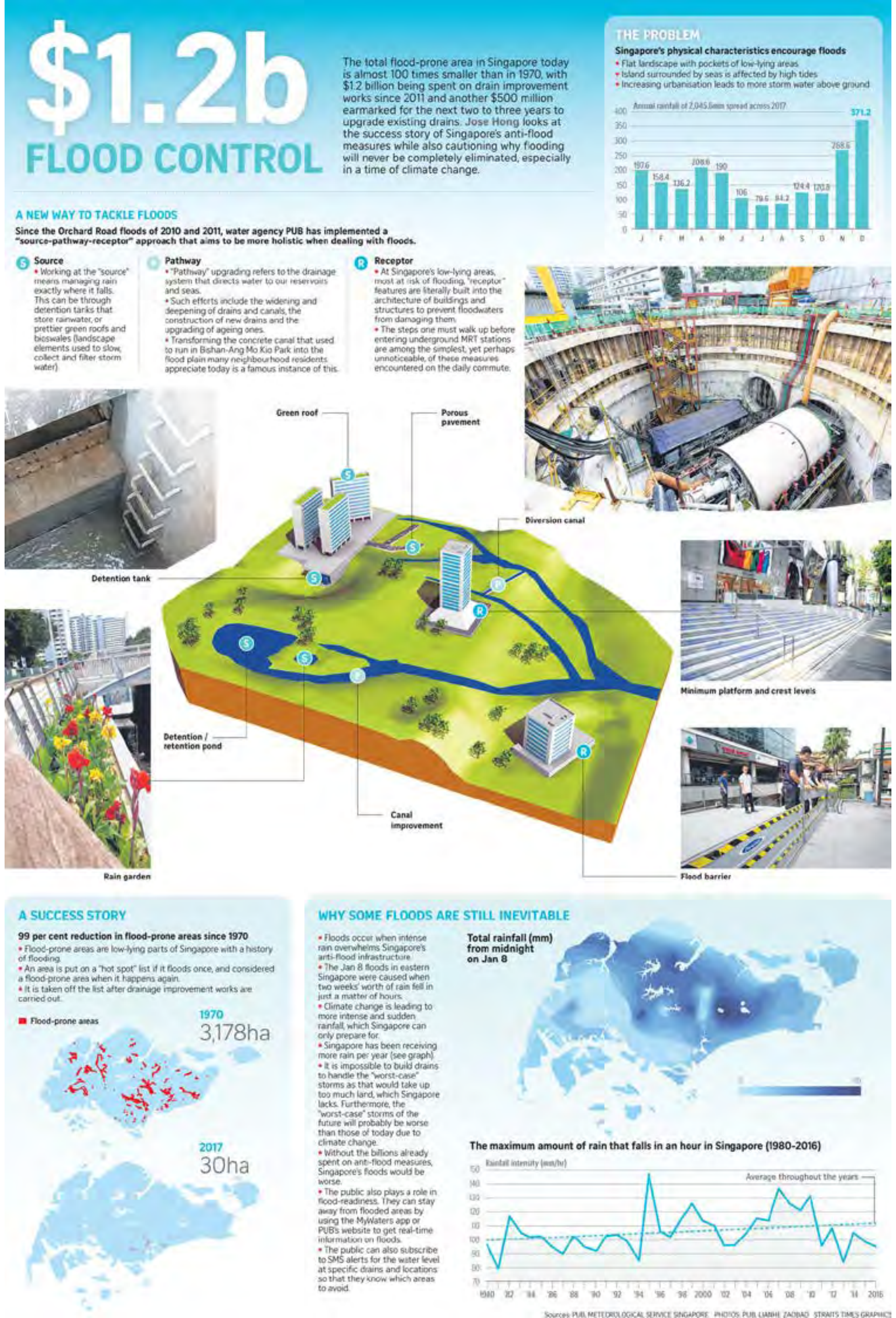
SMART GLASSES

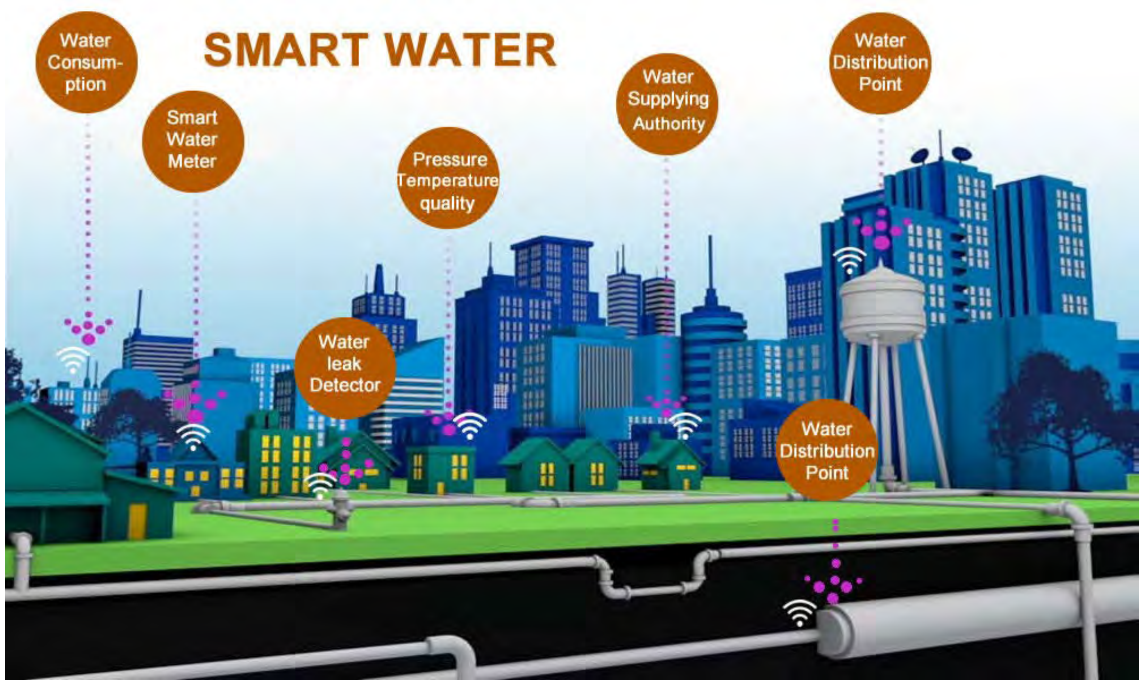
Support port equipment specialists will wear smart glasses for real-time visual aids and off-site assistance. The augmented reality (AR) technology helps to visualise equipment components and defects, reducing troubleshooting processes and the downtime of faulty equipment.
The visual guidance also acts as an effective learning experience.

Source: MPA ST PHOTOS: SIMON ANG STRAITS TIMES GRAPHICS

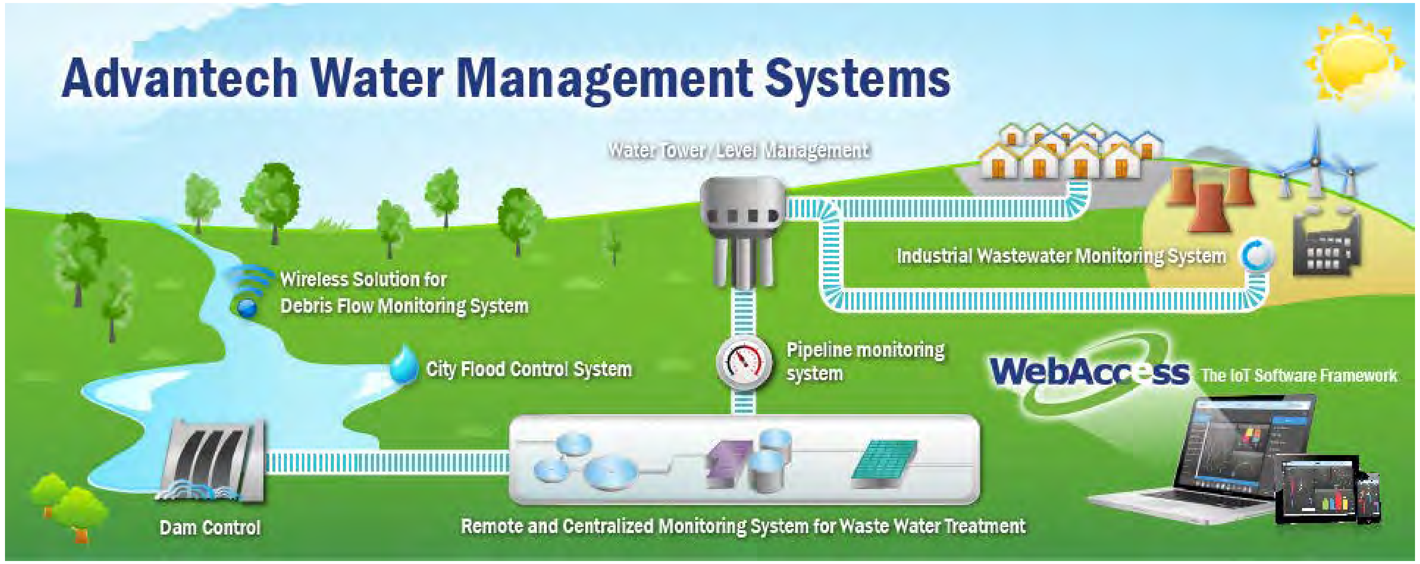
Sea robots to patrol waters


48
SERVICE
Transit





IoT and Water Management



http://www.straitstimes.com/singapore/12b-flood-control

How Singapore's land area has grown over the years

1960s: 580 sq km

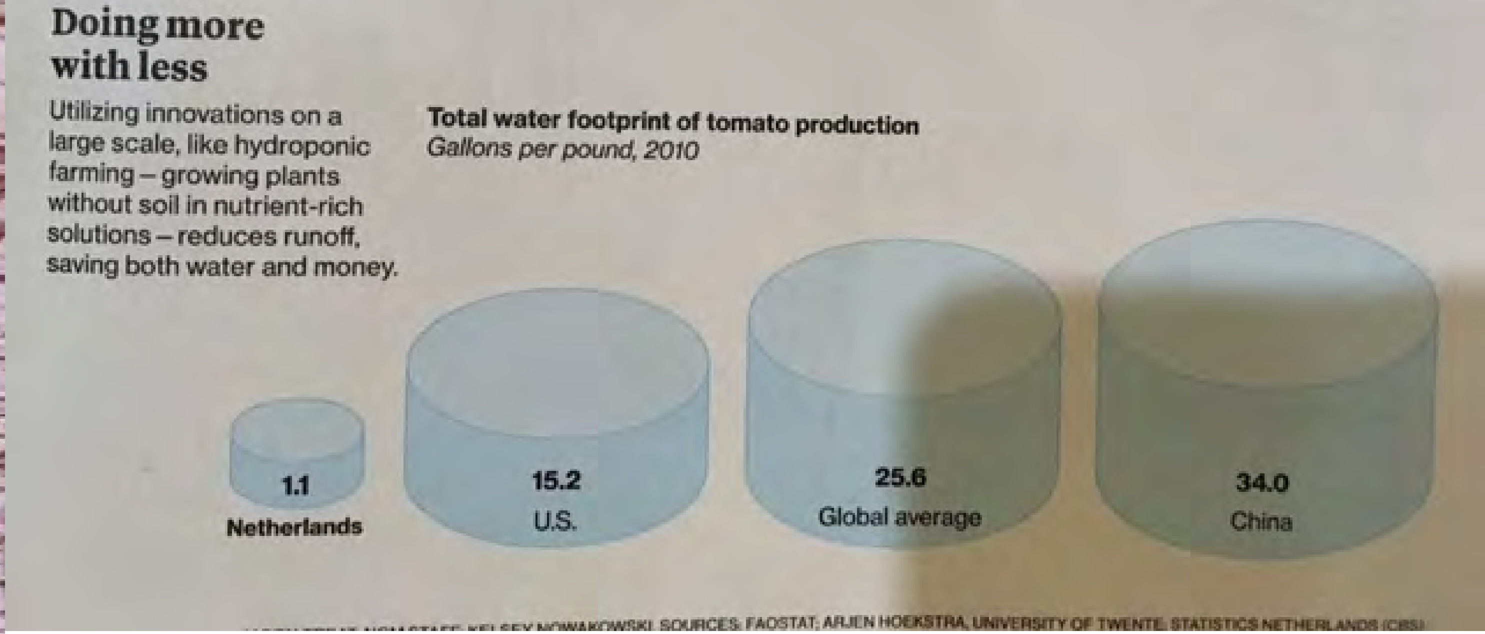
2007: 700 sq km

2017: 720 sq km

2030 (Projection)

Sources: DEPARTMENT OF STATISTICS, GOOGLE MAPS, ONEMAP.SG, MND
SUNDAY TIMES GRAPHICS

IoT & Urban Farming



Urban Farming

Digitized Farming

Clean Energy- Solar

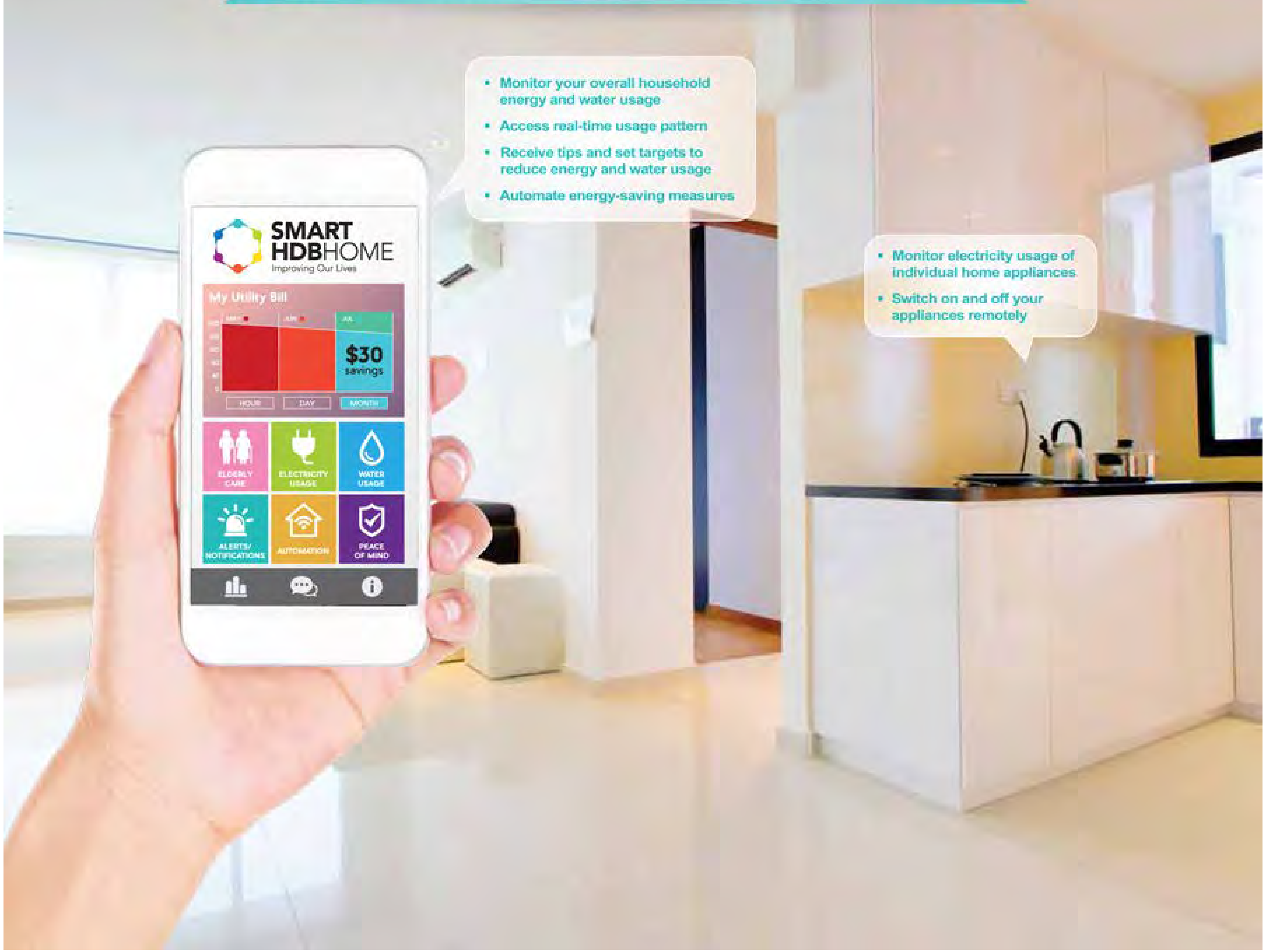
REC Solar

IoT Remote monitoring of floating solar farms!

Get your PV system green attributes endorsed by Solar Energy Research Institute of Singapore

eac.seris.sg

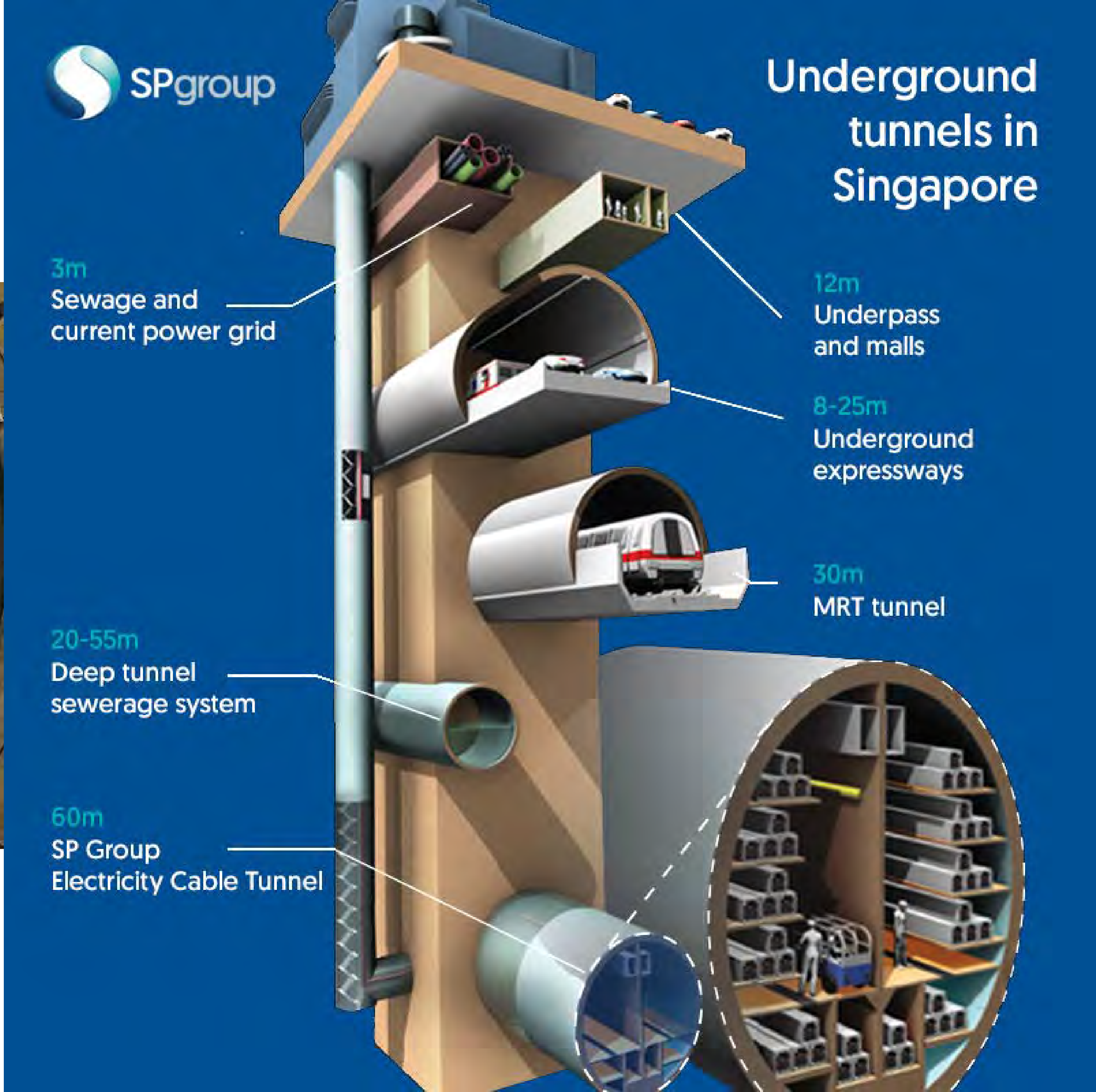
SAVE THE ENVIRONMENT AND LOWER YOUR BILLS



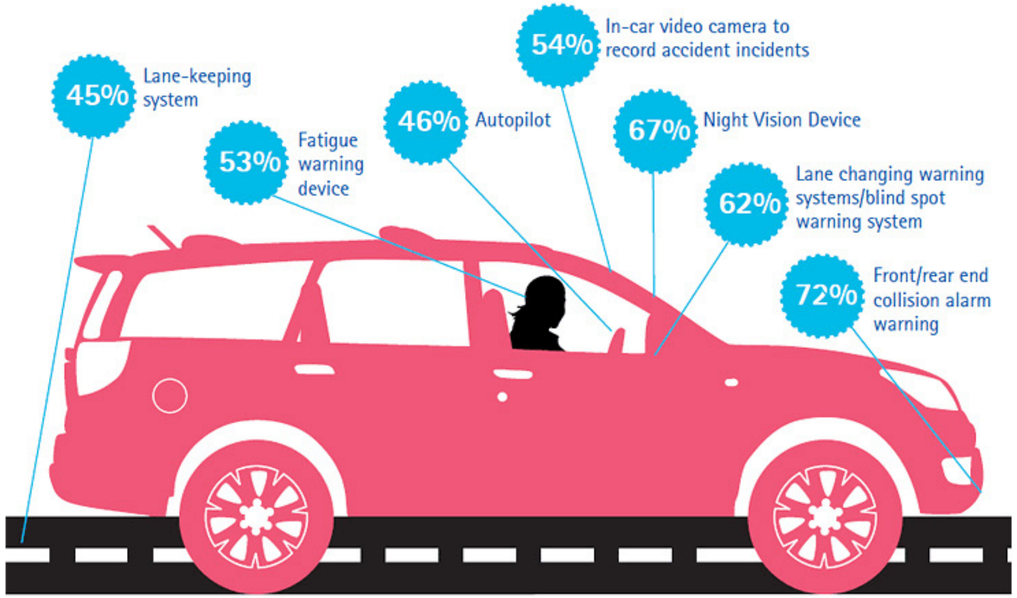
GREATER PEACE OF MIND

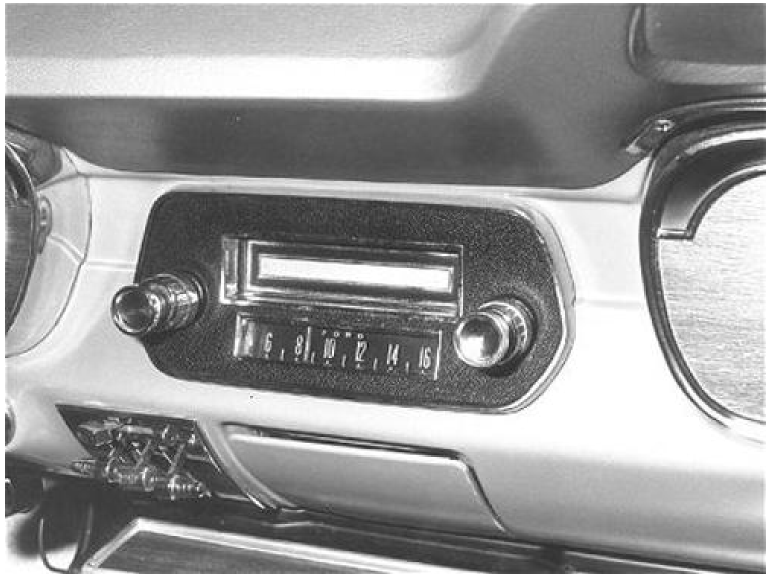

Future Living

Going Underground



Which of the information technologies/driving support systems listed below would you like to use in your car?





Vehicular Emissions Scheme

	Band				
	A1	A2	B	C1	C2
Carbon dioxide (g/km)	≤90	>90 to ≤125	>125 to ≤160	>160 to ≤185	>185
Hydrocarbons (g/km)	≤0.02	>0.02 to ≤0.036	>0.036 to ≤0.052	>0.052 to ≤0.075	>0.075
Carbon monoxide (g/km)	≤0.15	>0.15 to ≤0.19	>0.19 to ≤0.27	>0.27 to ≤0.35	>0.35
Nitrogen oxides (g/km)	≤0.007	>0.007 to ≤0.013	>0.013 to ≤0.024	>0.024 to ≤0.03	>0.03
Particulate matter (mg/km)	=0.0	>0.0 to ≤0.3	>0.3 to ≤0.5	>0.5 to ≤2.0	>2.0
Rebate/ surcharge (-/+) for cars	**-$20,000**	**-$10,000**	**Neutral**	**+$10,000**	**+$20,000**
Rebate/ surcharge (-/+) for taxis	**-$30,000**	**-$15,000**	**Neutral**	**+$15,000**	**+$30,000**

Source: NATIONAL ENVIRONMENT AGENCY
STRAITS TIMES GRAPHICS

Source: Ministry of Transport.

SensorComm Technologies

Consumer Electronics Show (CES) Eureka Park Climate Change Innovator Award winner for 2018

GHG Reduction, Extreme Weather, and Sustainability:
There are an estimated 263 million registered vehicles in the U.S. and 1.2 billion registered vehicles globally.

Wi-NO_x™ MONITORING SYSTEM

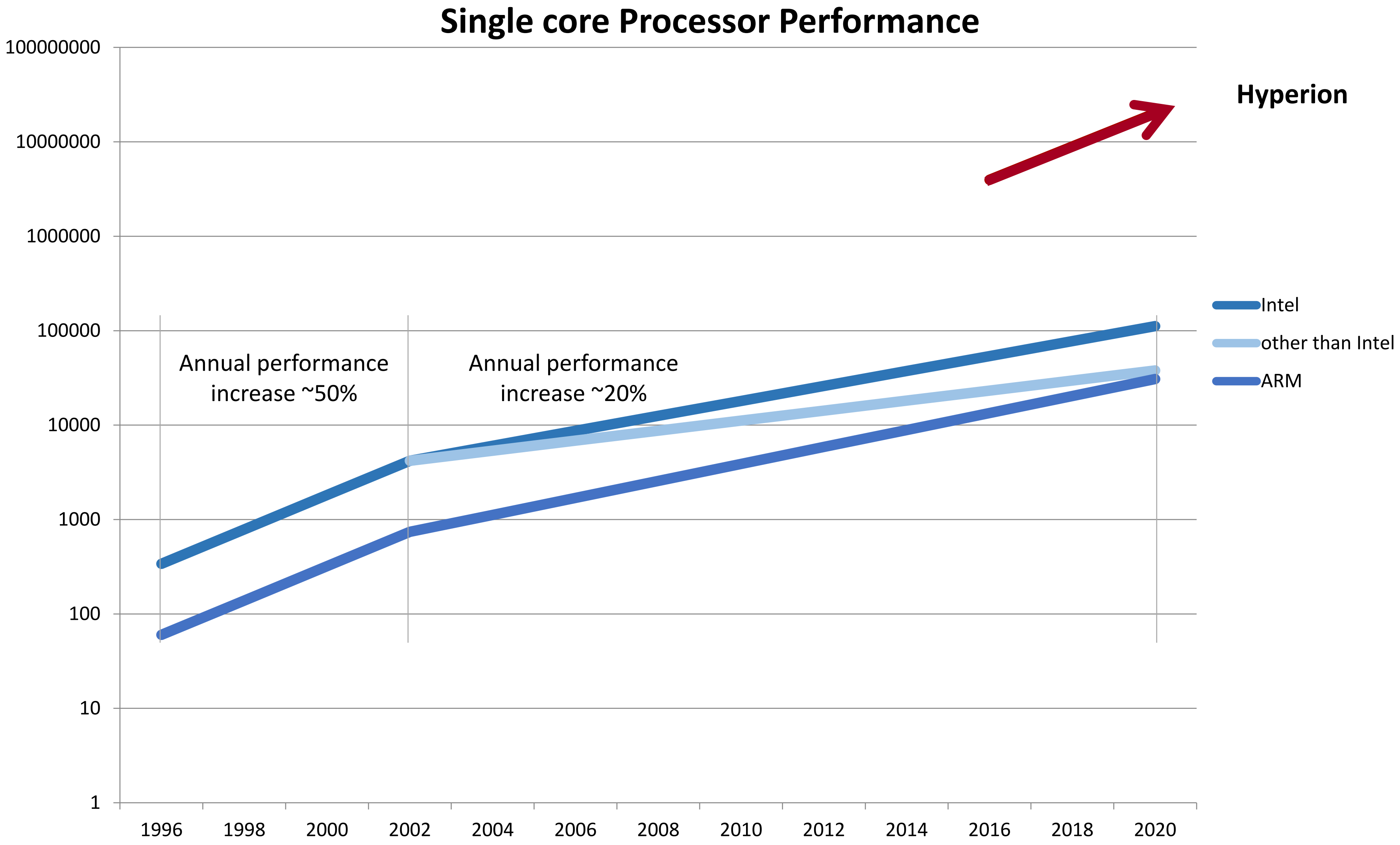
- IoT capability allows for collection of the NO_x data continuously (or at pre-specified intervals)
- Backup data is stored on-board in the sensor readout electronics

- Data is simultaneously transmitted over the communications network to a cloud-based database for real-time smart NO_x monitoring

http://sensorcommtech.com/

These mega trends demand for new microprocessors with new architecture.

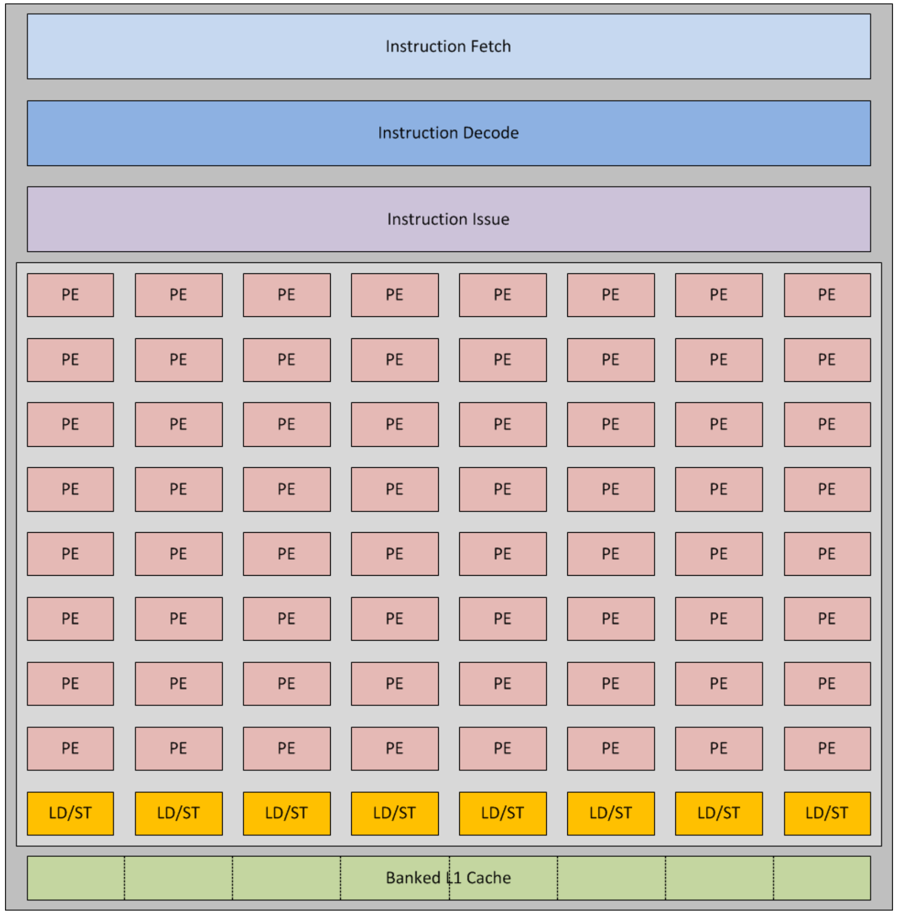
HYPERION CORE



Based on source: Hennessey and patterson, „Computer Architecture: A Quantitative Approach“

Hyperion-Core offers a new start with its Polymorphous Processor Platform. It increases processing power by up to 100-times while protecting the worldwide Software infrastructure. Based on the modern RISC-V ISA it fits into the growing RISC-V ecosystem.

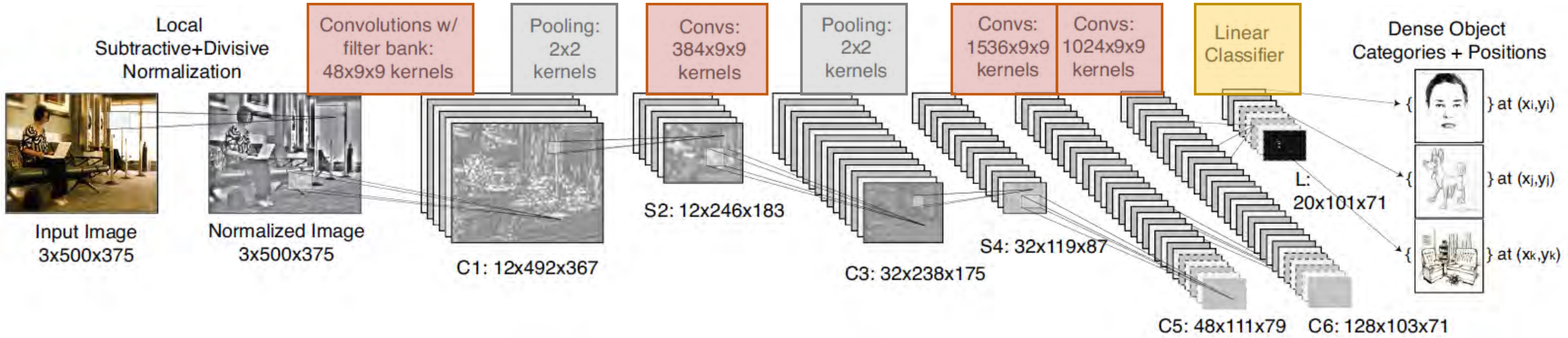
- **Array of Processing Elements (PEs)**
  - Replacing superscalar row of Execution Units, Reservation Stations and Reorder-Buffer
  - Distributed Register File formed by PE result registers
- **Two major processing modes:**
  1) Superscalar Out-of-Order
     - Instruction window equals size of array
     - High ILP, only limited by data availability
  2) Loop Acceleration, fully pipelined
     - Semi-static for loop processing: issued instructions remain the same until loop is completed
     - High ILP dataflow processing
- **Array shared by many threads**
- **Supporting all levels of parallelism:**
  - Multi-core
  - Superscalar
  - Slot independent Out-of-Order processing
  - Multi-Threading
  - Deep Pipelining / Dataflow Loop Acceleration



85% data processing area
15% area overhead for housekeeping

Convolutional Neural Networks, CNN on Hyperion

HYPERION CORE

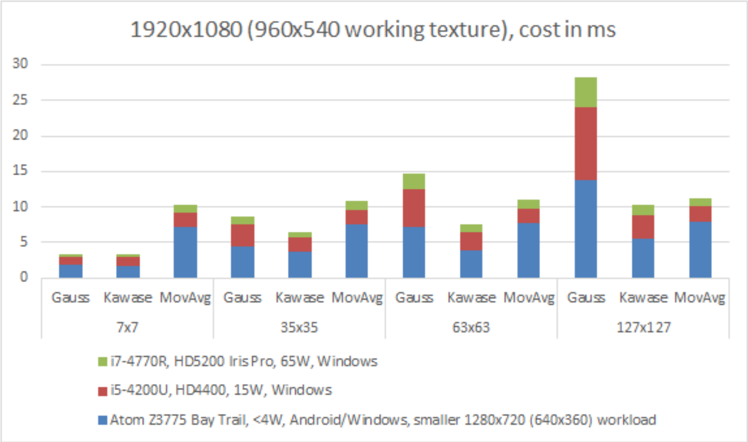


- **32 billion 7×7 convolutions per second**
- **512 billion 2×2 MaxPool per second**
- **206 million 3072×3 Linear Classifications per second**

Performance Comparison:

Time required to process a 7×7 convolution
(Gauss filter on a 960×540 working texture):

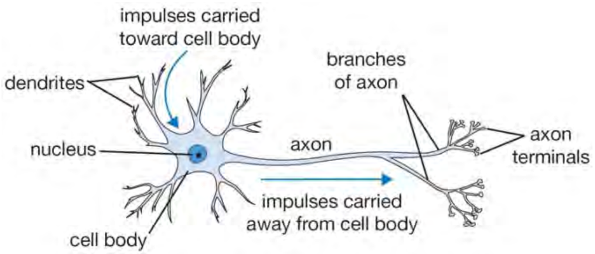
- Intel i7-4770R/HD5200 : 385µs
- **Hyperion HC18 : 16µs**

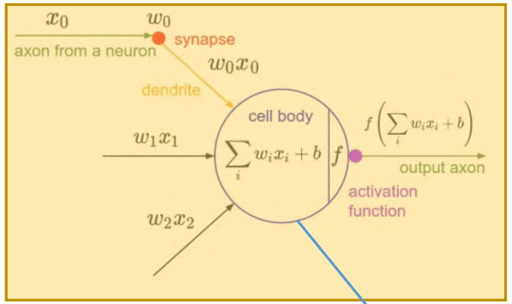


Source: Intel Developer Zone

Deep Neural Networks, DNN on Hyperion

HYPERION CORE

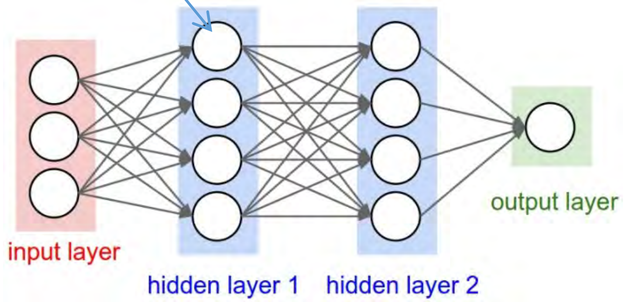




- **412 million Axons per second**

equivalent to

- **4.08 TeraOps/sec**

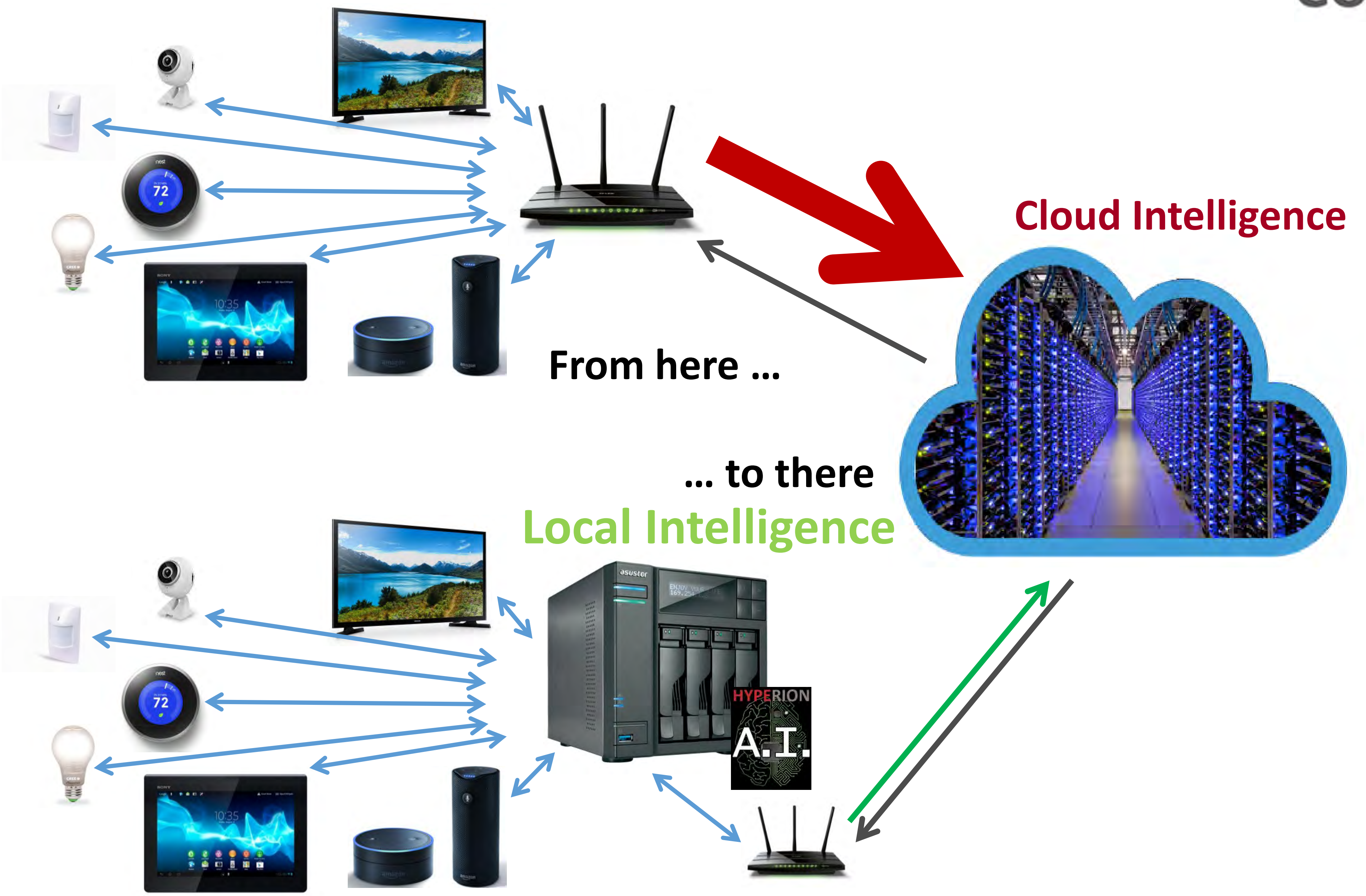


Compare to:

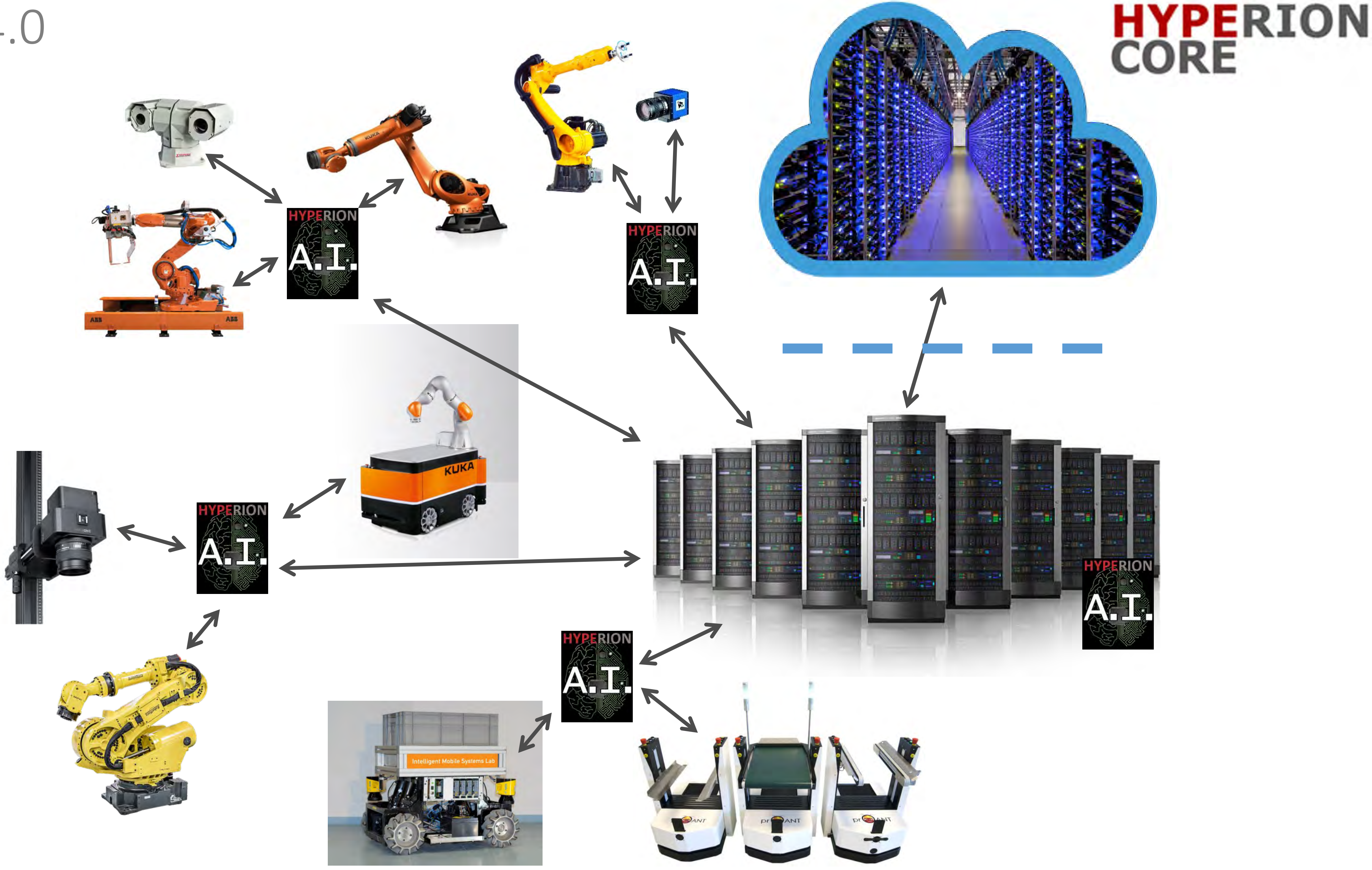
	MHz	TeraOps/s		Note
		8b	FP	
Intel Haswell E5-2699v3	2300	2.6	1.3	source: Google *)
NVidia K80	560		2.8	source: Google *)
Hyperion HC18	2000	4.1		

*) Source Google, **In-Datacenter Performance Analysis of a Tensor Processing Unit**

Autonomous Intelligence@Home

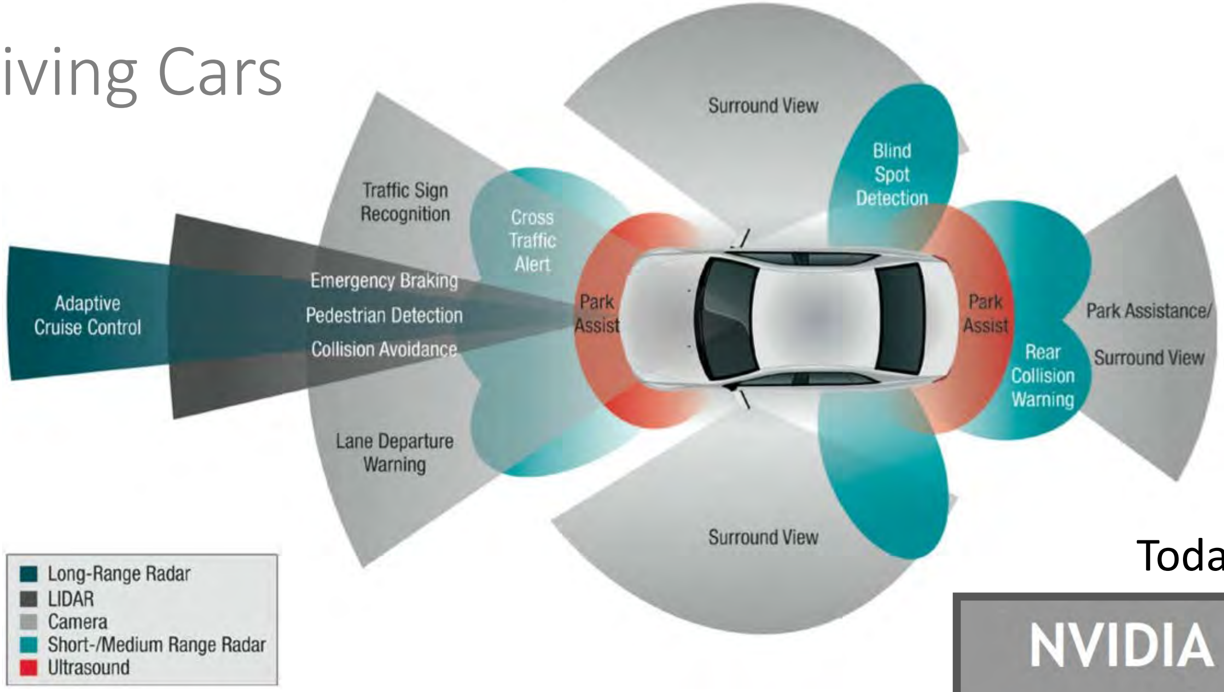


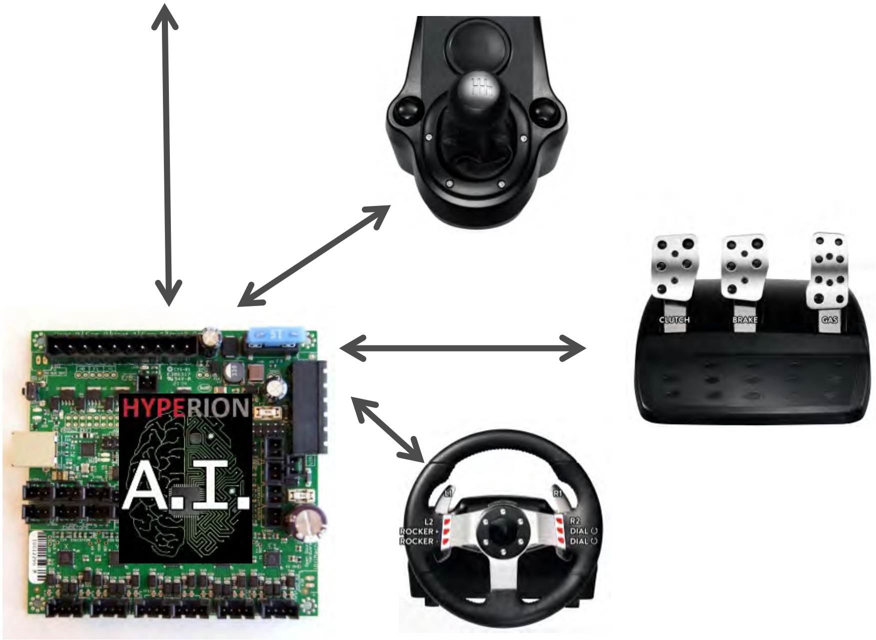
Industry 4.0


HYPERION
CORE
HYPERION
A.I.
HYPERION
A.I.
HYPERION
A.I.
HYPERION
A.I.
HYPERION
A.I.
KUKA
Intelligent Mobile Systems Lab

HYPERION CORE

Self Driving Cars

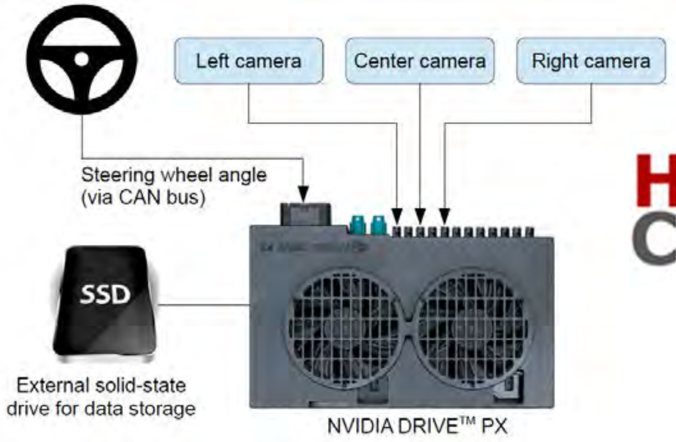




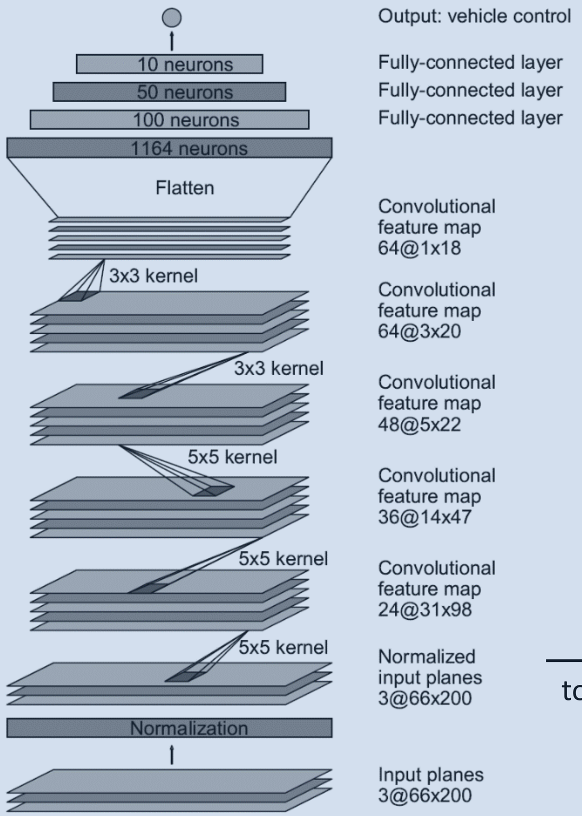
Today‘s *solution*

Self Driving Car

- Analysis based on NVIDIA's DAVE-2 project*)
- NVIDIA DRIVE PX platform
  - **Two Tegra X1 SoCs**



HYPERION CORE



HC18 performance analysis (cycles)

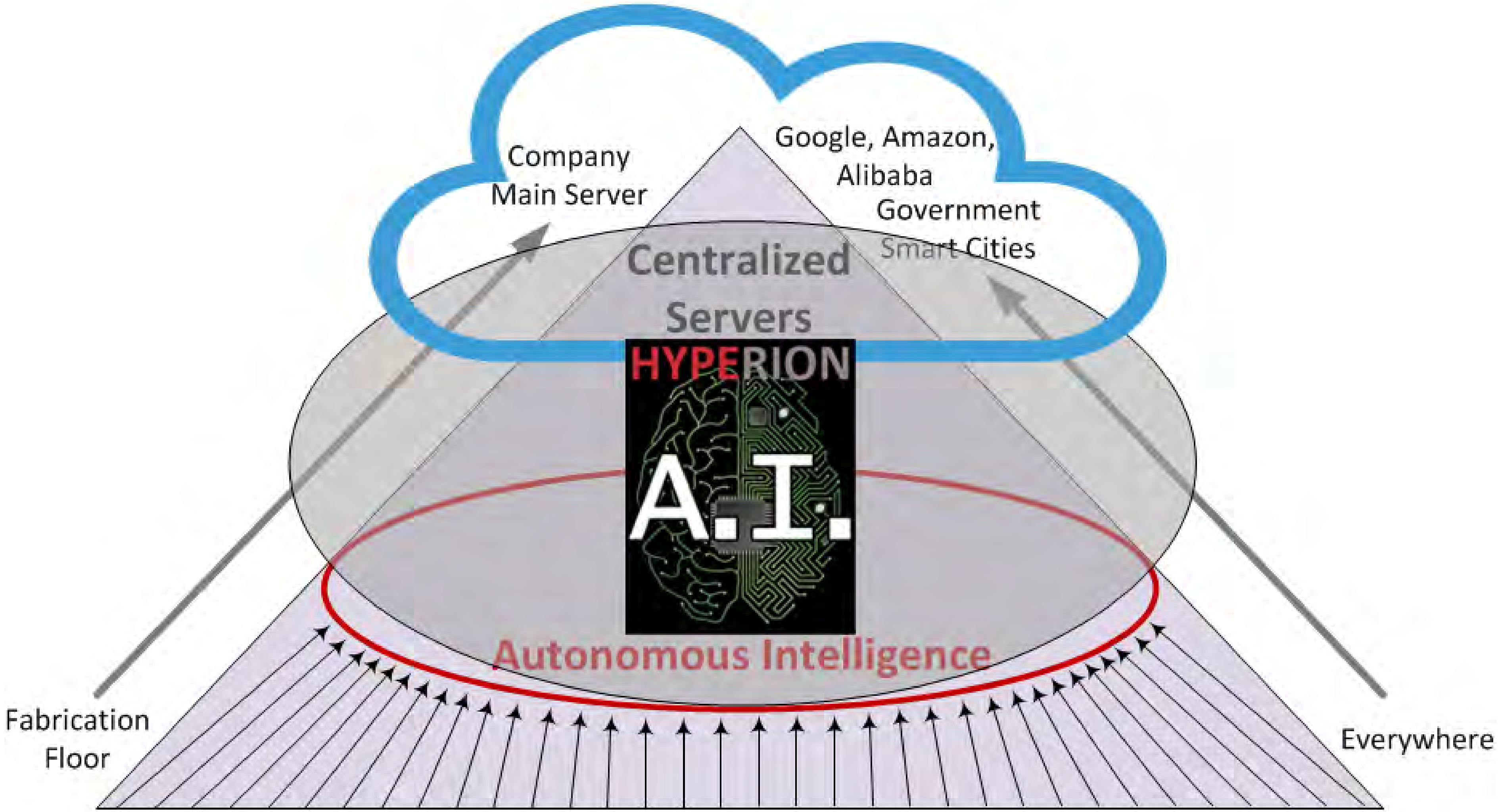
90
130
900
12,440
282,627
365,571
289,877
659,021
237,839

total 1,848,495

- Hyperion requirement analysis
  - All kernels fit on 32 PE array
  - 1,848,495 cycles required per frame
  - At 20MHz clock 93ms processing time
  - At 100MHz for 10fps (NVIDIA specification): 186ms
- **Hyperion Chip HC18-SDC**
  - **Small array of only 32 PEs**
  - **Clock frequency 100MHz**
  - **Cost: ~10USD**

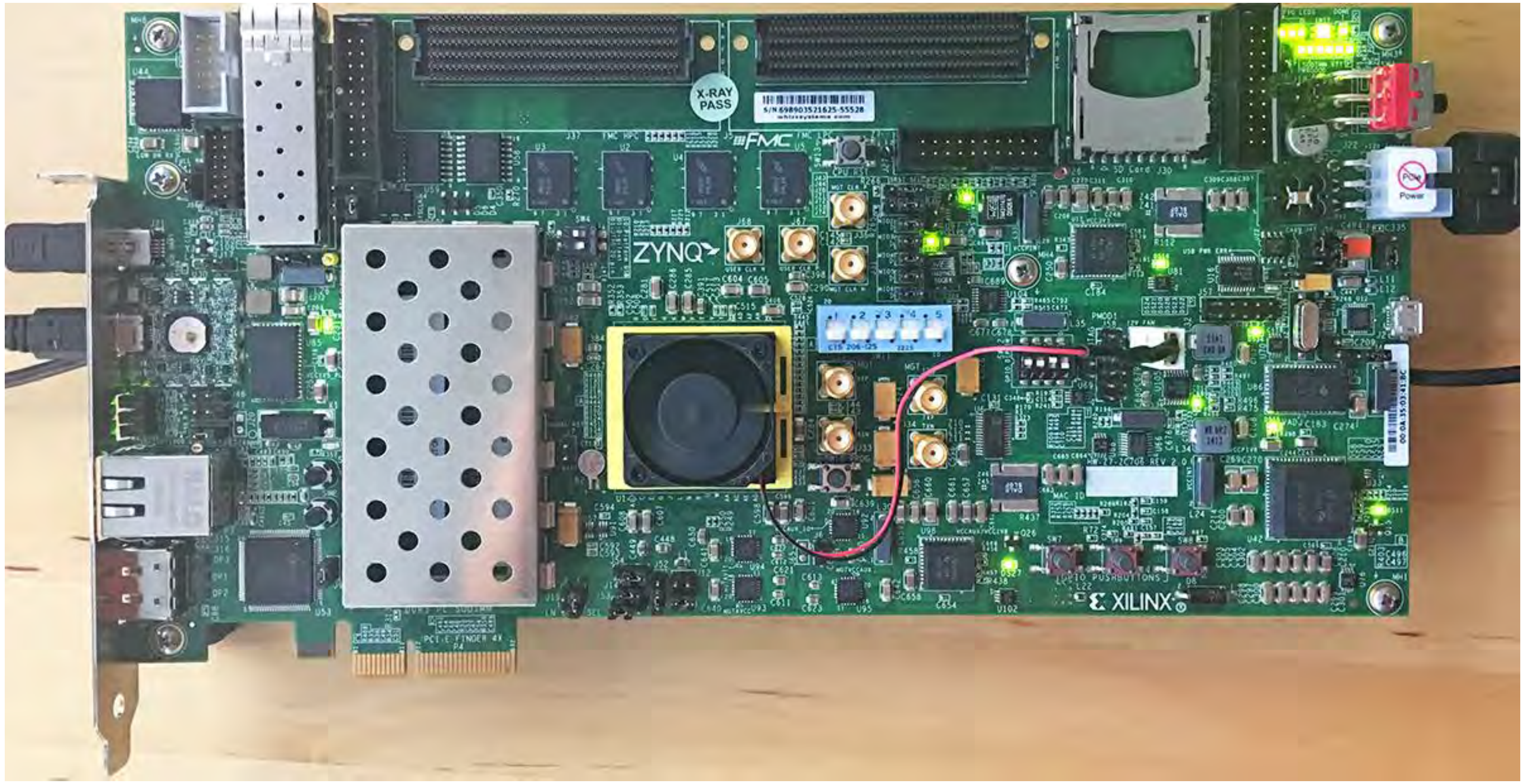
*) See paper: End to End Learning for Self-Driving Cars; NVIDIA

The position



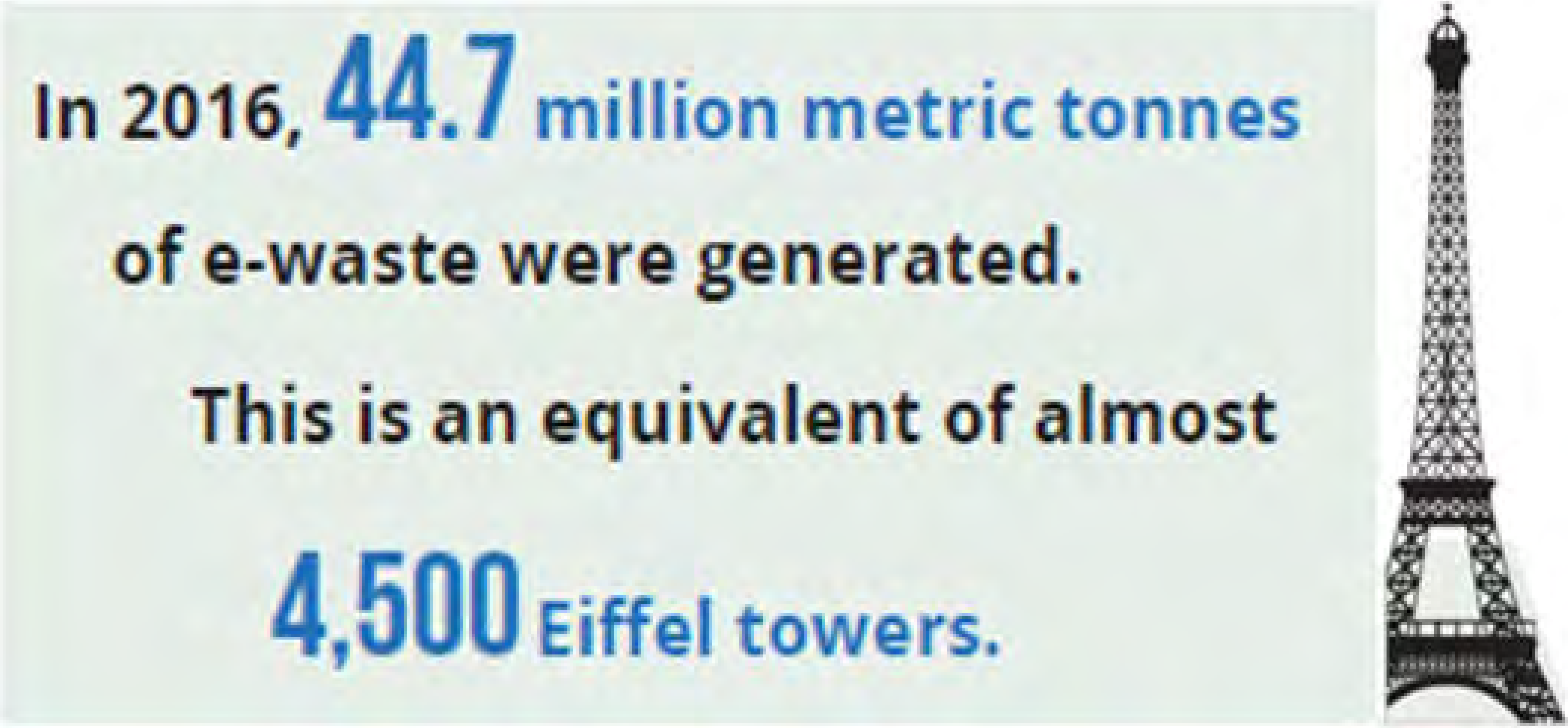
HYPERION CORE

FPGA-Prototype Implementation




Google
NEVER
SETTLE

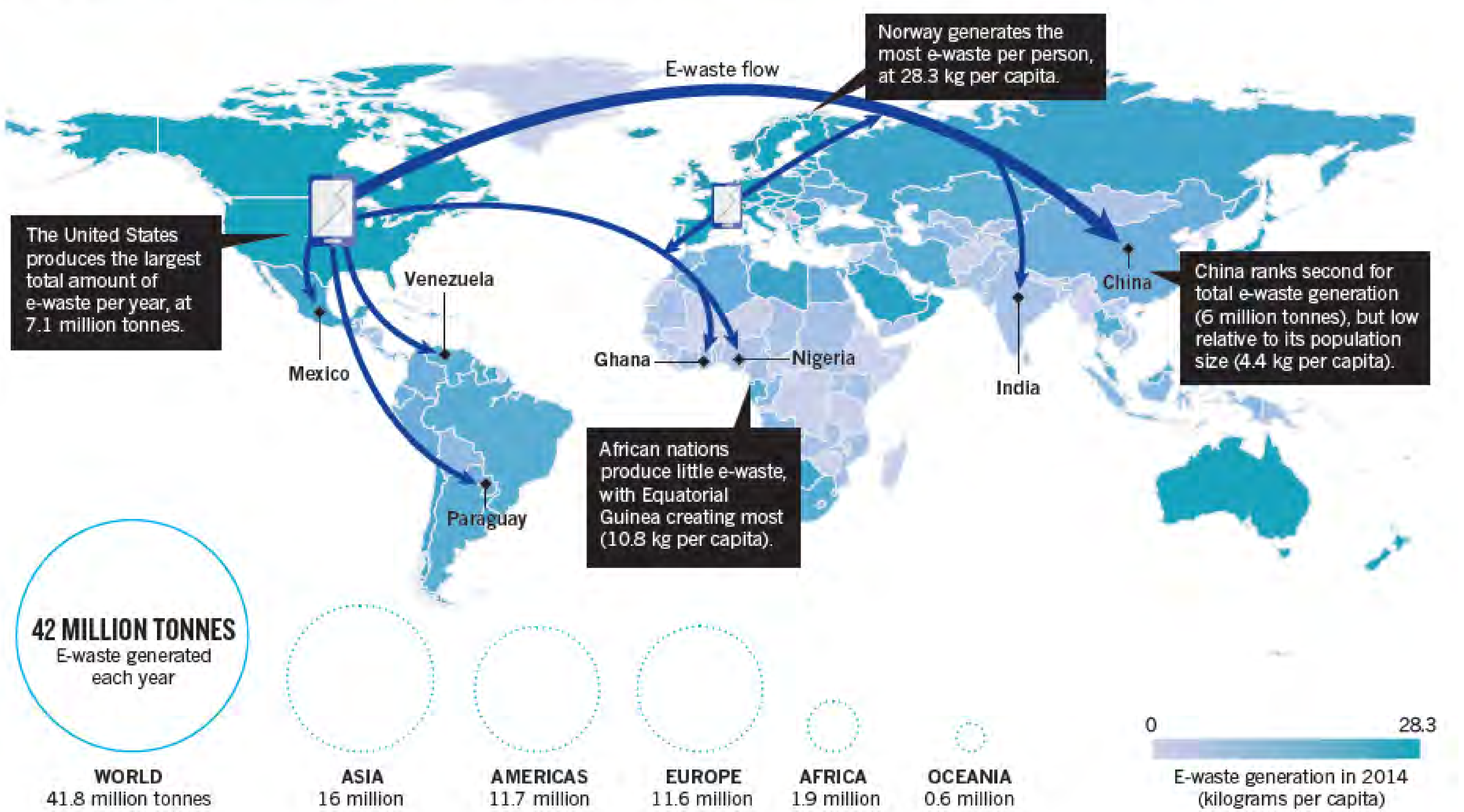
http://www.straitstimes.com/singapore/steps-to-shrink-mountain-of-e-waste-through-better-recycling



http://www.eco-business.com/news/how-smart-is-singapore-at-recycling-e-waste/
http://www.straitstimes.com/singapore/environment/singapores-mountain-of-e-waste

UNFAIR FLOW

Most electronic waste from developed countries ends up in poor nations that lack regulation. China processed around 70% of the world's e-waste in 2012; the rest goes to India and other countries in eastern Asia and Africa, including Nigeria.



officials had no idea that was the case.

Every day, some 3,700 shipping containers full of recyclables are trucked to US ports, loaded onto ships and sent to China. The items in those containers include plastics, metal, paper, cardboard, and textiles, which Chinese manufacturers use as raw materials, as Bloomberg News outlined in a report tracing the process.

The US exported some 37 million metric tons of scrap commodities valued at $16.5 billion to 155 countries last year. China accounted for almost one-third of that total, about $5.2 billion.

The State Council, China's Cabinet, however, announced on July 18 new regulations banning the import of foreign waste. On the same day, China notified the World Trade Organization that it will no longer accept imports of 24 types of solid waste.

The move will help reduce the health and environmental risks posed by the waste, and also free up more of China's large but somewhat chaotic recycling industry to tackle the rapid increase of solid waste produced by 1.3 billion Chinese themselves.

The US, China, Brazil, Japan and Germany are the leading generators of waste. The US produced about 228 million tons of waste in 2006, a figure that climbed to 254 million tons by 2013. China, which has a population four times the US', has caught up in recent years, producing 190 million tons of waste per year.

Sorting plastic bottles in China for recycling. Beijing banned the import of many recyclables as of Jan. 1. Right, a recycling center near Ascot, England. Experts say the immediate response to the crisis may be to turn to incineration or landfills.

Where to put all the rubbish China rejects?

LONDON

Rejection of many imports leaves recyclables piling up in heaps in other countries

BY KIMIKO DE FREYTAS-TAMURA

Ever since China announced last year that it no longer wanted to be the "world's garbage dump," recycling about half of the globe's plastics and paper products, Western nations have been puzzling over what to do after the ban went into effect on Jan. 1.

The answer, to date, in Britain at least, is nothing. At least one waste disposal site in London already has a buildup of plastic recyclables and has had to pay to have some of it removed.

Similar backups have been reported in Canada, Ireland, Germany and several other European nations, while tons of rubbish is piling up in port cities like Hong Kong.

Steve Frank, of Pioneer Recycling in Oregon, owns two plants that collect and sort 220,000 tons of recyclable materials each year. A majority was until recently exported to China. "My inventory is out of control," he said.

China's ban, Mr. Frank said, has caused "a major upset of the flow of global recyclables."

Now, he said, he is hoping to export waste to countries like Indonesia, India, Vietnam, Malaysia — "anywhere we can" — but "they can't make up the difference."

In Britain, Jacqueline O'Donovan, managing director of O'Donovan Waste Disposal, said that "the market has completely changed" since China's decision took effect. Her company collects and disposes of about 70,000 tons of plastic trash every year, she said, and expects "huge bottlenecks across the whole of England" in the coming months.

Britain's prime minister, Theresa May, pledged on Thursday to eliminate avoidable wastes within 25 years. In a prepared speech, she urged supermarkets to introduce plastic-free aisles where all the food is loose.

The European Union, for its part, plans to propose a tax on plastic bags and packaging, citing the China ban and the health of the oceans among other reasons.

Those measures might help ease the situation some day, but for now Britain is faced with growing piles of recyclables and no place to put them. Experts say the immediate response to the crisis may well be to turn to incineration or landfills — both harmful to the environment.

China's ban covers imports of 24 kinds of solid waste, including unsorted paper and the low-grade polyethylene terephthalate used in plastic bottles, as part of a broad cleanup effort and a campaign against "yang laji," or "foreign garbage." It also sets new limits on the levels of impurities in other recyclables.

China had been processing at least half of the world's exports of waste paper, metals and used plastic.

China had been processing at least half of the world's exports of waste paper, metals and used plastic — 7.3 million tons in 2016, according to recent industry data. Last July, China notified the World Trade Organization that it intended to ban some imports of trash, saying the action was needed to protect the environment and improve public health.

"Large amounts of dirty wastes or even hazardous wastes are mixed in the solid waste that can be used as raw materials," Beijing wrote to the W.T.O. "This polluted China's environment seriously."

Chinese officials also complained that much of the recyclable material the country received from overseas had not been properly cleaned or was mixed with non-recyclable materials.

The sudden change has left Western countries scrambling to deal with a buildup of plastic and paper garbage while looking for new markets for the waste.

"It's not just a U.K. problem," said Simon Ellin, chief executive of the Recycling Association in Britain. "The rest of the world is thinking, 'What can we do?' It's tough times."

In Halifax, Nova Scotia, which sent 80 percent of its recycling to China, Matthew Keliher, the city's manager of solid waste, said he had largely found alternatives to accept plastic, except for the low-grade plastic film that is used to make shopping bags and for wrapping. Stockpiles of those plastics have so exceeded the city's storage capacity that Halifax had to get special permission to bury about 300 metric tons of the material in a landfill.

In Calgary, Alberta, which sent 50 percent of its plastics and 100 percent of its mixed papers to China, the material is being stockpiled in empty storage sheds, shipping containers, trailers and warehouses since last fall. So far, 5,000 tons has been collected, Sharon Howland, the city's lead manager of waste and recycling services, told the Canadian Broadcasting Corporation.

The material is "a sellable resource, so we will store them as long as we can and evaluate our options from there," she said.

In Britain, the political class appeared caught by surprise.

When asked in front of lawmakers about the impending ban last month, Environment Secretary Michael Gove fumbled: "I don't know what impact it will have. It is something to which — I will be completely honest — I have not given sufficient thought."

Pollution from plastics has captured global attention in recent years. A new David Attenborough series on the BBC, "Blue Planet II," has shown plastic bags and bottles clogging oceans and killing fish, turtles and other marine wildlife, prompting governments to put in place more stringent rules.

Every year, Britain sends China enough recyclables to fill up 10,000 Olympic-size swimming pools, according to Greenpeace U.K. The United States exports more than 13.2 million tons of scrap paper and 1.42 million tons of scrap plastics annually to China, the Institute of Scrap Recycling Industries has reported. That is the sixth-largest American export to China.

"There may be alternative markets, but they're not ready today," said Emmanuel Katrakis, the secretary general of the European Recycling Industries' Confederation in Brussels.

Mr. Katrakis dismissed China's claims that all imported scrap waste contained high levels of contaminants, and said that Beijing's thresholds for most types of scrap were "far more demanding" than in Europe or the United States. At the same time, he said, Europe has focused too much on collecting plastic waste and shipping it out, and not enough on encouraging manufacturers to use it in new products.

"We've got to start producing less and we've got to produce better-quality recyclable goods," Mr. Ellin said.

Too often, he said, manufacturers produce environmentally harmful products and then "pass the buck" to retailers, who in turn pass it to local councils to pick up the tab to sort out the waste for recycling.

"*What's happened is that the final link in the supply chain has turned around and said: 'No, we're not going to take* this poor-quality stuff anymore. Keep it for yourself.'"

Ian Austen contributed reporting from Ottawa, and Catherine Porter from Toronto.

Investigators arriving at the Lactalis group headquarters yesterday to conduct searches at the Laval, western France, location. The investigation follows a baby milk that has sickened dozens of children and led to a major international recall by the dairy giant. PHOTO: AGENCE FRANCE-PRESSE

EU to ditch disposable plastic packaging by 2030

Packaging must be recyclable or reusable as China moves to ban import of waste products

STRASBOURG (France) • The European Union has unveiled plans for all plastic packaging in Europe to be recyclable by 2030 and to phase out single-use plastic like coffee cups to fight pollution.

The strategy announced on Tuesday by the European Commission follows China's decision to ban imports of foreign waste products for recycling, including huge quantities from Europe.

"The commission aims to increase plastic recycling and for all plastic packaging to be reusable or recyclable by 2030," the EU's executive body said.

The commission said its proposals also aim to create business opportunities by transforming the way plastic products are designed, produced and recycled in Europe.

The EU currently exports half of its collected and sorted plastics, 85 per cent of which goes to China.

Commission First Vice-President Frans Timmermans said: "We must stop plastics getting into our water, our food and even our bodies. The only long-term solution is to reduce plastic waste by recycling and reusing more."

"The Chinese decision is undoubtedly a big challenge but let's turn that challenge into an opportunity," he added.

The commission's strategy aims to rid the seas and oceans of the "700kg" of plastics it says gets washed up each day, and it "will take measures to limit the use of microplastics" found in cosmetics and detergents.

Proposed new rules on ports and the shipping industry are aimed at making sure waste generated at sea by ships is not released into the water. An additional €100 million (S$162 million) was also promised to fund research into technical innovations for tackling the problem.

The commission has already taken a number of steps to try to reduce plastic, particularly single-use shopping bags.

The proposals did not contain plans for a tax on plastic packaging, which Budget Commissioner Guenther Oettinger proposed last week to fight pollution and to help plug a hole of around €13 billion in the bloc's budget caused by Brexit.

"We have not found a way to introduce a European-wide plastic tax yet," Vice-President Jyrki Katainen, who is responsible for jobs and investment, told reporters. "It is too early to promise anything."

Britain's Prince Charles and others held an EU-backed conference last year for drastic action to stop eight million tonnes of plastic waste polluting the world's oceans annually.

The commission said Europeans generate 25 million tonnes of plastic waste annually, but less than 30 per cent is collected for recycling.

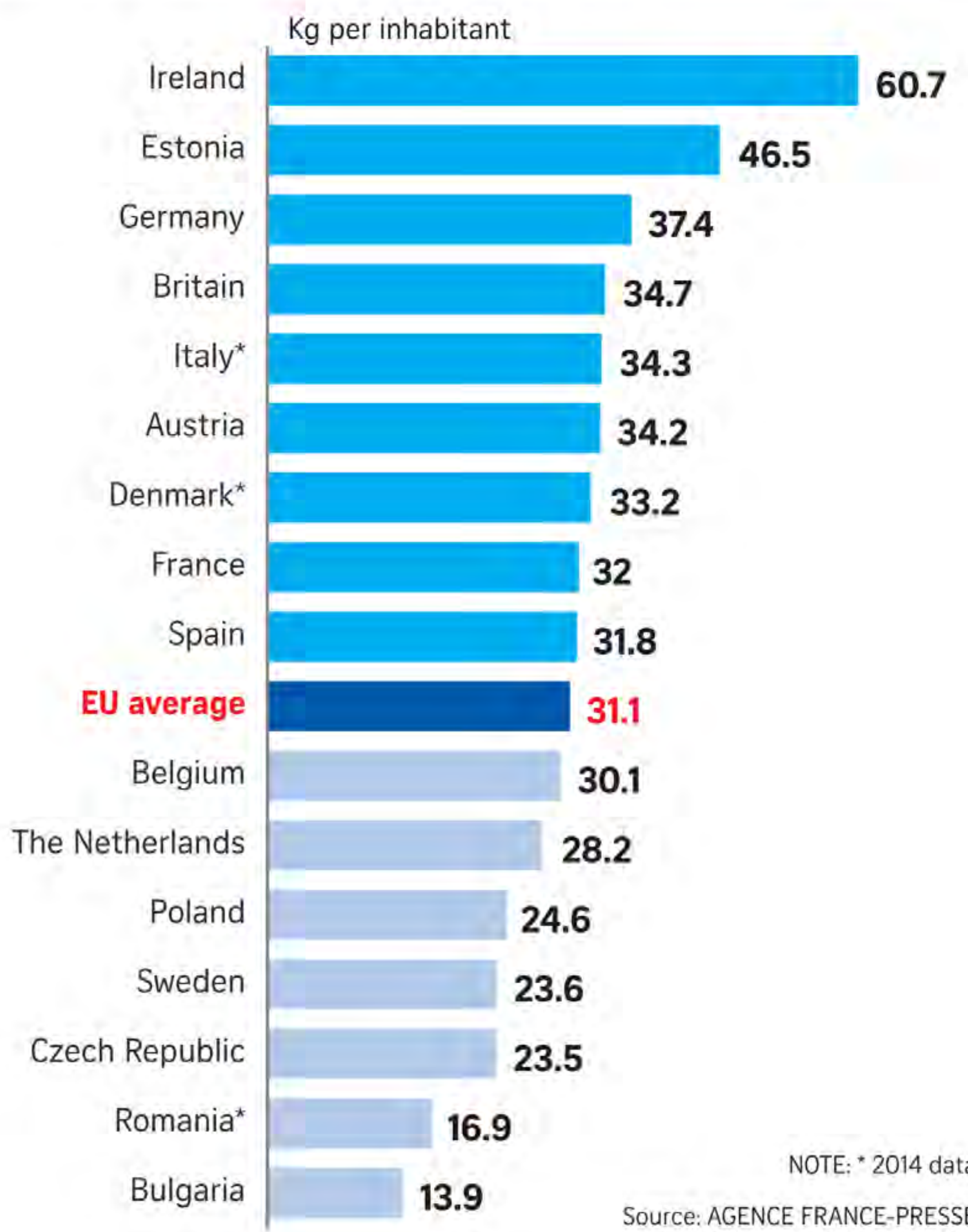
Mr Timmermans called for promoting awareness, urging parents to tell their children that a plastic straw takes only a second to produce but 500 years to degrade, and said the commission ultimately wants to ban microplastics.

Mr Katainen said the strategy is "a great opportunity for European industry to develop global leadership in new technology and materials".

He added Europe does not yet have a functioning single recycling market for plastic as there are no set standards.

According to Plastics Europe, the Brussels-based association of European plastics manufacturers, the in-

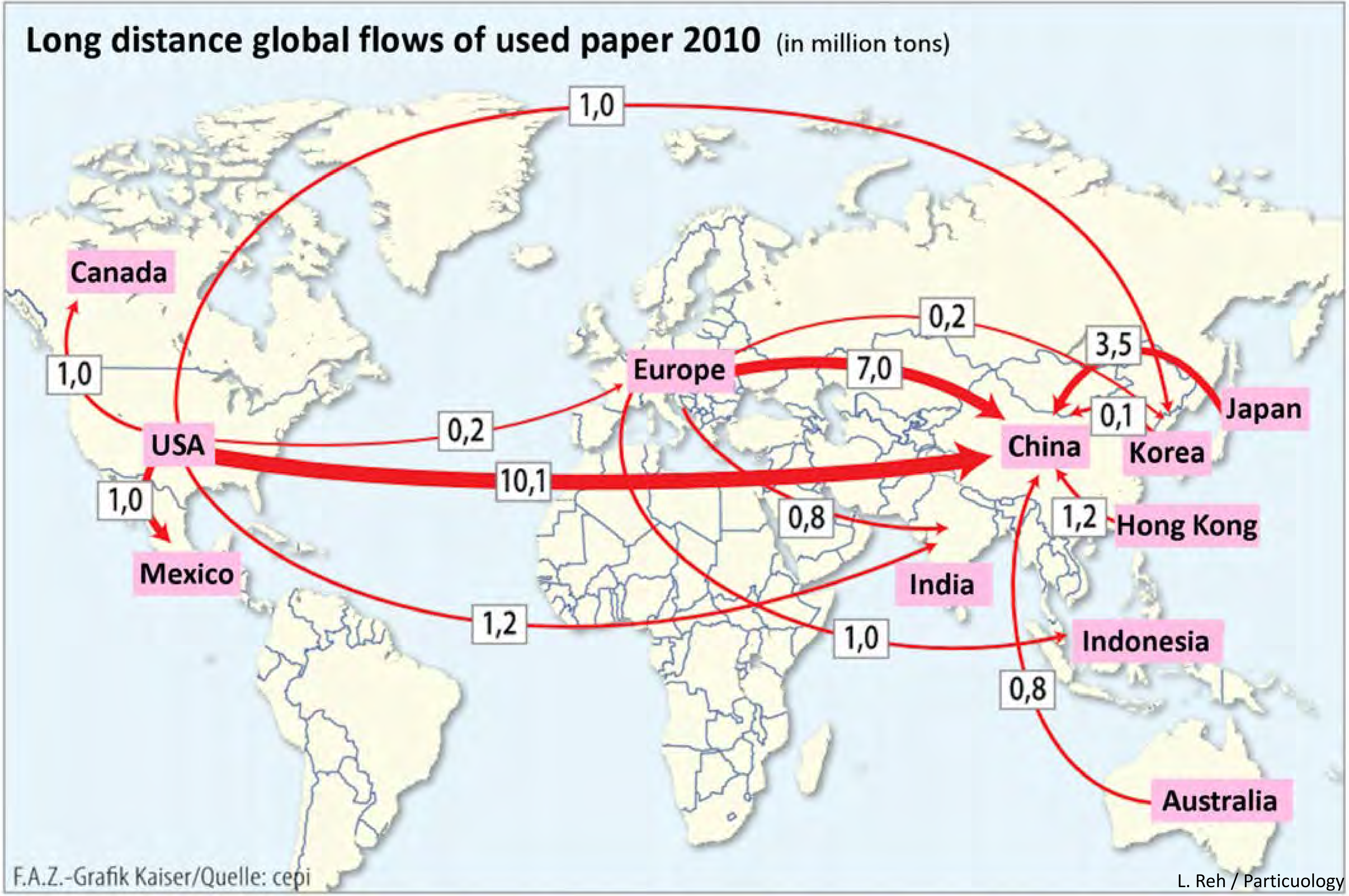
Plastic waste generated in 2015



NOTE: * 2014 data

Source: AGENCE FRANCE-PRESSE
STRAITS TIMES GRAPHICS

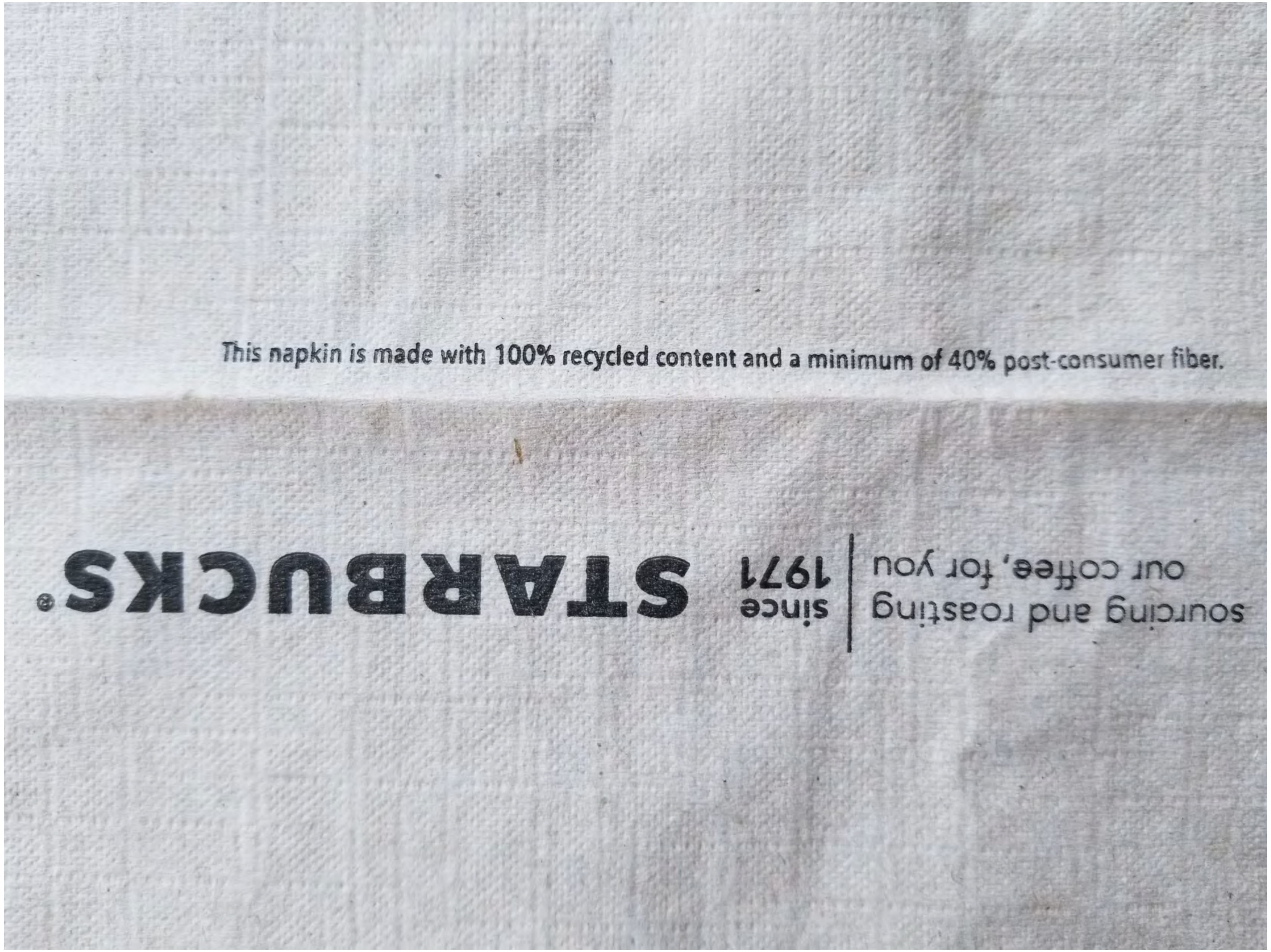

BY 2025, ALL OF OUR PLASTIC PACKAGING WILL BE REUSABLE, RECYCLABLE OR COMPOSTABLE
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
Unilever
Estação de Reciclagem
Pão de Açucar Unilever
Papel
Plástico
Vidro
THE GLOBAL GOALS
For Sustainable Development



L. Reh / Particuology *11 (2013) 119– 133*

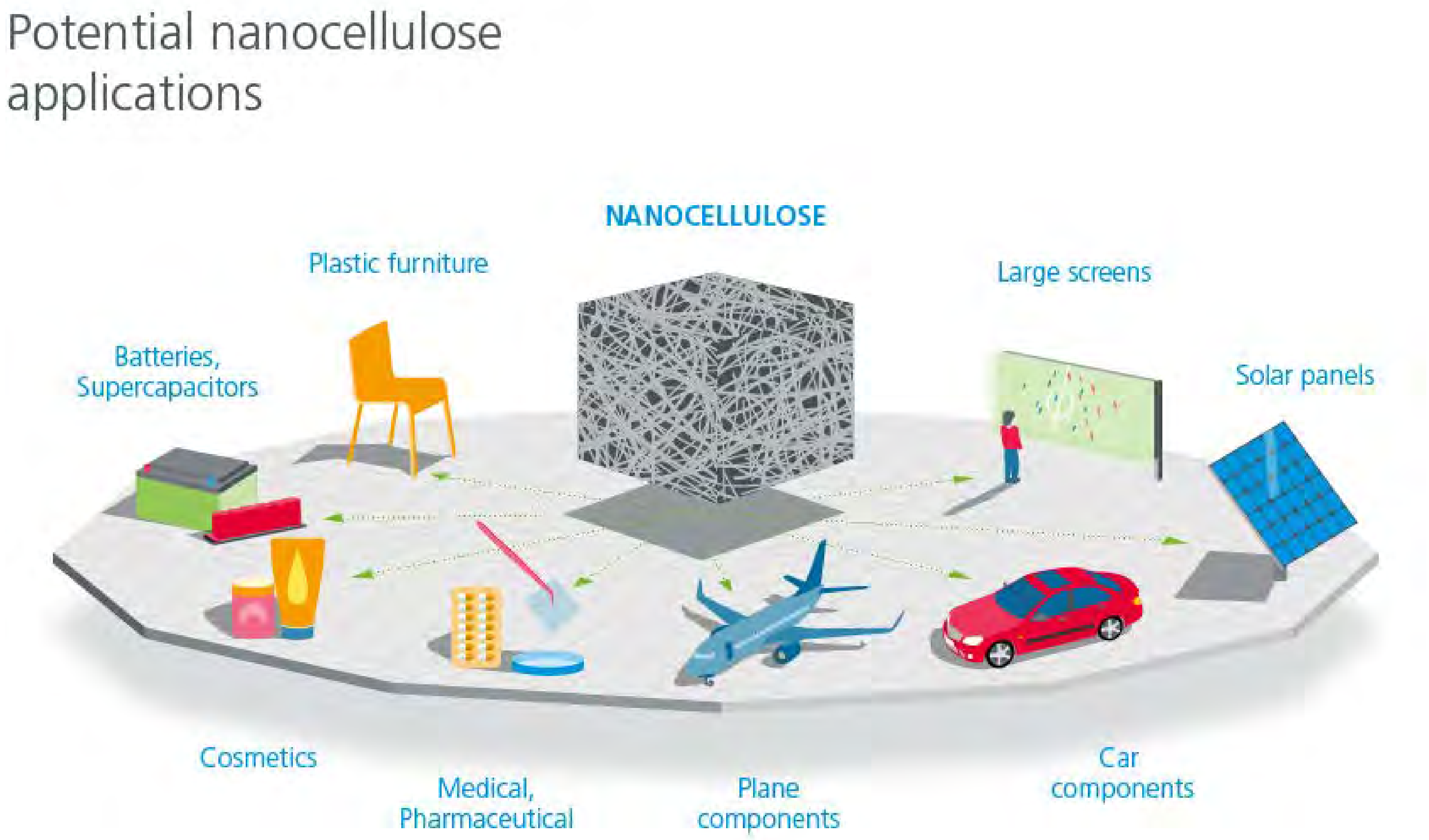
Stacks of paper waste at a dock in Hong Kong, after China imposed a ban on imports of 24 types of rubbish, including unsorted scrap paper, in July 2017.PHOTO: REUTERS

Waste Paper as a High Value Add Resource



http://www.gea.com/en/technology-talks/nanocellulose.jsp

Waste Paper as a High Value Add Resource



Lisa Jackson

Vice President, Environmental Initiatives

Lisa Jackson is Apple's vice president of Environmental Initiatives, reporting to CEO Tim Cook.

Lisa oversees Apple's efforts to minimize its impact on the environment by addressing climate change through renewable energy and energy efficiency, using greener materials, and inventing new ways to conserve precious resources. Apple has led the industry in powering all its data centers with 100 percent renewable energy and removing many harmful substances from its products.

From 2009 to 2013, Lisa served as Administrator of the U.S. Environmental Protection Agency. Appointed by President Barack Obama, she focused on reducing greenhouse gases, protecting air and water quality, preventing exposure to toxic contamination, and expanding outreach to communities on environmental issues. She has also served as Chief of Staff to New

Continue reading ▾

What happens when we recycle a laptop?

More than 60,000 tonnes of e-waste is generated in Singapore each year, but just a fraction gets recycled. When recycled properly, e-waste like laptops can yield a trove of materials which can be used to make new products.

LCD panel

Plastic and glass from the LCD panels end up at glass and plastic recycling plants where they are processed.

Metal housing and component

Metals like copper, aluminium and steel are extracted from the external structure and electrical components of the laptop.

Plastic housing

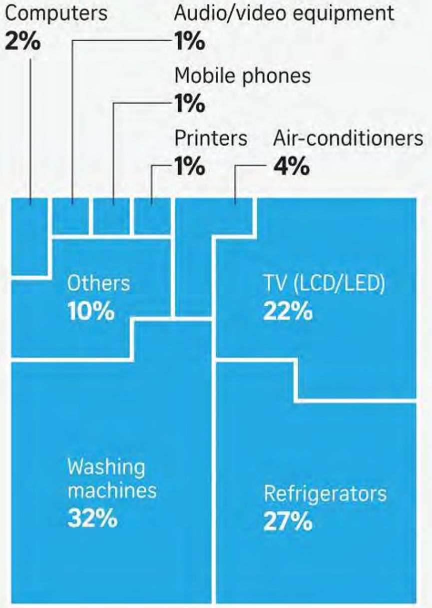
Plastic found in the external structure of a laptop is turned into pellets by plastic recycling plants, which can be used to make plastic bags, bottles and other items.

Printed circuit board

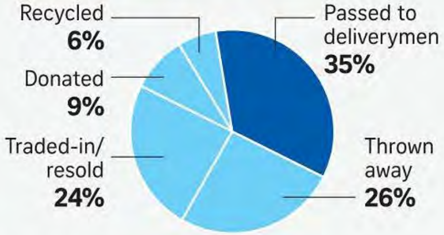
Precious metals like gold, silver, platinum and palladium are extracted, melted and then turned into ingots.

E-waste facts and figures

Types of e-waste (by weight)



Disposal pattern (by weight)



About 60,000 tonnes

of e-waste is generated a year. This is equivalent to the weight of

220 A380 planes.

About 11kg

of e-waste – equal in weight to 73 mobile phones – is discarded by each person a year.

Source: TES-AMM, NEA

PHOTOS: NG SOR LUAN, ST FILE PHOTO STRAITS TIMES GRAPHICS

What happens to e-waste in Singapore

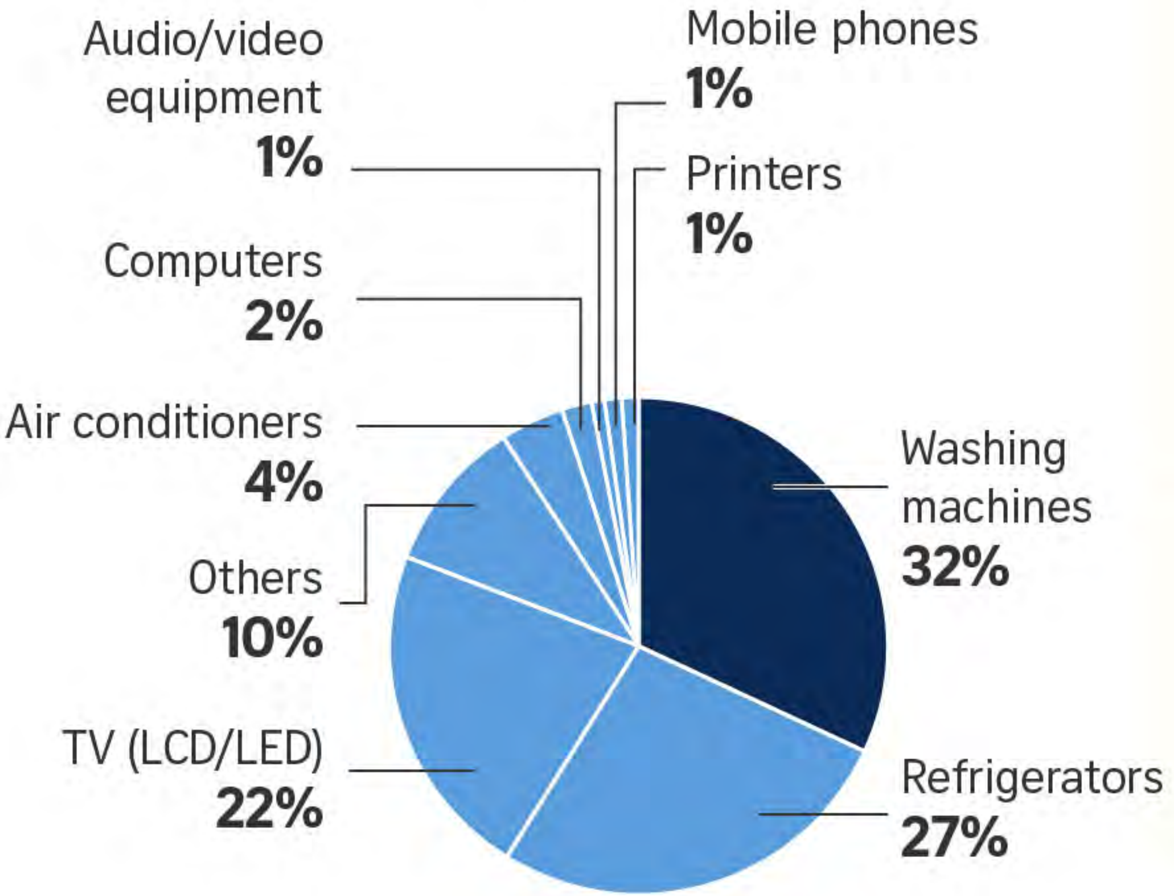
- A 2017 global report estimates that the world generated 44.7 million tonnes of e-waste in 2016 – equal in weight to almost **9** Great Pyramids of Giza.

- About **60,000** tonnes of e-waste are generated a year. This is equivalent to the weight of **220** Airbus A380 airplanes.

- About **11kg** of e-waste – equal in weight to 73 mobile phones – is discarded by each person a year.

- About **11kg** of e-waste – equal in weight to 73 mobile phones – is discarded by each person a year.

Types of e-waste (by weight)



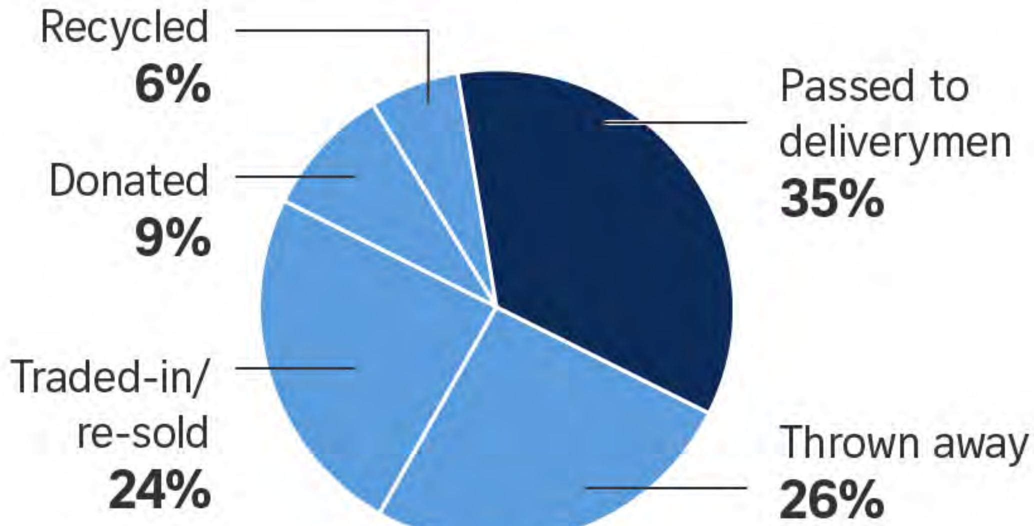
AN NEA SURVEY FOUND 60% OF CONSUMERS SAID THEY DON'T KNOW OR ARE UNSURE OF HOW TO RECYCLE THEIR E-WASTE. E-WASTE IS NORMALLY:

- **Traded-in/ re-sold**

- **Thrown away**

- **Passed to deliverymen**

Disposal pattern (by weight)



CHANNELLING E-WASTE TO REPUTABLE E-WASTE RECYCLERS WILL BENEFIT THE ENVIRONMENT AND THE PUBLIC, AS THIS:

- Keeps valuable resources out of the waste of the stream.
- Conserves our planet's finite resources.
- Ensures harmful substances are not released into the environment.
- Grows our green economy and local employment opportunities.
- Helps fight climate change.
- Reduces strain on Singapore's waste disposal facilities and frees up land for better quality of life for residents.

Source: NATIONAL ENVIRONMENT AGENCY
STRAITS TIMES GRAPHICS

S'pore should aim to be model country for e-waste management

THE waste from electrical and electronic equipment, or e-waste, is the fastest-growing waste stream globally.

According to an e-waste directive of Europe, the diverse categories include large household appliances, small household appliances, IT and telecommunications equipment, consumer equipment, lighting equipment, electrical and electronic tools, toys, leisure and sports equipment, medical devices, monitoring and control instruments, and automatic dispensers. Smartphones, wearables and driverless vehicles are more recent examples.

The increased number of devices, intentionally designed for shorter life cycles, are resulting in rapid growth of e-waste worldwide. Growing affluence, consumerism, and hasty discarding for newer models are contributing to the exponential growth of e-waste.

Singapore, with 20kg e-waste per capita, is among the leading generators in the region, and comparable to the other high-income countries around the world.

The National Environmental Agency (NEA) estimates about 60,000 tonnes of e-waste is generated in Singapore every year. About 70 million tonnes of e-waste is generated globally per year. China is the largest producer as well as recipient of e-waste.

E-waste is shipped to the lowest cost destinations for re-use, dismantling and parts re-use, incineration, and land-fill. E-waste contains toxic substances.

Its informal disposal and low-technology recycling generates toxic pollutants and heavy metals harmful to the ecosystem. Considering the adverse effects on environment and human health, barriers are coming up for e-waste movement across borders.

For example, this year China banned incoming shipments of over 20 types of solid waste.

On the other hand, e-waste contains valuable metals, and simply discarding amounts to wastage of precious resource.

E-products approximately use 100 per cent of the indium, 72 per cent of the ruthenium, 50 per cent of the tin, 44 per cent of the copper, 34 per cent of the silver, and 22 per cent of the mercury mined globally every year.

Recovering raw materials from e-waste is an effective solution to mitigate increasing costs of new raw materials.

Moreover, recycling reduces the amount of greenhouse gas emissions caused by the manufacturing of products from all new raw materials.

Pyro-metallurgical and chemical methods are employed to recover valuable metals. Environmentally benign biotechnology processes using genetically engineered microorganisms are being developed.

Traditional e-waste management involves collection of waste, pre-processing and end-processing for recovery of high value metals.

With global movement towards the circular economy, innovations in terms of more efficient recycling, direct reuse after the end of life cycle, reuse after repair, and remanufacturing are being pursued.

This requires sophisticated e-waste management systems.

A common feature of e-waste management systems overseas is the Extended Producer Responsibility (EPR) concept, which obliges the manufacturers and importers to be responsible for the collection and environmentally sound disposal of e-waste from consumers.

For example, in Germany, Korea and Taiwan, the costs of e-waste collection and disposal are borne by the manufacturers, importers and retailers.

In Switzerland and Japan, the costs are borne by consumers.

China began EPR in a phased manner. Moreover, European Union set e-waste collection and recycling targets for member states there by enabling viable e-waste recycling business.

New regulations in Europe and Japan restrict the use of specific hazardous substances in the products there by enhancing the recyclability of e-waste.

A notable recycling effort in Singapore is StarHub's RENEW programme, where more than 400 e-waste bins are placed around the island.

This programme collected approximately 60 tonnes of e-waste in 2016.

While commendable, this is a small fraction of Singapore's total e-waste generated every year. Consumers as well as businesses are unaware of the need to properly dispose of their e-waste for recycling.

Diversity of e-waste is an obstacle for recycling. Emerging digital technologies provide an opportunity to overcome this challenge, and means to evaluate EPR implementation.

For example, wireless GPS location trackers are helpful in monitoring the flow of e-waste.

The massive data generated during the manufacturing, use and disposal fits the characteristics of Big Data.

RFID, QR, block chain, wireless sensor networks, internet of things (IoT), cloud computing, Big Data business analytics, and Artificial Intelligence (AI) enable new ways to monitor, regulate and enforce rules on the movement of e-waste.

Privacy is another reason for current lower recycling rates, and requires further innovations in digital technologies.

Authors collaborate on data collection for diverse waste characteristics and web-based materials flow analysis to match with recycling solutions.

There are abundant opportunities for innovations to enhance the recovery of valuables from the e-waste, and to eco-design products.

The environmentally sound management of e-waste is a complex activity. This requires behavioural change as well as innovations on multiple fronts.

Effective e-waste management provides opportunities for creating new jobs. It enables Singapore to transition into a smart and liveable city, efficient, and green economy.

As the sustainable management of e-waste is a growing concern of all countries, Singapore can strive to provide an example to emulate.

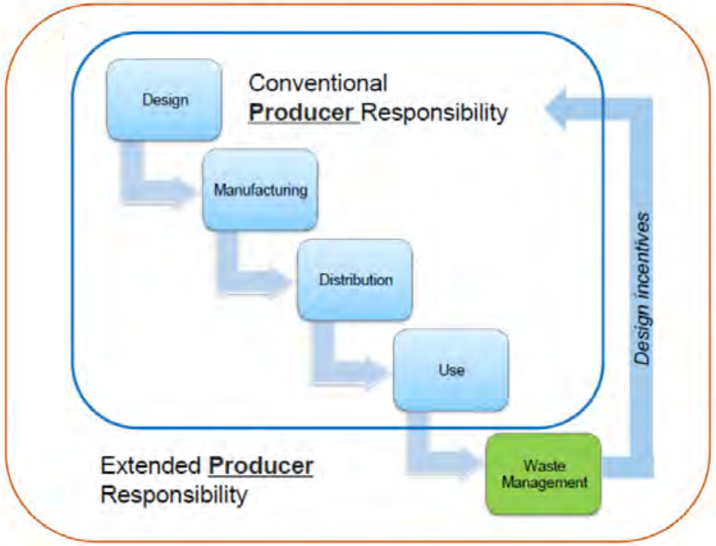
— [illegible]

Professor Seeram Ramakrishna, Chair of Circular Economy Taskforce, National University of Singapore

Notable effort... E-waste recycling bin located at Singapore malls to encourage shoppers and tenants to adopt electronic waste recycling. PHOTO: CAPITALAND

EXTENDED PRODUCER RESPONSIBILITY (EPR)

Extended Producer Responsibility (EPR) is a common feature amongst many systems:



Producers take physical and/or financial responsibility for the proper treatment or disposal or electrical & electronic products that have reached their end-of-life.

Environmental Services Industry Transformation Map

A vibrant, sustainable and professional environmental services industry for Singapore and growing cities

Cleaning Sector

- Office and commercial
- Food and beverage
- Conservancy

Waste Management Sector

- Waste collection
- Sorting and recycling
- Treatment and disposal

COMPANIES

>1,700

TOTAL WORKFORCE

>78,000

INDUSTRY TRANSFORMATION

Industry transformation will ensure that the industry remains competitive and attractive

DRIVING INNOVATION AND WIDESPREAD TECHNOLOGY ADOPTION

- Creating opportunities for technology collaboration and adaptation
- Helping companies access ready technology to develop new capabilities and address manpower challenges

UPSKILLING WORKFORCE TO TAKE ON BETTER JOBS

- Promoting a self-service culture and waste minimisation mindset to reduce service demand
- Improving work tasks through job redesign and use of technology
- Developing internship, apprenticeship and scholarship programmes to attract talent to the industry

IMPROVING PRODUCTIVITY

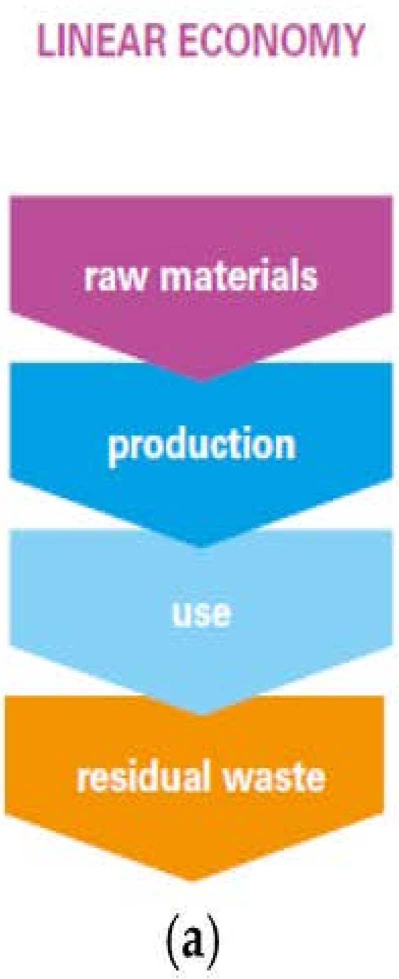
- Encouraging adoption of outcome-based contracts
- Driving procurement practices to focus on quality, technology use and productivity

CAPTURING VALUE OVERSEAS

- Enhancing export capabilities and market access
- Working with partners to offer integrated solutions

http://www.nea.gov.sg/industry-transformation-map

Linear Economy to Circular Economy



http://www.wrap.org.uk/
.mdpi.com/2071-1050/8/7/647/htm

The CE concept is trending both among scholars and practitioners.

Over 100 articles were published on this topic in 2016, compared to ~ 30 articles in 2014

The major consulting firms Accenture, Deloitte, EY and McKinsey & Company all have published on CE in the past two years

The main aim of CE is sustainable development i.e. economic prosperity, environmental quality, and impact on social equity and future generations.

Circular economy

↑ Increasing circularity

Linear economy

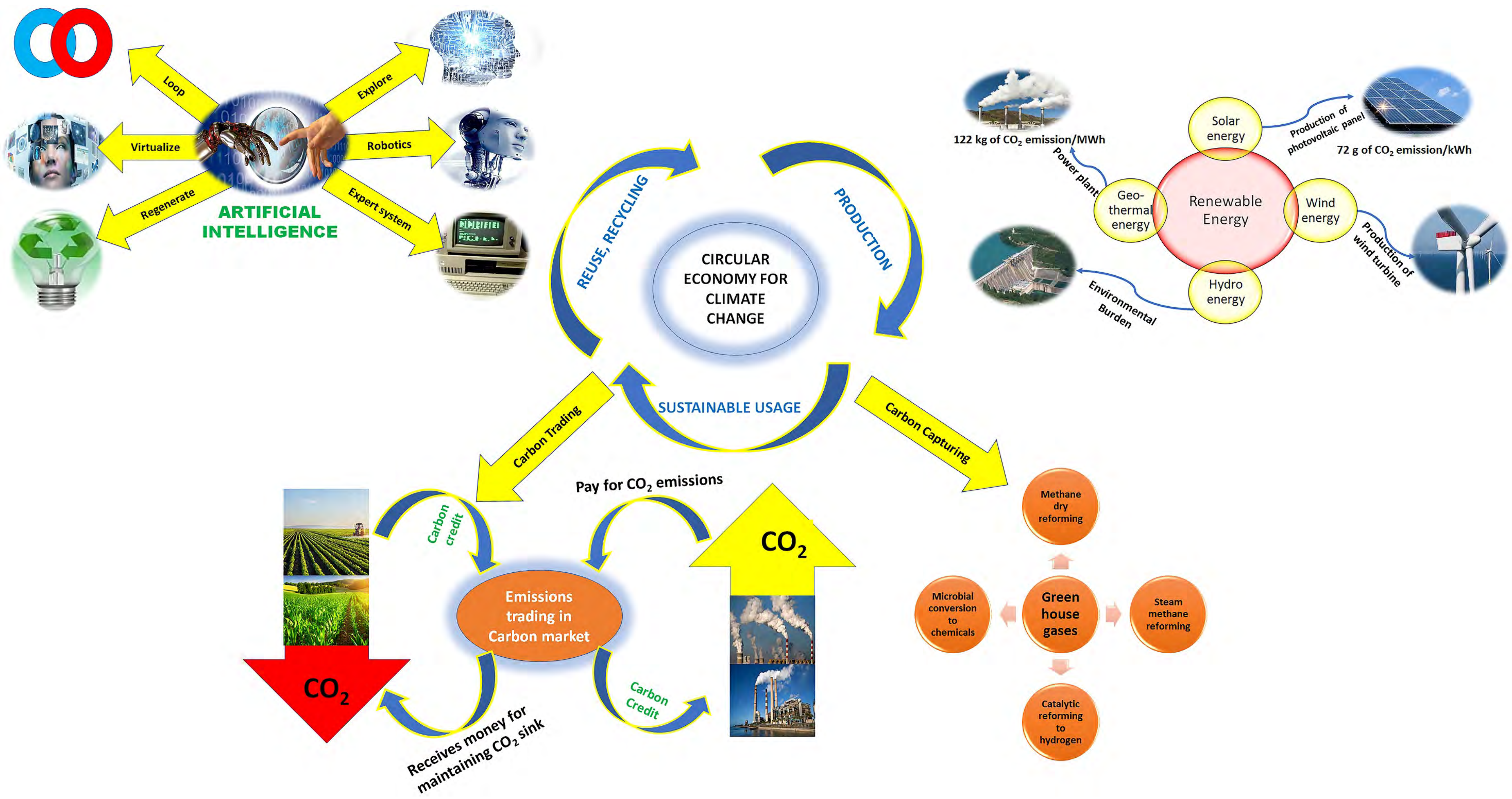
	Strategies	
Smarter product use and manufacture	R0 Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
	R1 Rethink	Make product use more intensive (e.g. by sharing product)
	R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of product and its parts	R3 Reuse	Reuse by another consumer of discarded product which is still in good condition and fulfils its original function
	R4 Repair	Repair and maintenance of defective product so it can be used with its original function
	R5 Refurbish	Restore an old product and bring it up to date
	R6 Remanufacture	Use parts of discarded product in a new product with the same function
	R7 Repurpose	Use discarded product or its parts in a new product with a different function
Useful application of materials	R8 Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
	R9 Recover	Incineration of material with energy recovery

Resources, Conservation & Recycling 127 (2017) 221–232

Circular Economy, CE is an alternative to a traditional linear economy. In CE, we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and resources/materials at the end of each service life. CE is derived from semi-scientific and empirical concepts. CE emphasizes the 3Rs (reduce, reuse, recycle) and the 6Rs (reuse, recycle, redesign, remanufacture, reduce, recover). In other words, nothing is lost!

CE- an industrial system that is restorative or regenerative by intention and design. It replaces the 'linear economy or end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.

Resources, Conservation & Recycling 127 (2017) 221–232



Loop
Explore
Virtualize
Robotics
Regenerate
Expert system
ARTIFICIAL INTELLIGENCE
REUSE, RECYCLING
PRODUCTION
CIRCULAR ECONOMY FOR CLIMATE CHANGE
SUSTAINABLE USAGE
122 kg of CO_2 emission/MWh
Power plant
Solar energy
Production of photovoltaic panel
72 g of CO_2 emission/kWh
Geo-thermal energy
Renewable Energy
Wind energy
Production of wind turbine
Hydro energy
Environmental Burden
Carbon Trading
Carbon Capturing
Pay for CO_2 emissions
Carbon credit
CO_2
Emissions trading in Carbon market
CO_2
Carbon Credit
Receives money for maintaining CO_2 sink
Methane dry reforming
Microbial conversion to chemicals
Green house gases
Steam methane reforming
Catalytic reforming to hydrogen


EMPTY CANS
Save The Environment
Please Recycle
EMPTY PLASTICS
Save The Environment
Please Recycle
CLEAN PAPER
Save The Environment
Please Recycle

A reverse vending machine, which identifies, sorts and collects used cans and bottles for recycling

Rubbish bins get smart

Bins are no longer just receptacles for rubbish. Newfangled ones are solar-powered and can be used as Wi-Fi hot spots. Here is a look at how one works and its features.

Wi-Fi router
Enables the bin to provide free Wi-Fi between 11am and 9pm.

Communication module
Allows the bin to send notifications when it is ready to be cleared.
It can also send alerts when there is a problem with the bin.

Compactor
Allows it to hold rubbish up to eight times the capacity of a standard bin.

Enclosed design
Prevents pests from gaining access to waste. It also slows down decomposition by preventing air circulation in the bin.

Solar panel
Provides a sustainable energy source for the bin. Energy is also stored in a battery, so the bin can still function during cloudy/rainy periods.

Hopper handle
Makes it impossible for contact with the compaction mechanism when it is in operation.

Weight 120kg

Height 128cm

Materials:
Recycled plastics and galvanised steel

Rubbish is deposited into the bin. A sensor measures the bin's capacity.

A compactor compresses the rubbish and measures the resistance of the compacted trash.

Notifications on how full the bin is and when it needs to be cleared are sent through e-mail or SMS.

Source: TERRA SOL SMART SOLUTIONS ST PHOTO: KUA CHEE SIONG STRAITS TIMES GRAPHICS

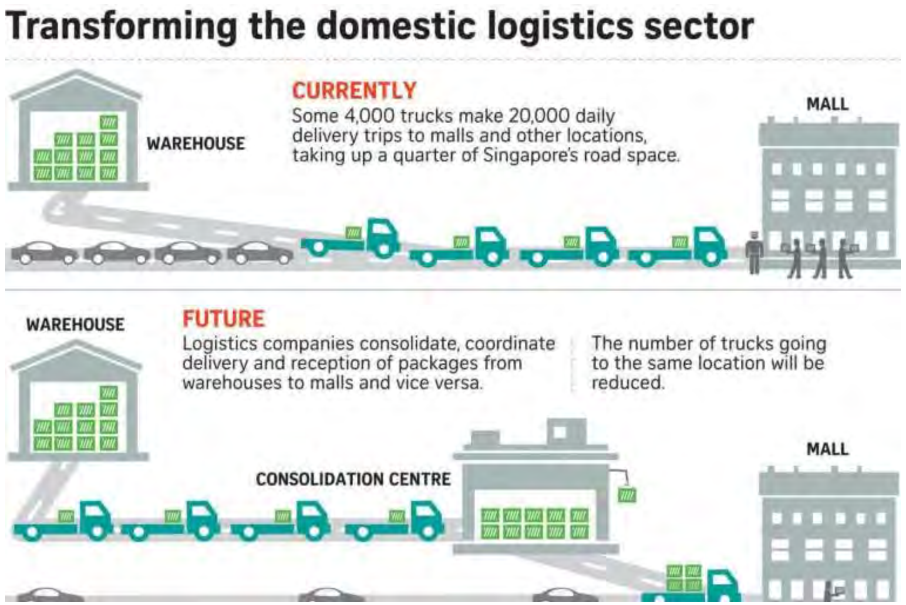
SCIENTIFIC AMERICAN™ CUSTOM MEDIA

SINGAPORE: A SMART NATION

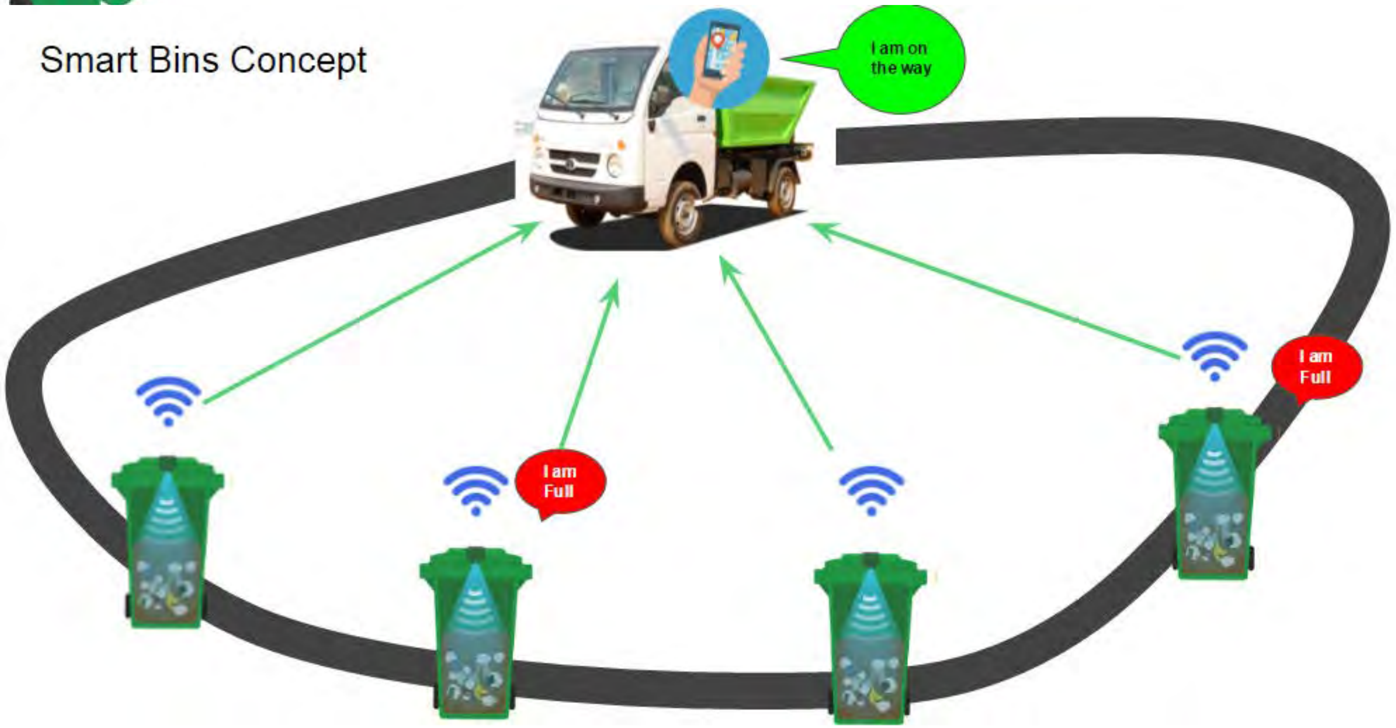
PRODUCED IN COLLABORATION WITH THE INFOCOMM DEVELOPMENT AUTHORITY OF SINGAPORE (IDA)

EDITOR: MIKE MAY
ART DIRECTOR & ILLUSTRATION: JOELLE BOLT
PUBLISHING DIRECTOR: JEREMY ABBATE
DIRECTOR, INTERNATIONAL MEDIA: TED MACAULEY

Smart Bins for Smart City

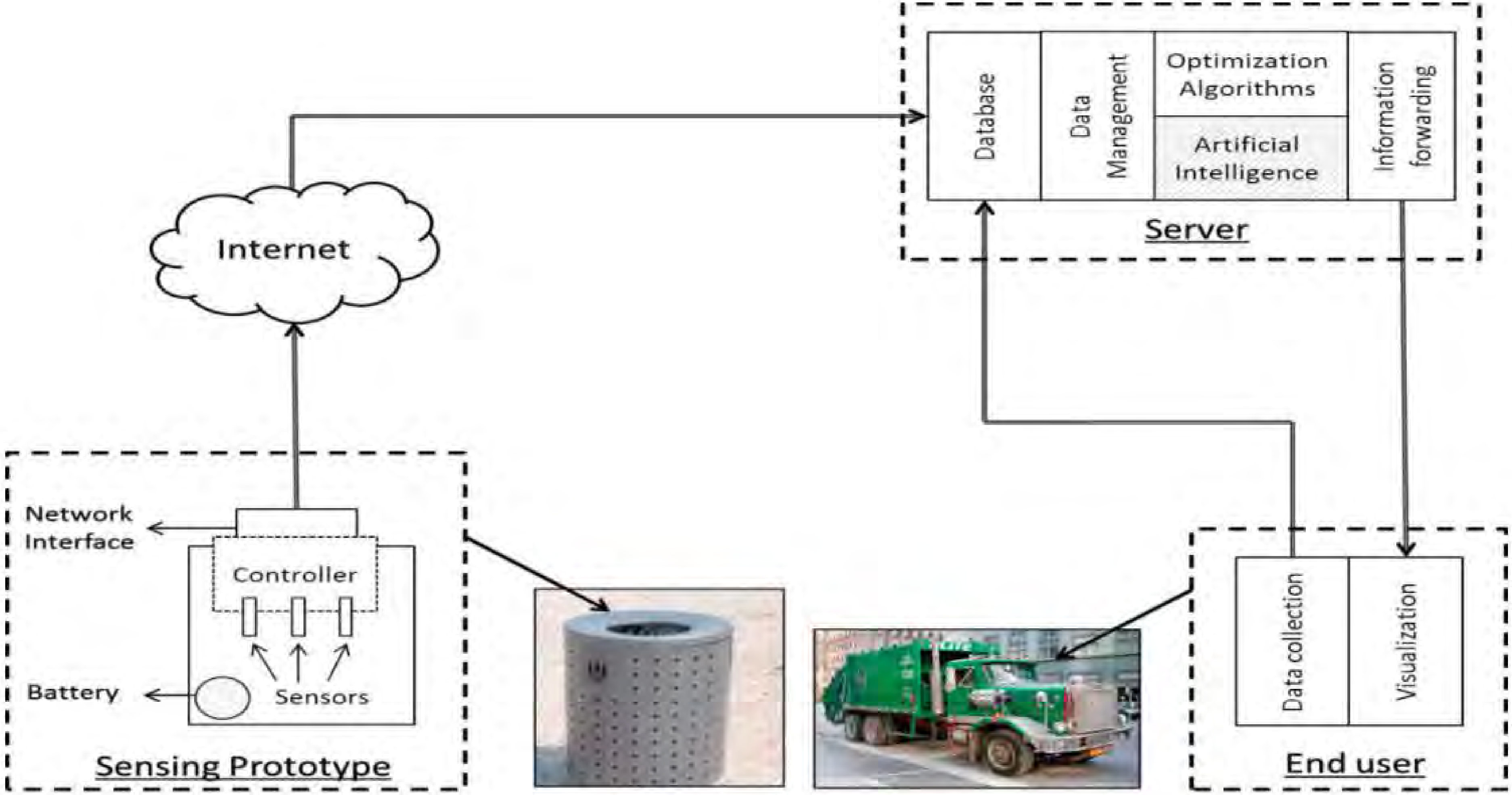


Smart Bins Concept



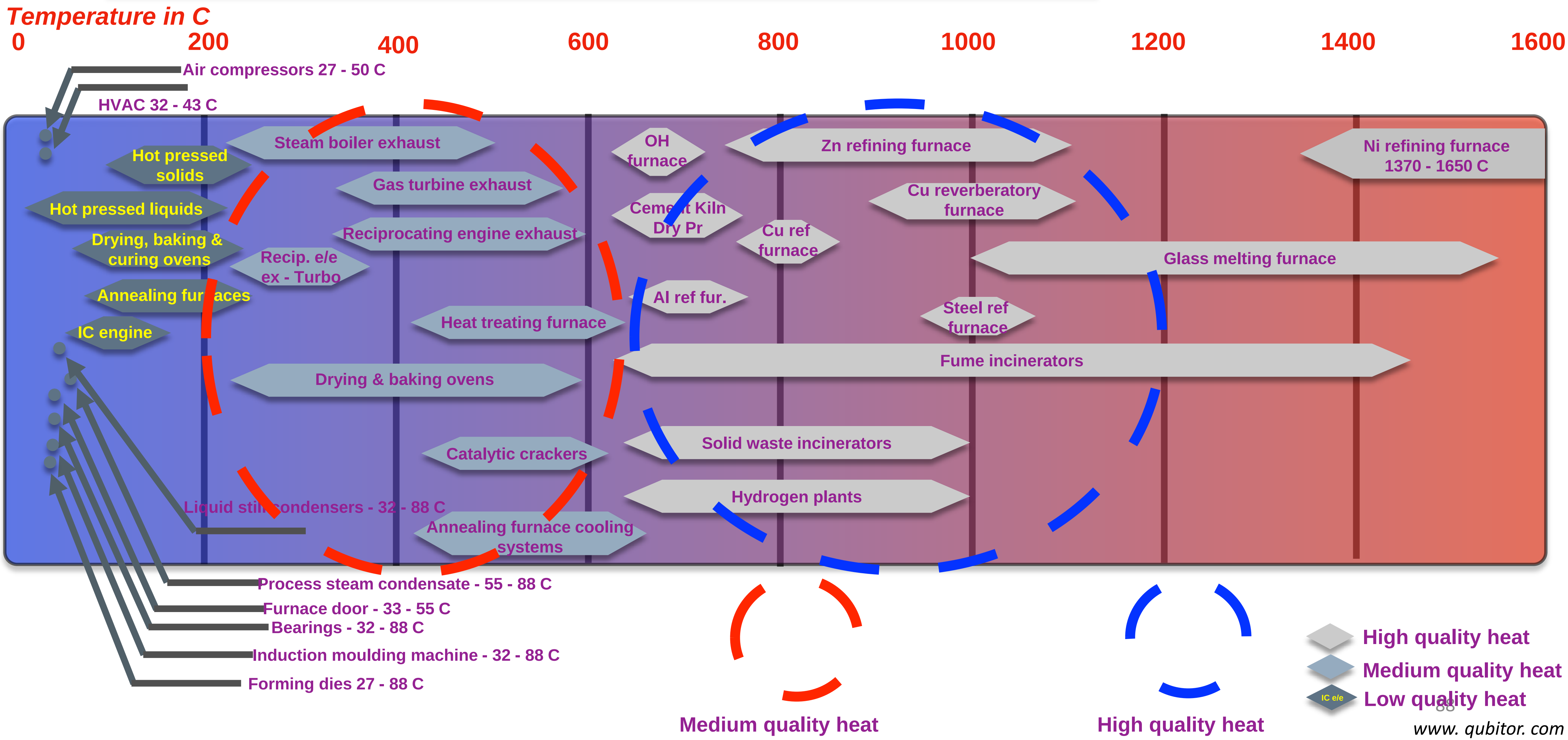
https://www.bioenabletech.com/smart-bins-for-smart-city.html

IoT and AI enabled smart waste collection

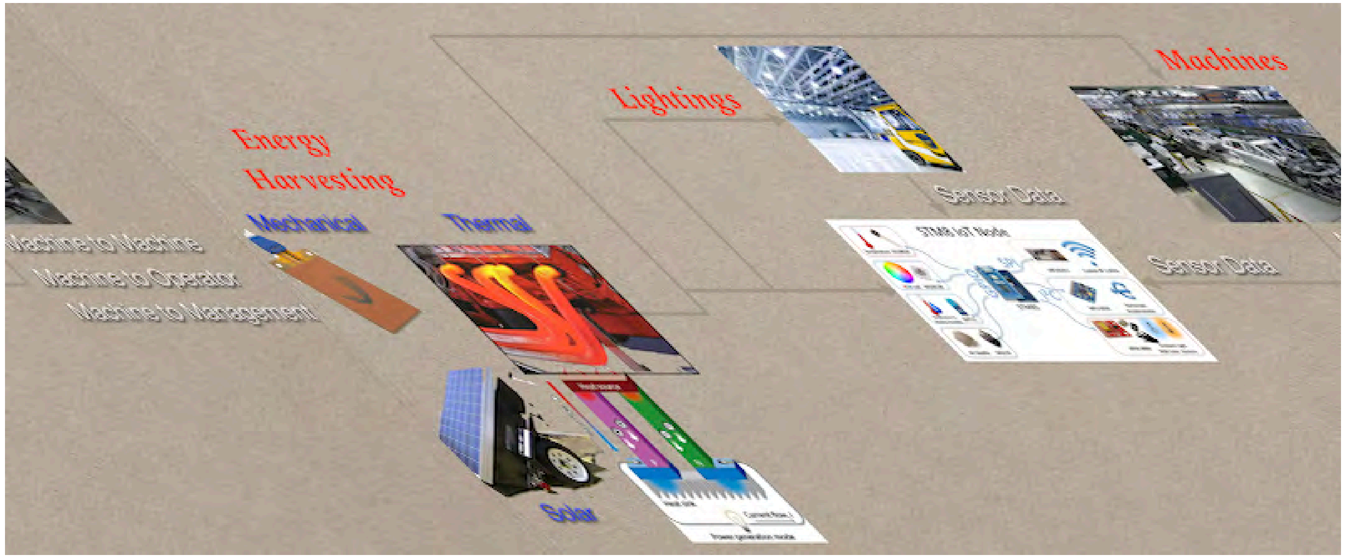


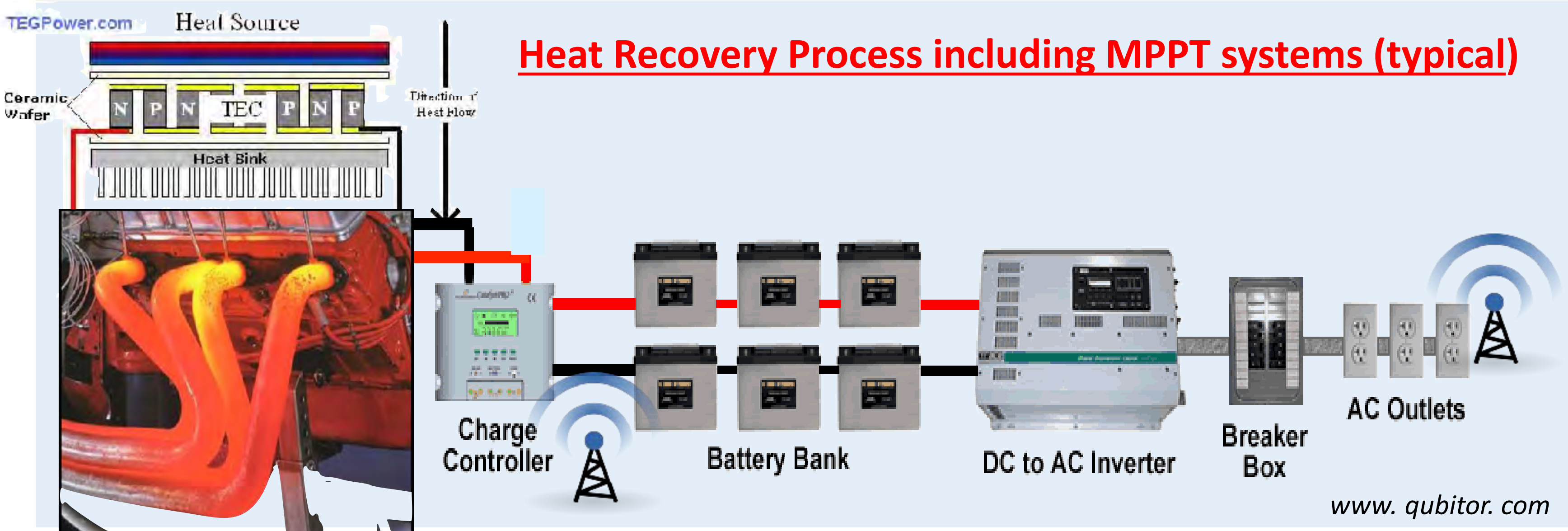
Jose M. Gutierrez et al. / Procedia Computer Science 61 (2015) 120 – 127, https://doi.org/10.1016/j.procs.2015.09.170

Waste heat recovery system and IoT

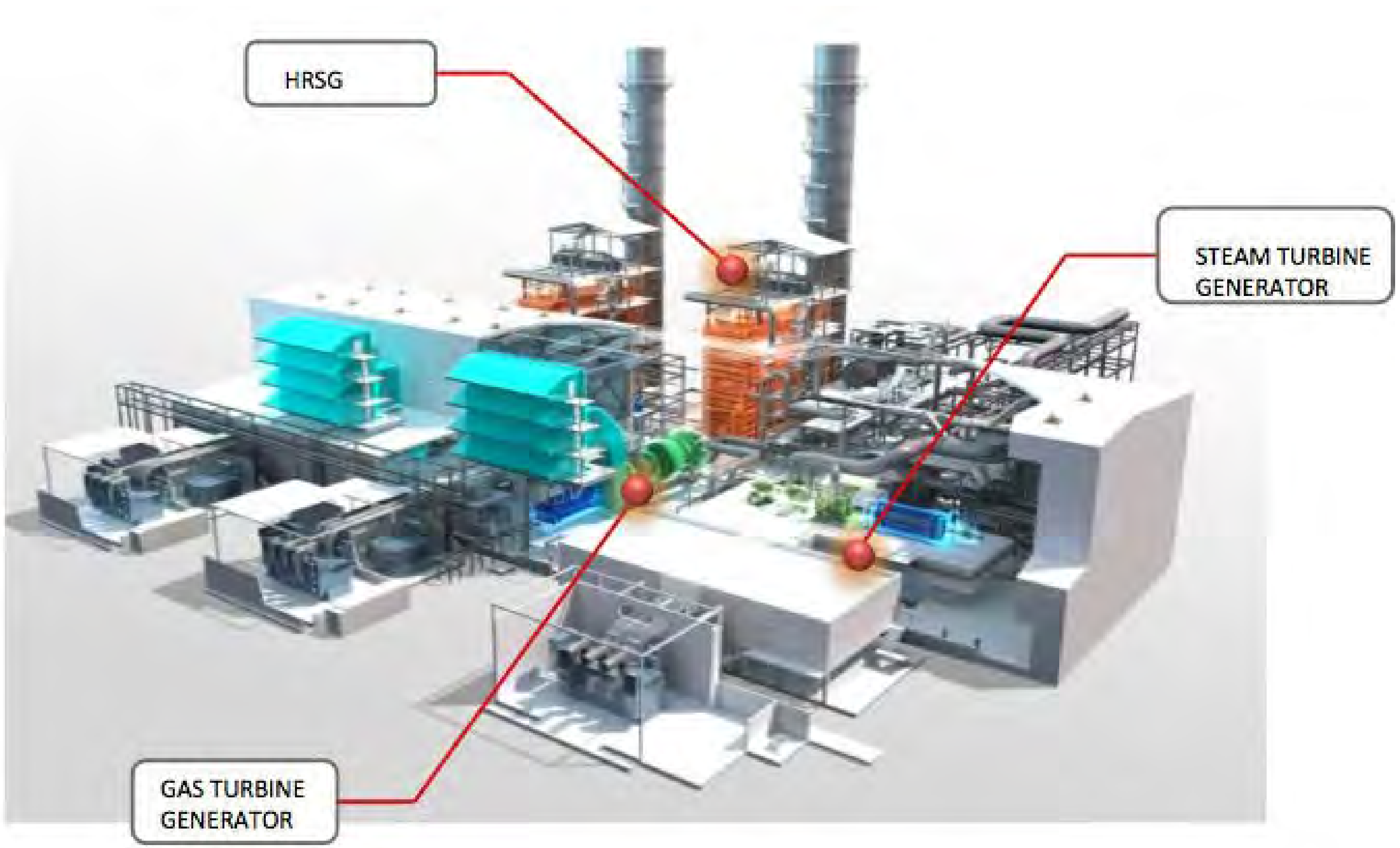


Waste heat recovery system and IoT





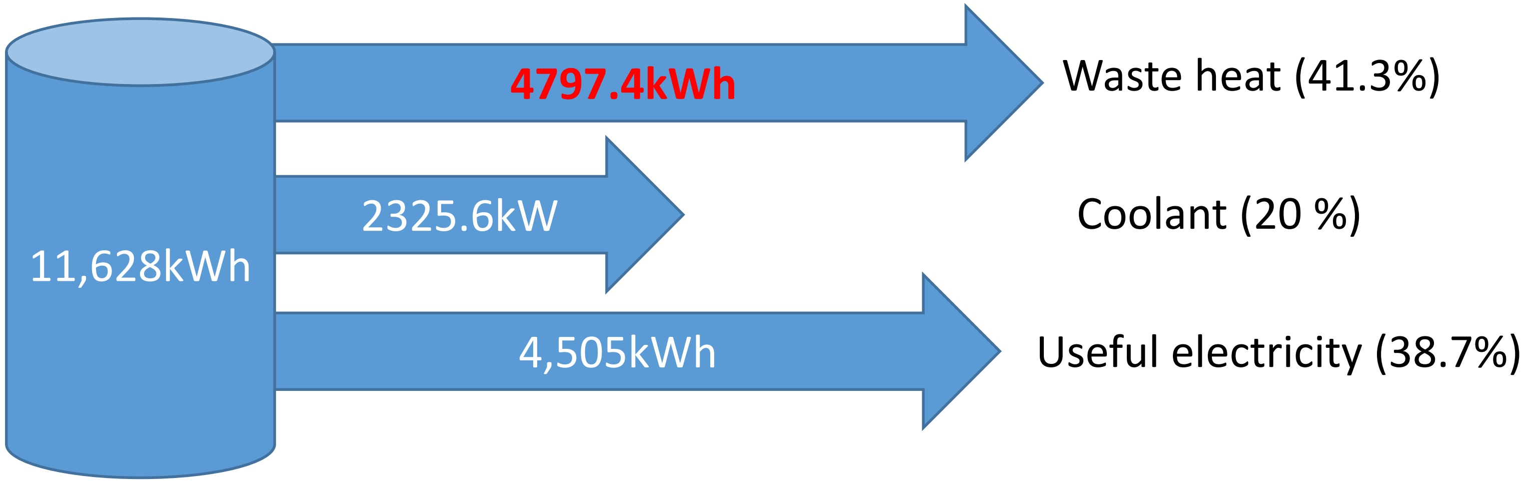
Waste heat recovery system and IoT



- *~ **1kW for 100°C** with 50 sq meter hot spots (more kW for higher temperatures).*
- *conversion efficiency about 7 - 10%*
- *life (duration) about 10 - 12 years*

- ***An industry emitting heat between 100°C - 400 °C which typically loses between 20-30% of energy as heat and hence, in average 2-3% of energy can be restored and re-used using TEG***

1 tonne of oil equivalent in Fossil fuel power station = 11,628 kWh (Total energy generation capacity)

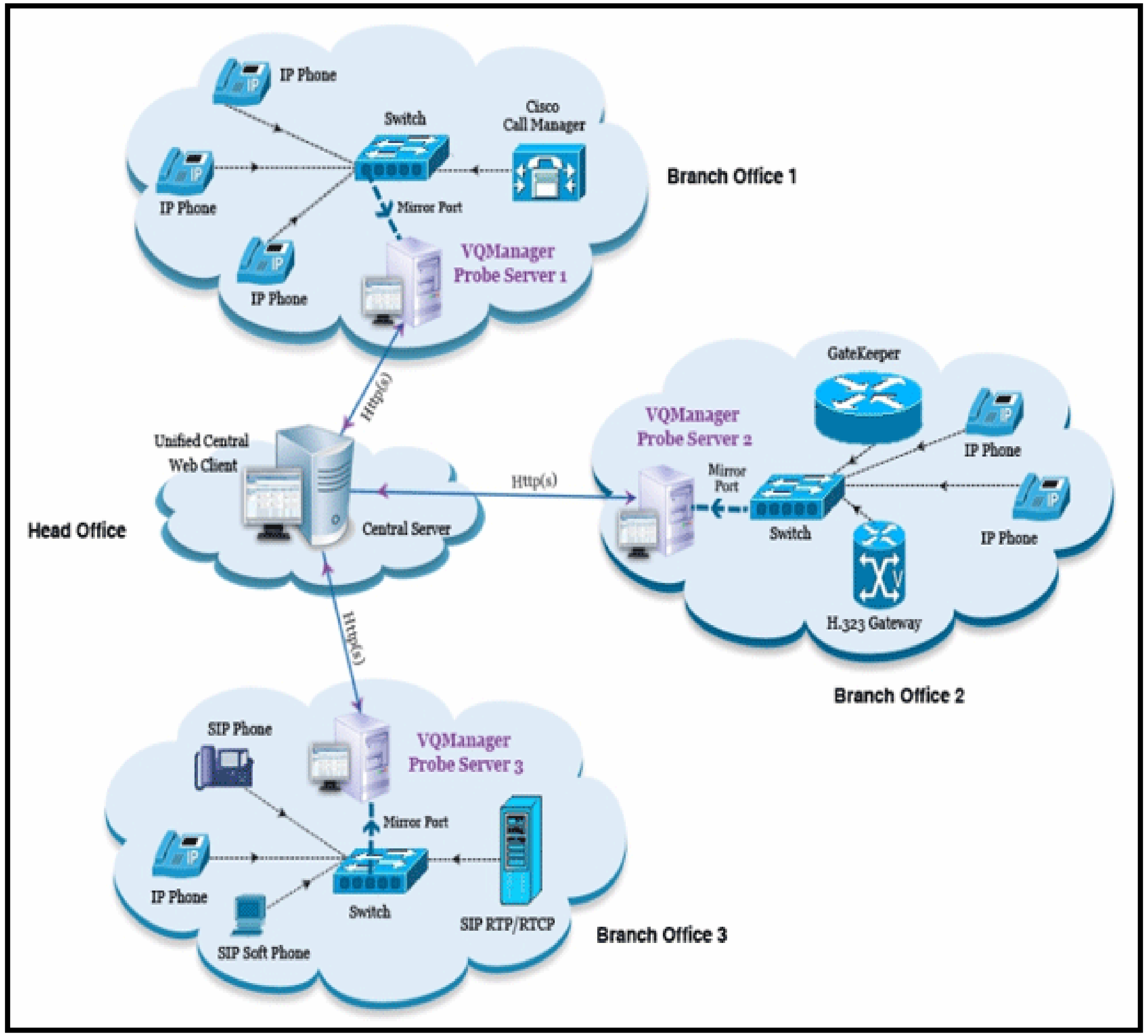


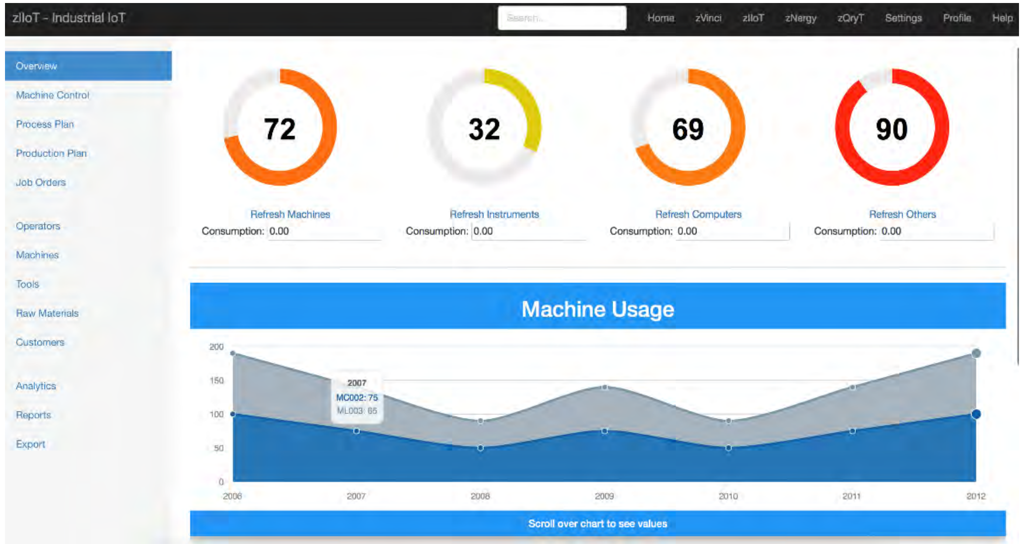
A staggering amount of **4797.9kWh** is being wasted as heat

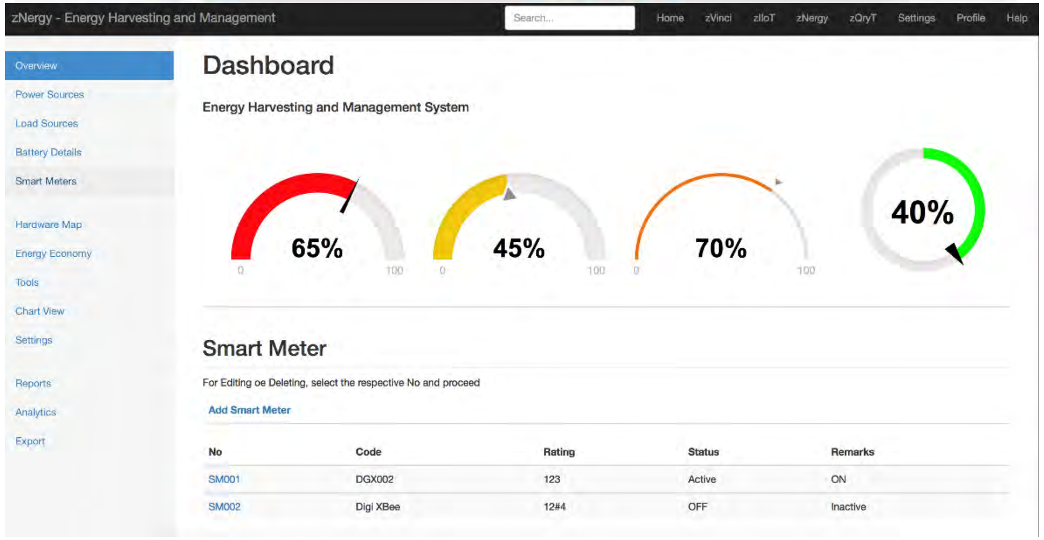
Thermoelectric generator (TEG) **efficiency η= ~12%** at above 250 °C will recover **0.575kWh** energy from the waste heat

Hence the overall energy generation efficiency of the power plant can be improved to **5080kWh** after implementing TEG

Waste heat recovery system using IoT







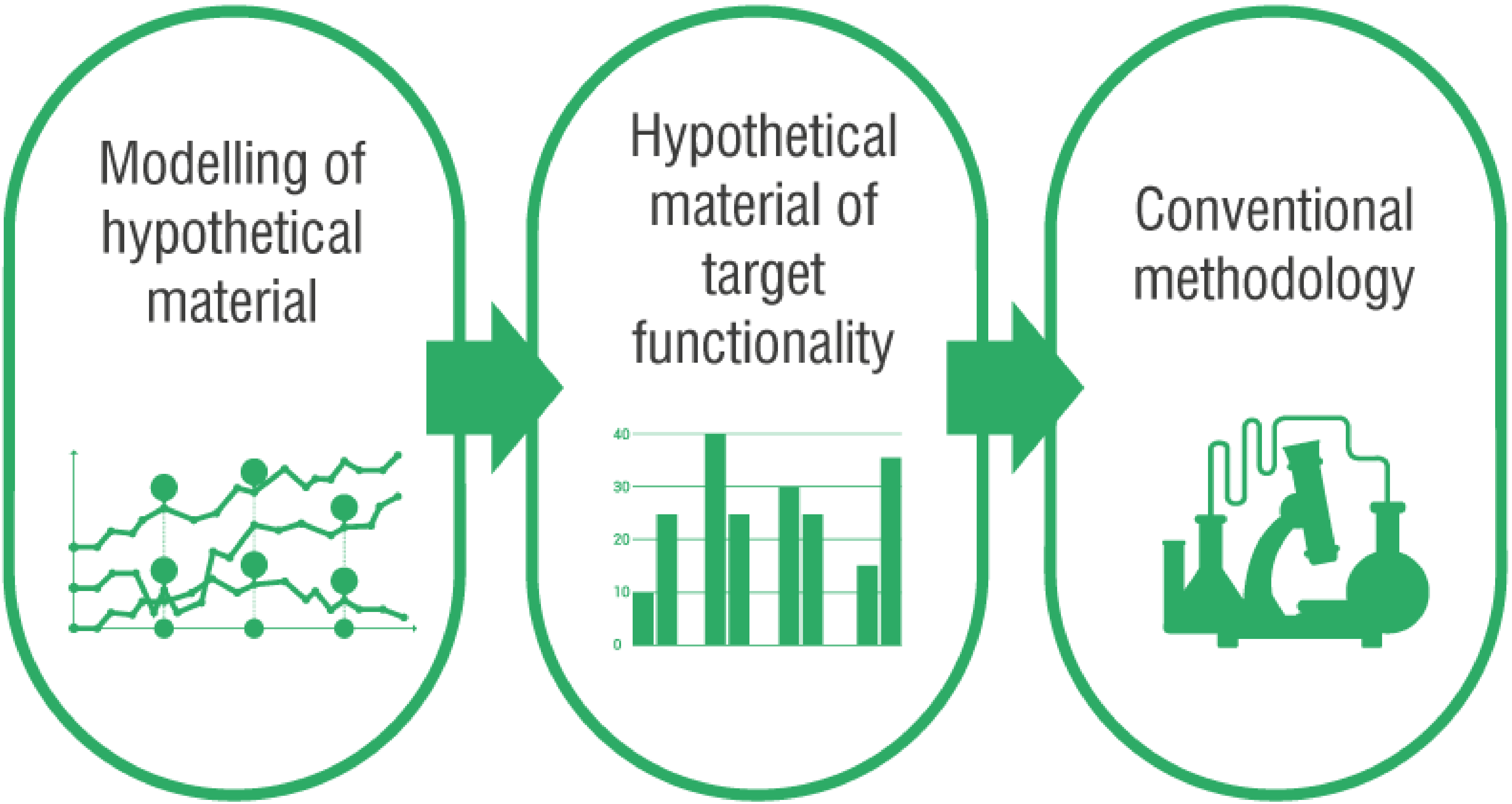
Designed for the Environment: Allbirds are machine washable and meant to be worn without socks. Made of a very fine merino wool.

allbirds

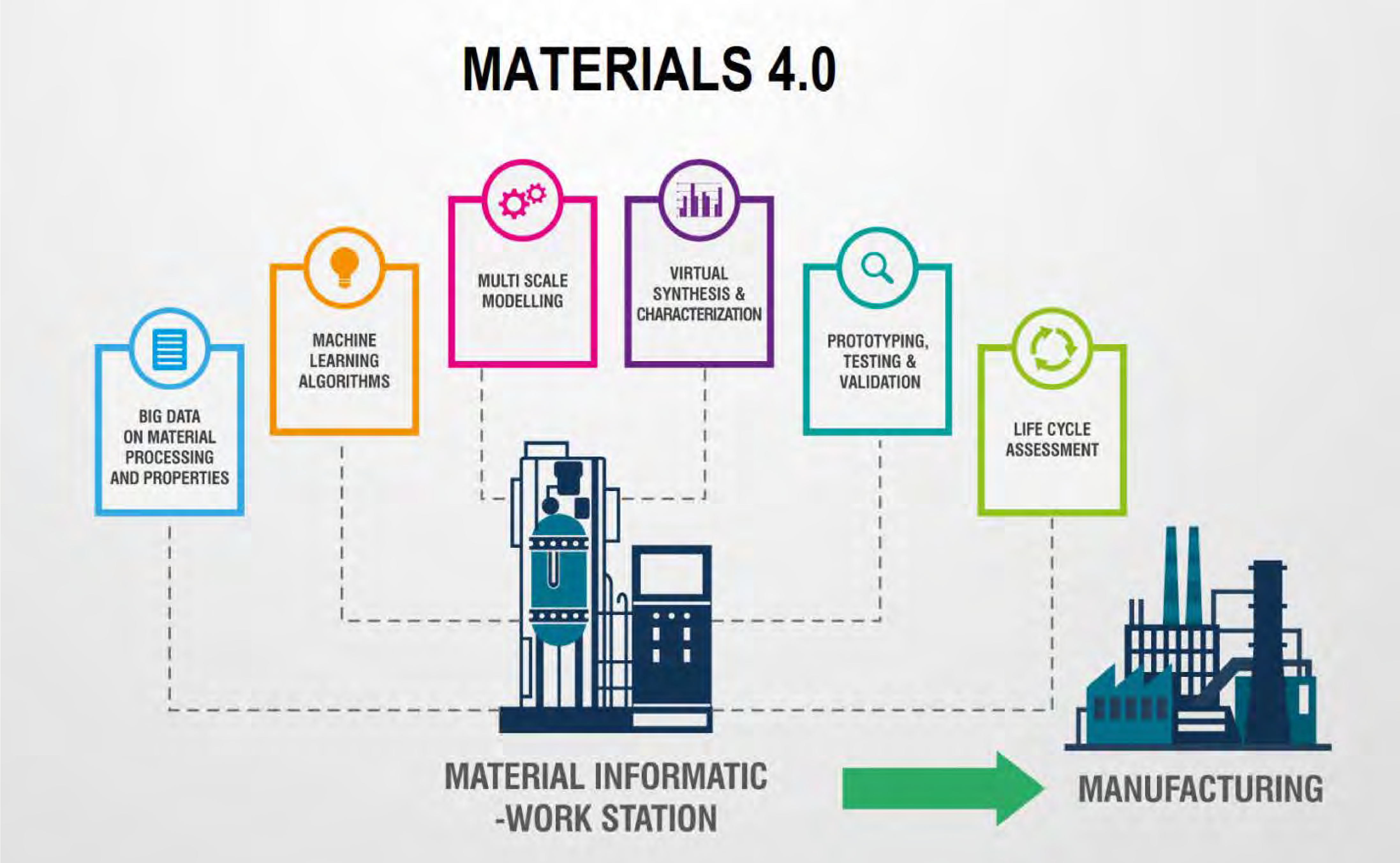

Allbirds founders Joey Zwillinger, left, and Tim Brown

Applied Materials Today 10 (2018) 127–132   https://doi.org/10.1016/j.apmt.2017.12.015

MATERIAL 3.0



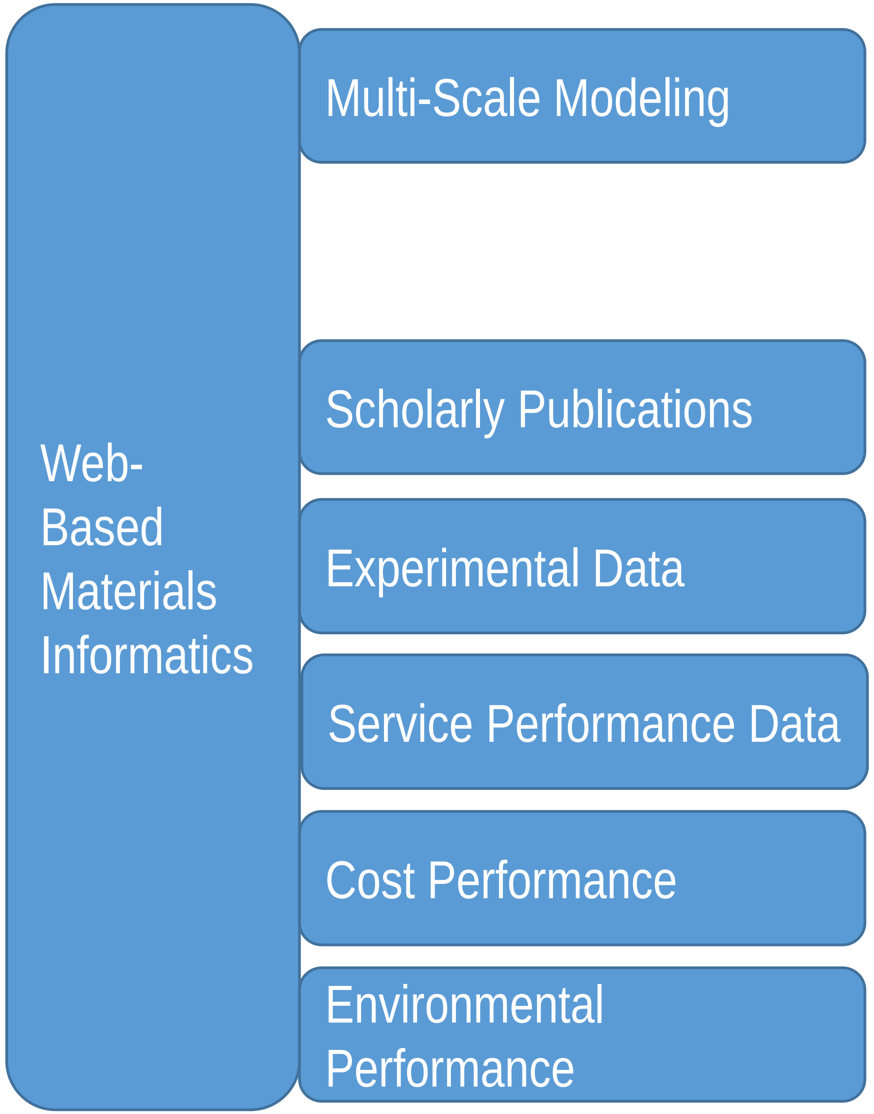
Applied Materials Today 10 (2018) 127–132   https://doi.org/10.1016/j.apmt.2017.12.015



Applied Materials Today 10 (2018) 127–132 https://doi.org/10.1016/j.apmt.2017.12.015

Materials Informatics

- ❑ Microstructure Informatics
- ❑ Data Science and Analytics
- ❑ Data mining and quality
- ❑ Machine Learning/AI/Deep Learning
- ❑ Materials Knowledge Systems
- ❑ Cyberinfrastructure for materials data
- ❑ Spectral Methods for Microstructure-Property-Processing-Performance (s-p-p-p) Linkages
- ❑ Standards and codes
- ❑ E-collaboration networks



- o Density Functional Theory
- o Molecular Dynamics
- o Combinatorial materials science
- o Quantum Mechanics
- o Continuum Mechanics
- o Finite Element Modeling
- o Monte Carlo Model
- o Analytical Equations, theory
- o Empirical Equations

- o Life Cycle Cost, LCC
- o Life Cycle Assessment, LCA
- o Life Cycle Engineering, LCE

Journal of Intelligent Manufacturing, https://doi.org/10.1007/s10845-018-1392-0

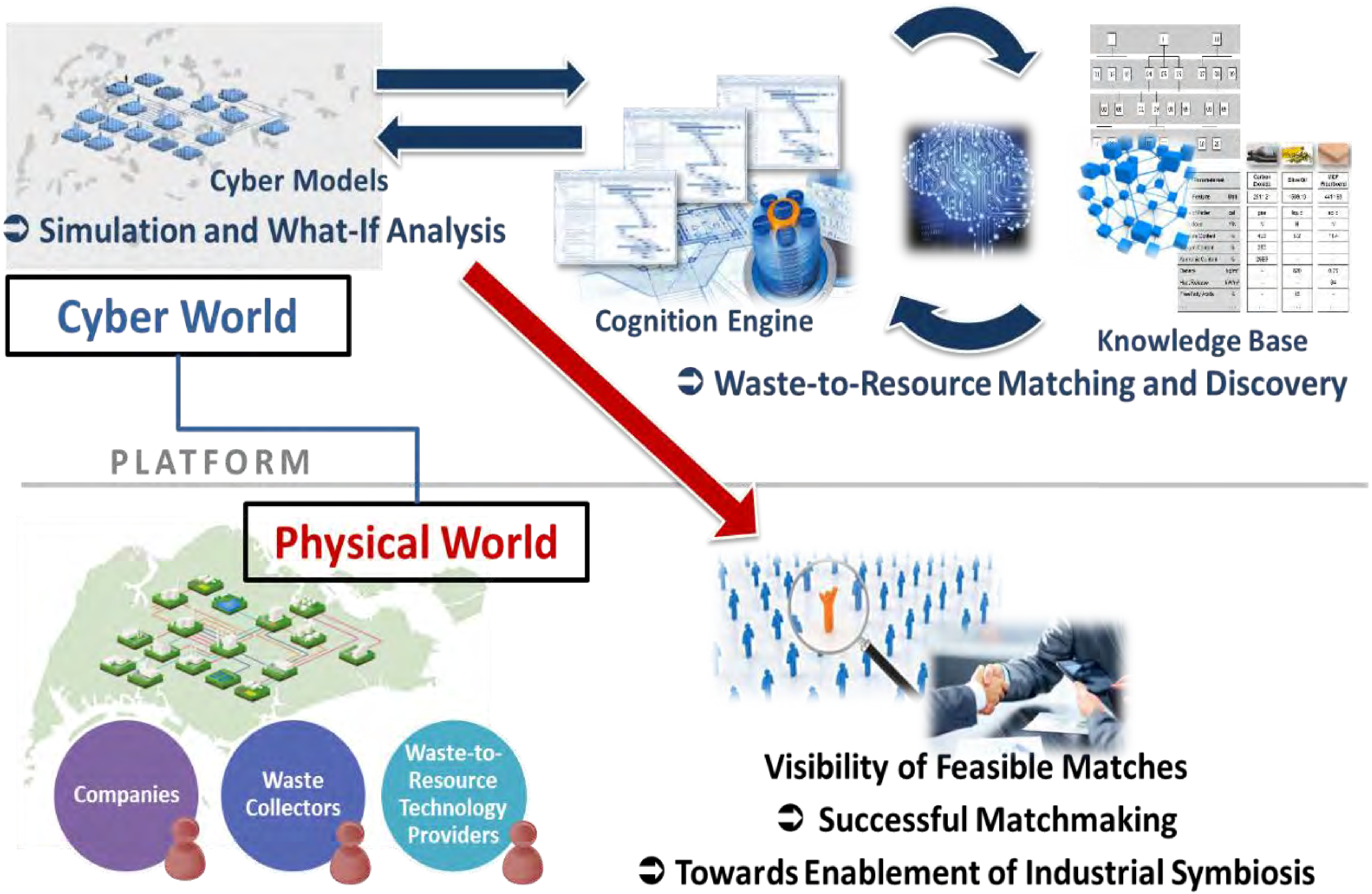
@ Seeram Ramakrishna

Materials Informatics helps you with ….

Web-Based Materials Informatics

- Materials selection (matching with product design)
- Materials designed for functional performance
- Modeling and simulation- property & failure prediction
- Matching materials and processes
- Matching with service performance
- Materials efficiency
- Materials designed for environmental performance
- Material solution for recycling, upcycling and zero waste

Journal of Intelligent Manufacturing, https://doi.org/10.1007/s10845-018-1392-0



http://www.europeanbusinessreview.com/smart-manufacturing/

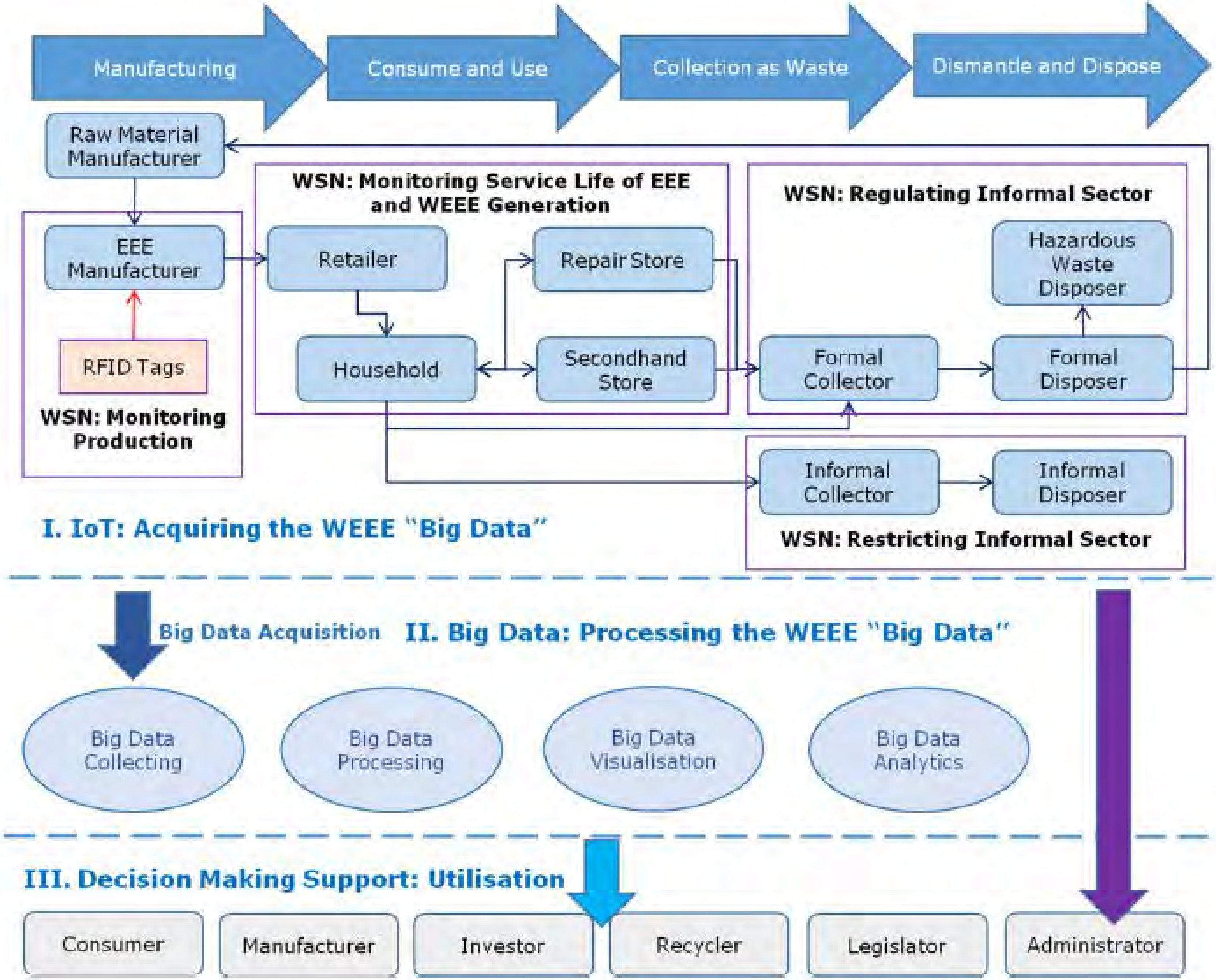


Fig. 2. The framework of the IoT and the Big Data implementation for WEEE management.

F. Gu et al. / Waste Management 68 (2017) 434–448

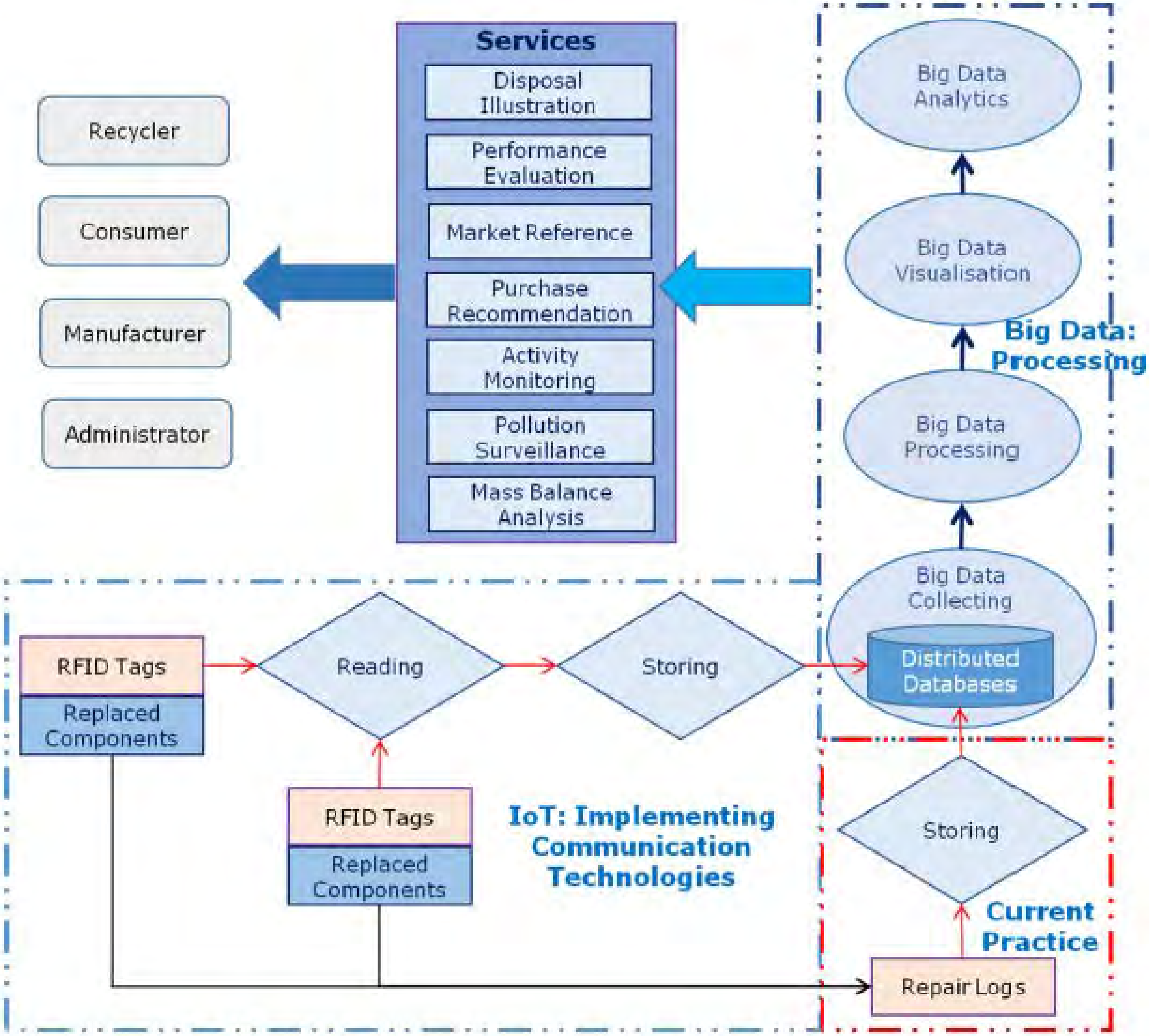


Fig. 4. The scenario of implementing the IoT and the Big Data technologies in monitoring the repair activities.

F. Gu et al. / Waste Management 68 (2017) 434–448

Data structure of the repair records stored in the log database.

Column no	Content
1	Serial number
2	Time of receiving call
3	Name of customer
4	Contact number
5	Location of customer
6	Operator
7	Brand
8	Type
9	Model
10	Complained problem
11	Time of sending Technician
12	Service content
13	Identified problem
14	Whether fixed?
15	Service completion time
16	Charge of service
17	Charge of parts changed
18	Total charge
19	Fee received
20	Whether case closed?
21	Whether repay a visit?
22	Audit

F. Gu et al. / Waste Management 68 (2017) 434–448

Detailed information on components or products replacements in the repair store during the period from 1st July 2015 to 31th December 2015.

Replaced components	Number of units[a]	Estimated average weight (kg)[b]	Accumulated weight (kg)	Contained resources[b]
Compressor	506	18.5	9361.00	Al, Cu, Fe
Electric motor	377	0.05	7.54	Cu, Fe
PCB	312	0.50	156.00	Ag, Cu
Remote Control	910	0.12	109.20	Cu, plastics
Display panel	118	0.25	29.50	In, glass
Capacitor	481	0.07	33.67	Al
Sensor	149	0.10	14.90	Cu
Valve	755	0.15	113.25	Cu, Fe
Blades	85	2.50	212.50	Fe
Evaporator	69	5.50	379.50	Al, Cu, Fe
Drip tray	93	1.50	139.50	Fe
Aqueduct	223	1.20	267.60	Cu, plastics
Acoustic Panel	476	0.30	142.80	Plastics
Pegboard	134	0.20	36.80	Plastics
Cable and switch	11	0.50	5.50	Cu
Whole machine	184	45.00	8280.00	Ag, Al, Cu, Fe, glass, plastics, etc.
Total weight			19290.57	

[a] In some cases, more than one unit of component needed to be replaced.

[b] Information provided by the technicians in the repair store.

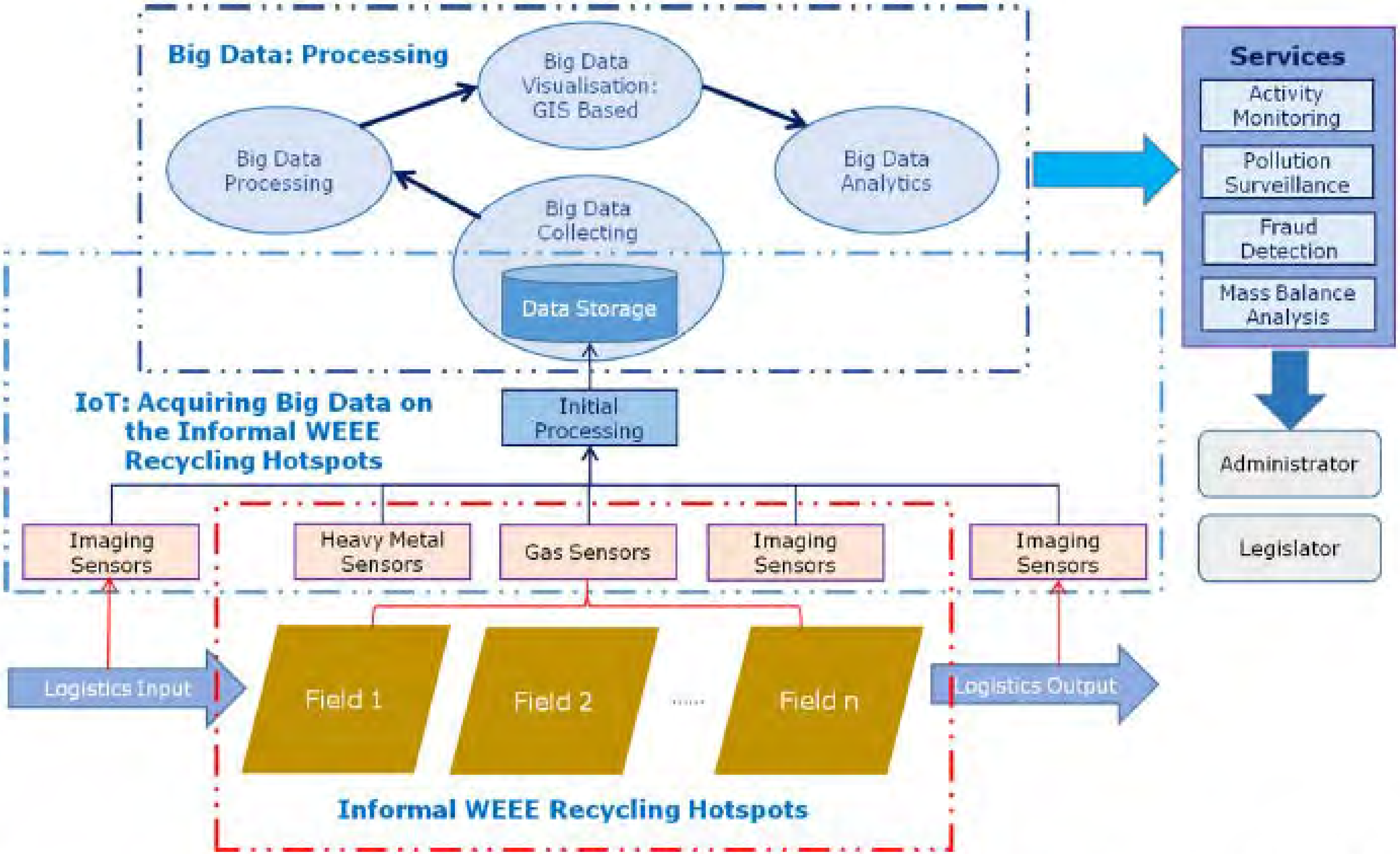


Fig. 6. The scenario of implementing the IoT and the Big Data technologies in monitoring the informal WEEE recycling activities in the hotspots.

F. Gu et al. / Waste Management 68 (2017) 434–448

Knowledge Management System to Support Waste-to-Resource Matching: Application in Paper Waste

	NISP	**E-Symbiosis**	**US Materials MarketPlace**
Country	UK	Greece	US
Year	2006	2010	2015
Platform	Web-Based	Web-Based	Web-Based
Scale	National	International	International
Opportunity Identification	Yes	Yes	Yes
Identification Method	Input Output Match Relationship Mimicking	Input Output Match Process Characteristics	Supply & Demand

Mr Arthur Huang's upcycling company has created 1,200 new materials from trash. In his right arm is a concrete-like building material made from 2,000 cigarette butts. Sitting on it are air filters made from old clothes. The piece of fabric in his left hand is made from plastic bottles. A database of Miniwiz's materials will be opened to 100 universities, and students will receive funding to create new products with the materials.

http://www.straitstimes.com/singapore/environment/from-trash-to-treasure

Fig. 1. Drivers for transforming current cities into zero waste cities.

CONCLUSIONS

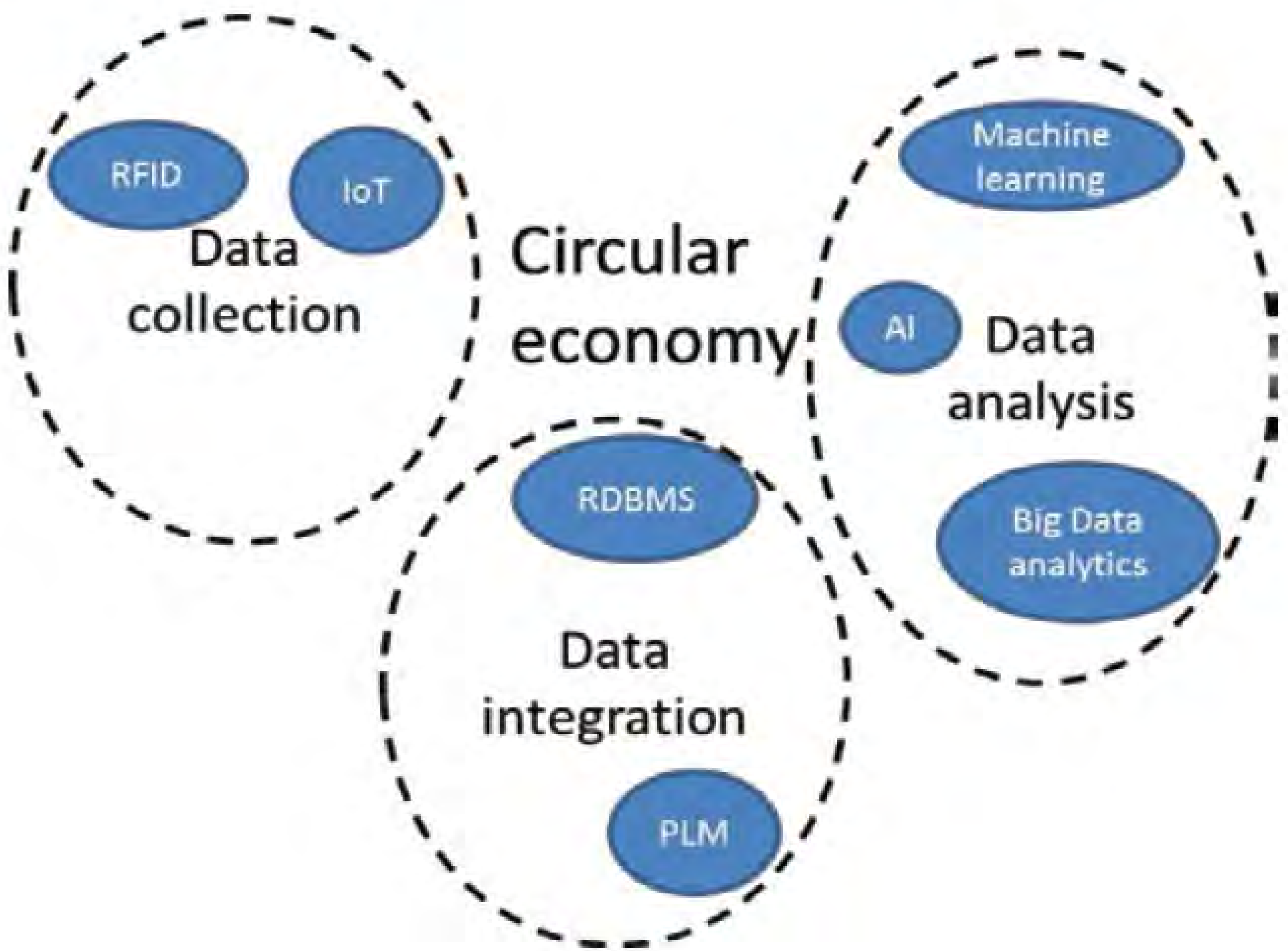
Human progress has been defined by

- hunter-gatherer (Society 1.0)
- Agriculture (Society 2.0)
- industrial revolution (Society 3.0)
- information revolution (Society 4.0)

Society 5.0

Physical space and cyberspace will be seamlessly connected via integration of emerging technologies such as artificial intelligence, machine learning, Big Data, and augmented reality into every aspect of life

IoT, Big Data, AI & Materials Informatics enable Circular Economy



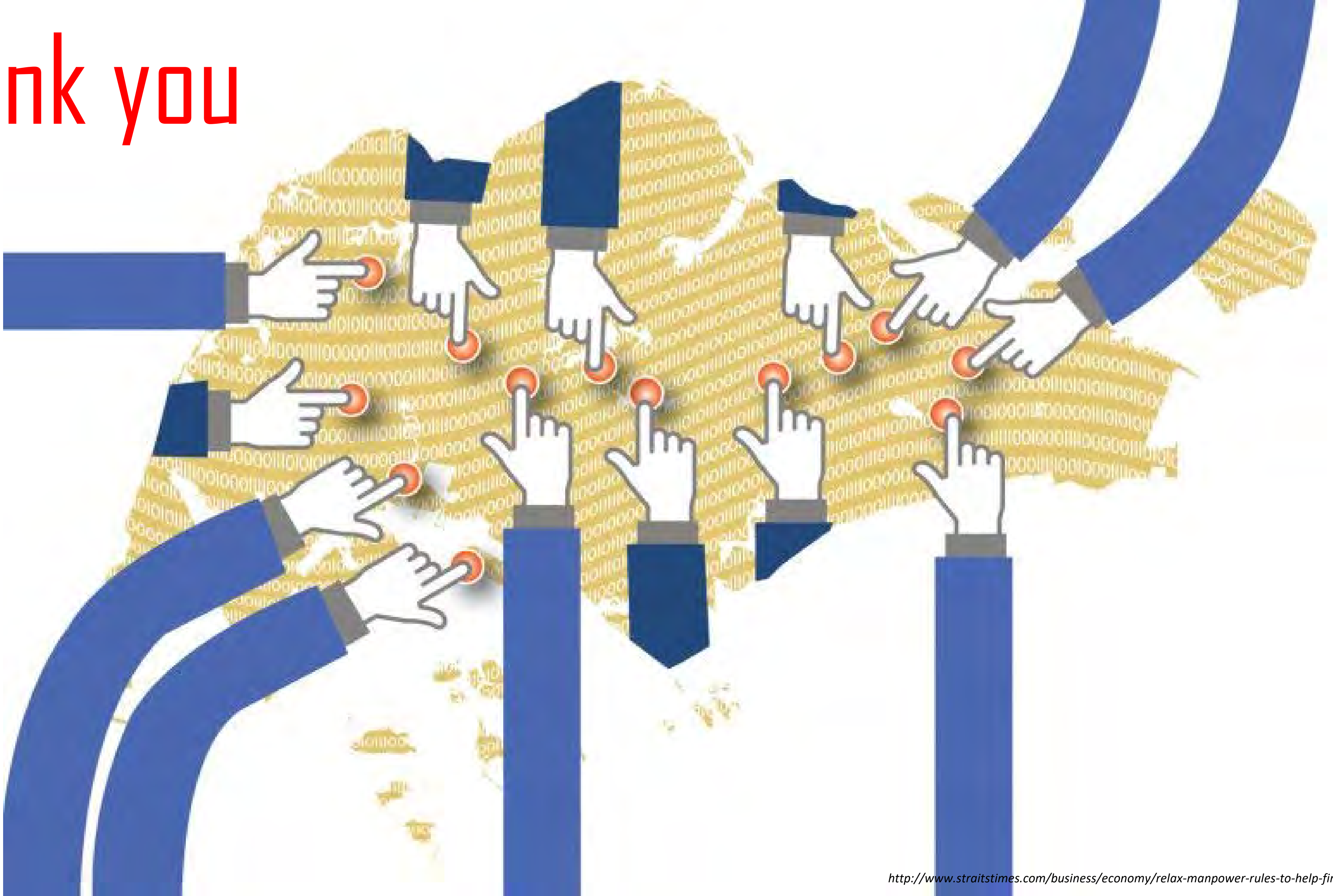
·is Pagoropoulos et al. / Procedia CIRP 64 (2017) 19 – 24
Saidani, M., Resources, Conservation & Recycling (2017), http://dx.doi.org/10.1016/j.resconrec.2017.06.017

Sectors with greater impact of IoT, Big Data, AI, Materials Informatics on Circular Economy?

Business Value? Customer Experience, Increased Quality, Lower Costs, Operational Efficiency, Lower Environmental Effects

	Industry 4.0	Circular Economy	Environment
Pollution control (Transportation)	Data Analytics, IoT, AI	Efficient Supply chain	Lower emissions
Plastics (& Bio-based substitutes)	Knowledge Platform	Waste to Resource	Lower waste disposal
Wood and Paper	Knowledge Platform	Waste to Resource	Lower waste disposal
Construction materials	3D Printing, Nanotech	Waste to Resource	Lower carbon foot print
Water	IoT, Data Analytics	Waste water reuse	Energy efficient
Solid waste	Data Analytics	Waste to Resource	Lower waste disposal
Clean energy gen, storage, supply	IoT, AI, Data Analytics	Lower consumption	Lower energy losses
Energy efficiency (processes, systems, etc.)	Real Time Monitoring	Lower consumption	Lower energy losses
Food (& faux meat)	Data Analytics	Waste to Resource	Lower wastage
Agriculture, Urban Farmed Products	Data Analytics	Efficient Supply chain	Lower pollution
Beverages	Data Analytics	Waste to Resource	Lower wastage
Textiles (wearables, biotech leather, etc.)	Data Analytics	Waste to Resource	Lower pollution
Services	AI, Data Analytics	Efficient delivery	Lower pollution
Value chains, material flows, and products	AI, Data Analytics	Efficient delivery	Lower pollution
Electricals & Electronics	Knowledge Platform	Product re-routing	Co2 savings

Thank you



http://www.straitstimes.com/business/economy/relax-manpower-rules-to-help-firms-go-digital-kpmg