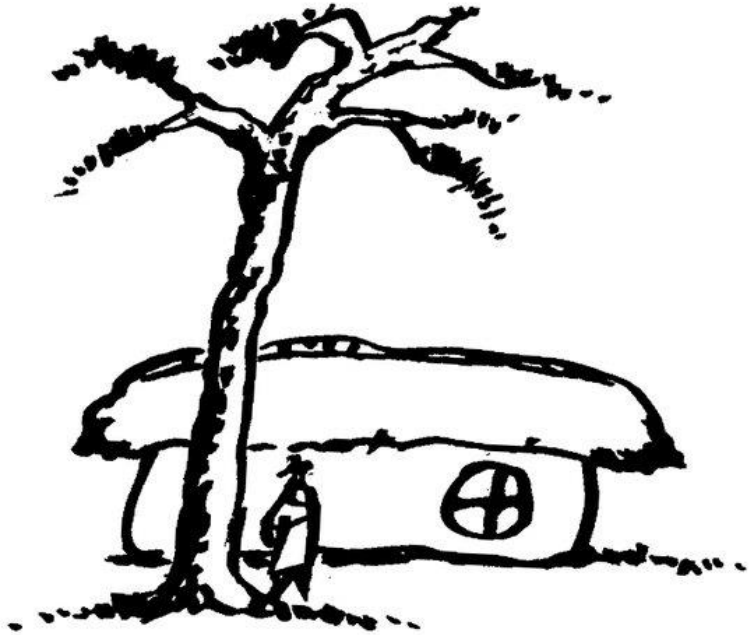


KOREA,
Your global link to SUCCESS

December, 2018

Yongsoo PARK
Key Industry Investment Promotion Team
KOTRA Invest KOREA

Economy

Facts & Figures

Initiatives for 4th Industrial Revolution

Innovative Growth

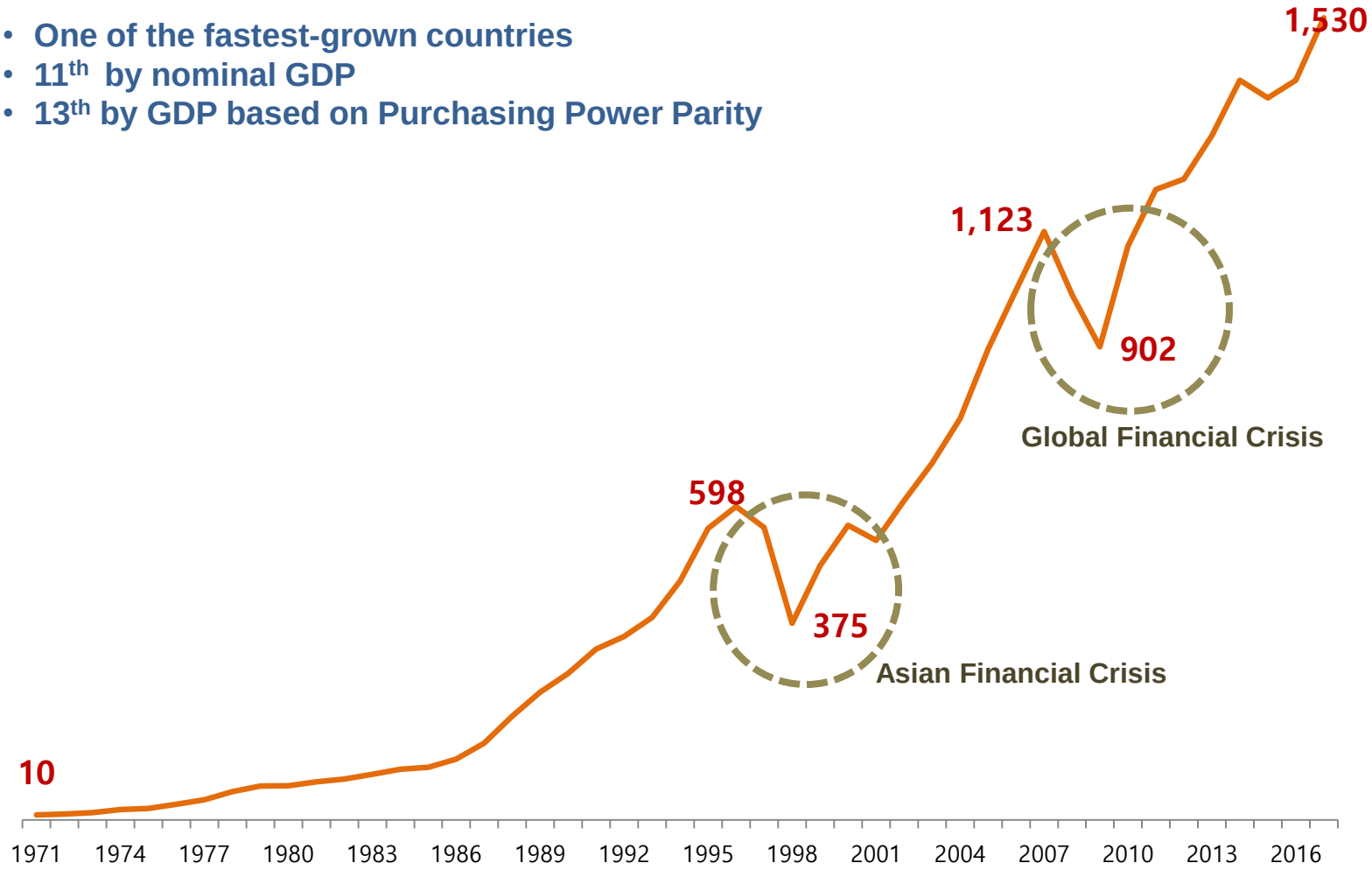
KOTRA

Economy

- GDP
- GDP Growth
- Export
- Import

GDP

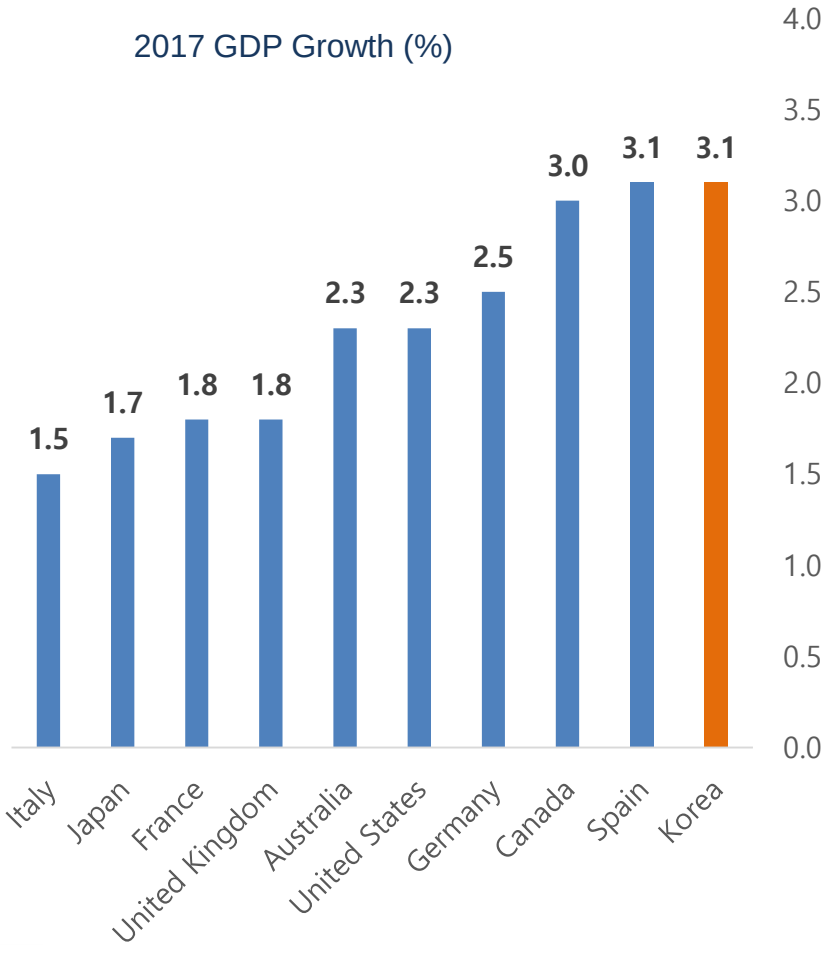
- One of the fastest-grown countries
- 11th by nominal GDP
- 13th by GDP based on Purchasing Power Parity



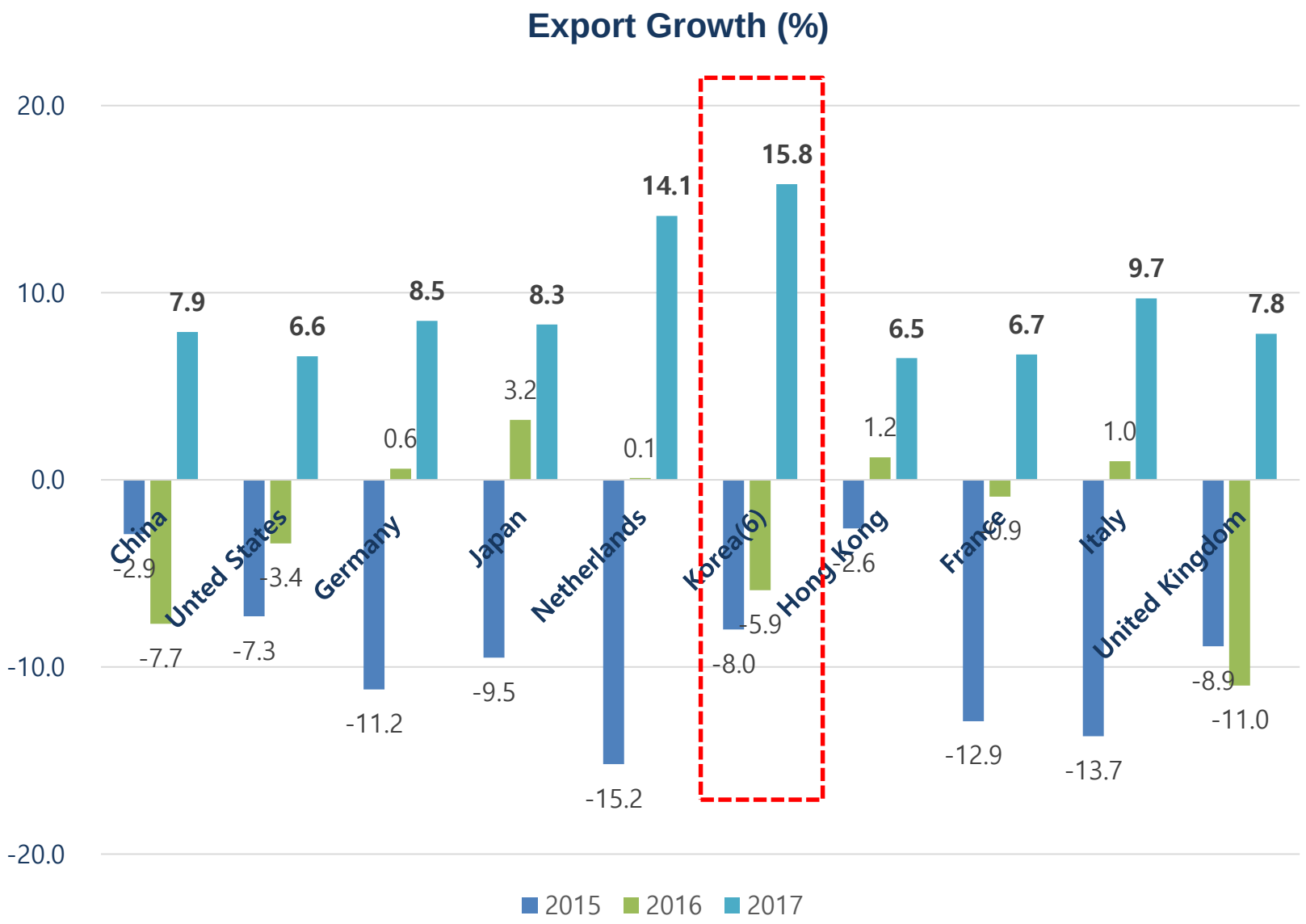
(unit: US$ billion)

GDP Growth

- **Real GDP Growth: (‘13)2.9% → (‘14)3.3% → (‘15)2.6% → (‘16)2.8% → (‘17)3.1%→ (‘18)2.9%(E)**
- **(‘17) The highest growth among countries above US$20,000 GDP per capita & 20 million population**

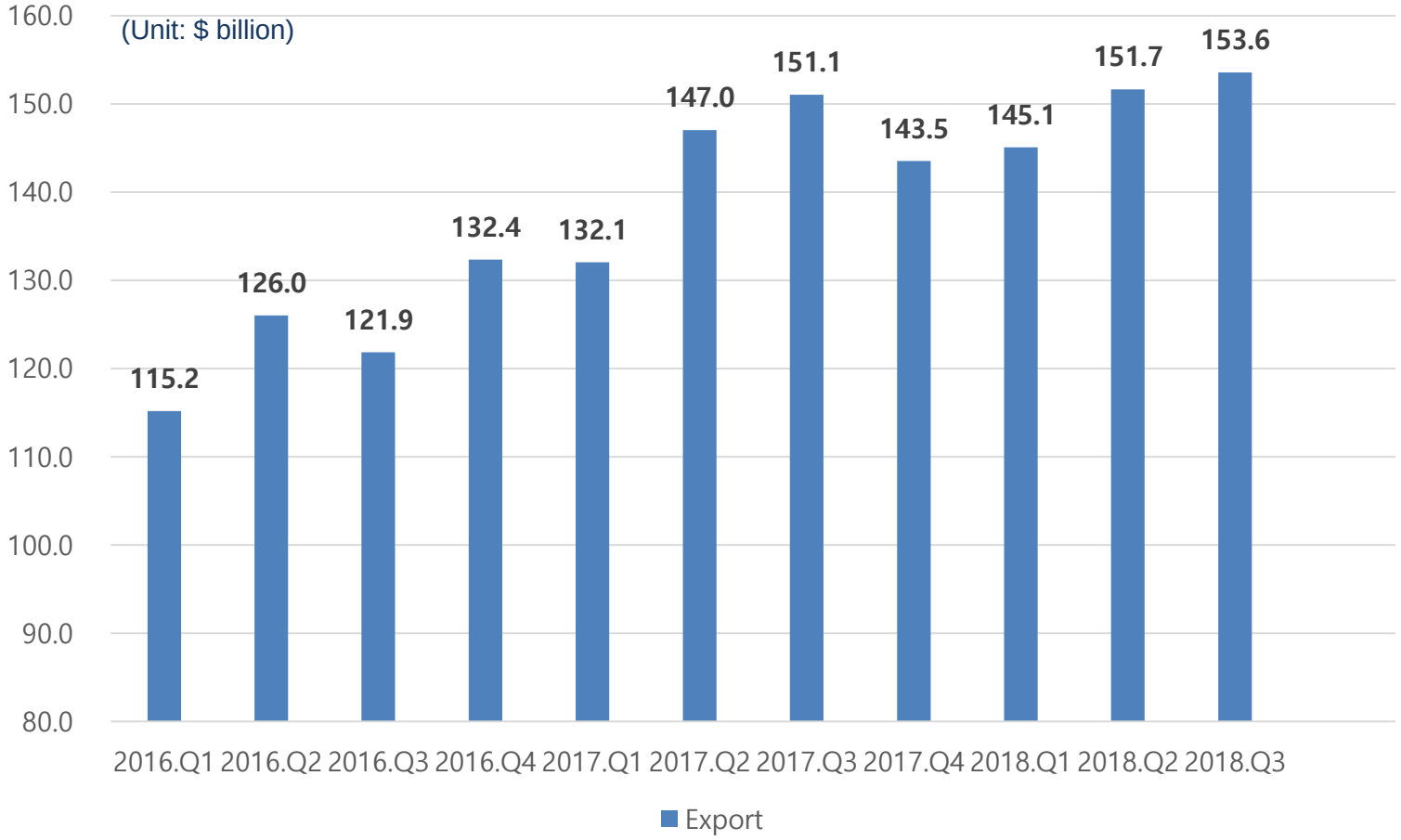


Top10 Export Countries



Export

- In 2017 Korea's exports surged by 15.8% to a record $573.7 billion from a year earlier
- In 2018 the cumulative volume of exports from January to October rose 6.4% compared with the same period a year earlier to $505.3 billion and exports to EU rose 3.1% to $45.3 billion



Top Export Items

- In 2017 the record-high export was driven by a significant growth in semiconductor exports, which soared by 57.4% to $97.7 billion due to the high demand for memory chips
- As of Oct. 2018, Semiconductor(+22.2%), General Machinery(+51.7%), Automobiles(+35.7%), Petrochemicals(+42.9%), Ships(-55.0%), Wireless Communication Devices(-18.2%), Steel(+22.2%), Petroleum Products(+75.5%), Automotive Parts(+36.9%), Displays(-7.9%), Textile(+30.4%), Home Appliances(+5.6%), Computers(+3.4%)

10.1%

57.4%

9.2%

78.2% of Exports

① Semiconductor
② General Machinery
③ Automobiles
④ Petrochemicals
⑤ Ships
⑥ Wireless Communication Devices
⑦ Steel
⑧ Petroleum Products
⑨ Automotive Parts
⑩ Displays
⑪ Textile
⑫ Home Appliances
⑬ Computers

-22.2%

3.8%

-0.5%

23.6%

9.0%

23.1%

-9.5%

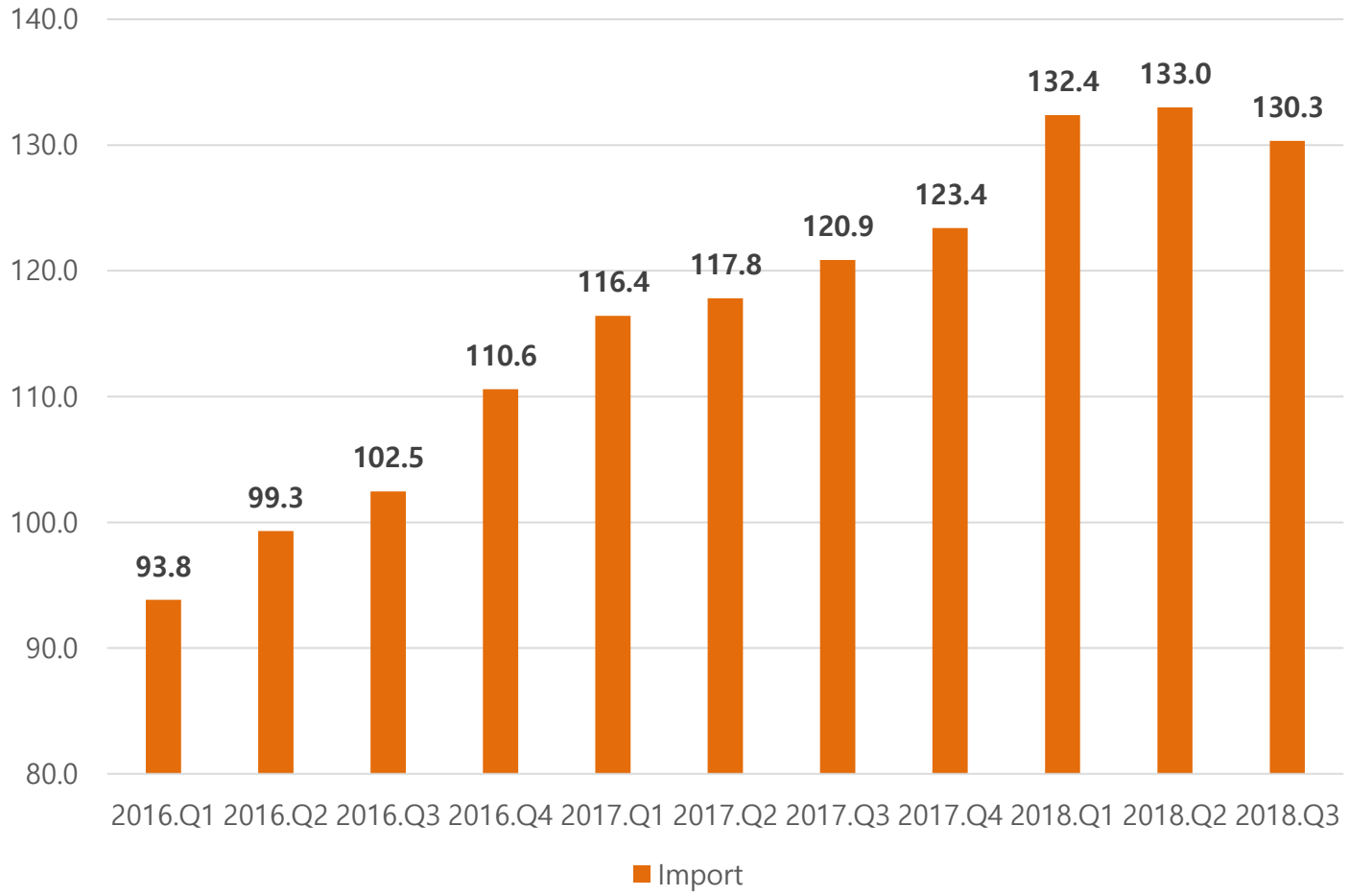
-14.5%

19.9%

32.4%

Import

- **In 2017 brisk domestic production and exports of Korea helped drive up its imports by 17.8% to $478.4 billion**
- **In 2018 the cumulative volume of imports from January to October rose 13.0% compared with the same period a year earlier to $444.1 billion and imports to EU rose 11.7% to $20.3 billion**



Top Import Items

- **In 2017 inbound shipments of capital goods increased by 33.2% as imports of semiconductor manufacturing equipment more than doubled**
- **And imports of commodities and intermediary goods expanded by 32.9% and 11.9% respectively**

Item	Amount ($ billion)	Growth (%)
Semiconductor	41.2	12.5
Semiconductor Manufacturing Equipment	19.3	120.4
Petroleum Products	15.1	26.0
Wireless Communication Devices	13.3	0.4
Computers	11.7	19.4
Automobiles	10.9	4.1
Fine Chemicals	9.9	21.9
Textile	9.2	7.9
Steel Plate	7.9	13.4
Measurement and Analysis Instruments	7.3	10.4
Agricultural chemicals and Pharmaceuticals	6.8	2.5
Industrial electric devices	6.6	14.5
Aluminum	6.4	19.2

Facts & Figures

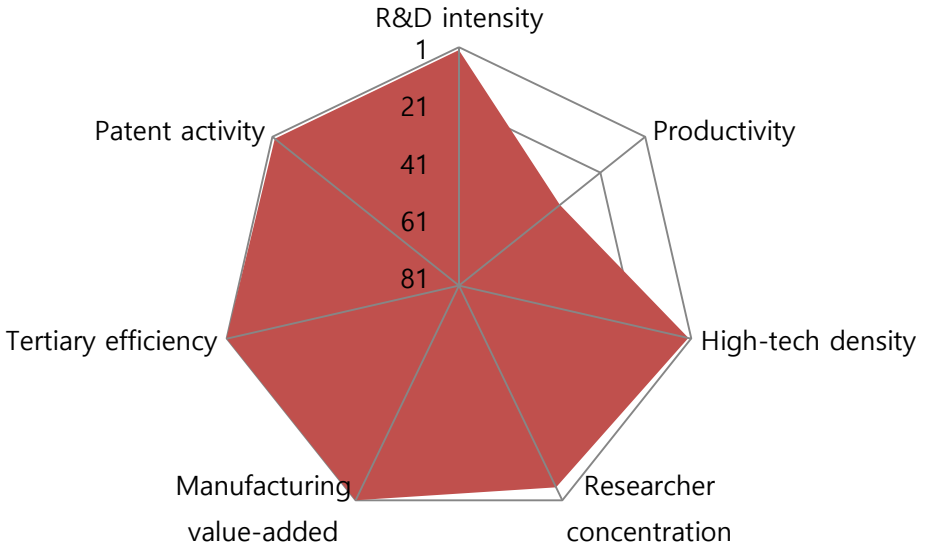
- Innovation
- Business Environment
- FTA Network

Innovation

- **The most innovative country for 3 consecutive years**
- **1st in Manufacturing value-added and Tertiary efficiency**
- **2nd in R&D intensity and Patent activity**

Bloomberg Global Innovation Index

Rank	Country	Total score
1	**South Korea**	**91.3**
2	Germany	85.5
3	Sweden	85.2
4	Japan	85.1
5	Switzerland	85.0
6	Singapore	84.5
7	Finland	83.8
8	United States	82.8
9	Denmark	81.4
10	France	80.4



- R&D intensity : Research and development expenditure, as % of GDP
- Manufacturing value-added : MVA, as % of GDP and per capita
- Productivity : GDP per employed person age 15+ and 3Y improvement
- High-tech density : Number of domestically domiciled high-tech public companies, as % of domestic publicly listed companies and as a share of world's total public high-tech companies
- Tertiary efficiency : Total enrollment in tertiary education, regardless of age, as % of the post-secondary cohort; % of labor force with tertiary degrees; annual new science and engineering graduates as % of total tertiary graduates and as % of the labor force
- Researcher concentration : Professionals, including postgraduate Ph.D. students, engaged in R&D per million population
- Patent activity : Resident patent filings per million population and per $100 billion GDP; Patent grants as a share of world total

Business Environment

"It's so amazing to building a new joint venture in an environment in Korea, which is very spontaneous, which is very open for any new technology. And comparing this with other regions, this is very supporting, that you can work in this environment."

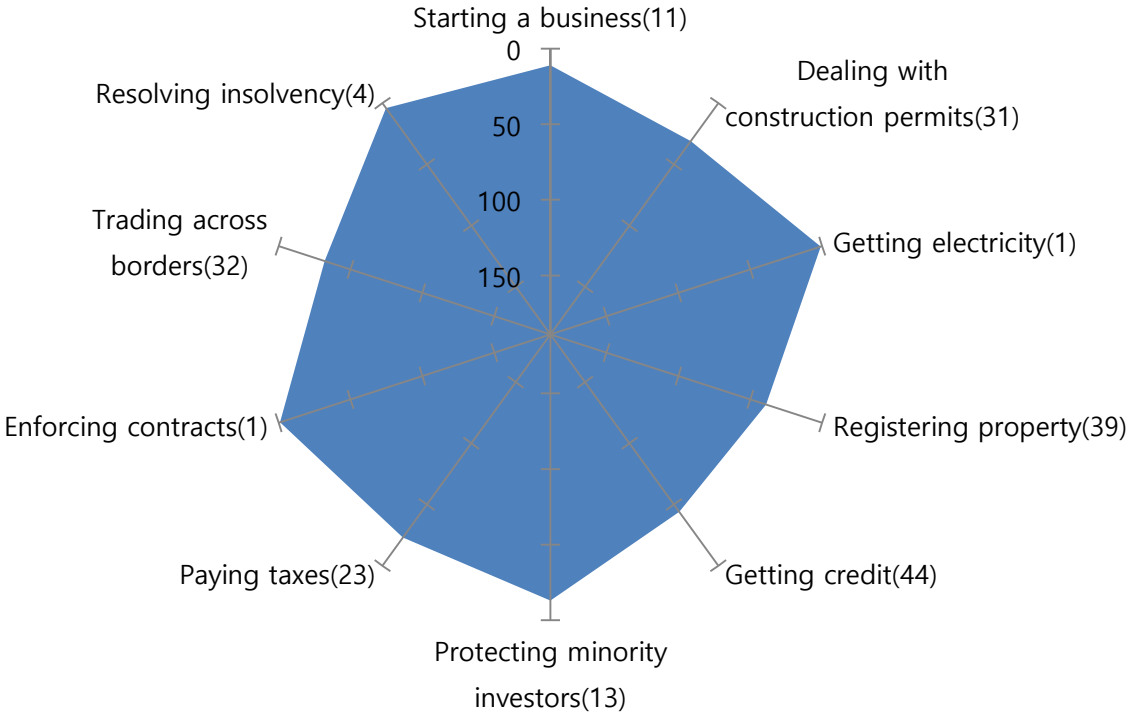
(Markus Stehle, Co-CEO, Mando-Hella Electronics Corp.)

- **5th easiest country for doing business among 190countries**

Rank	Country	DTF Score
1	New Zealand	87.01
2	Singapore	85.05
3	Denmark	84.87
4	Hong Kong	84.21
5	**Korea**	**84.07**
6	Norway	82.82
7	United Kingdom	82.74
8	United States	82.45
9	Sweden	82.13
10	Macedonia	81.74

* DTF: Distance to frontier

(Source: World Bank)

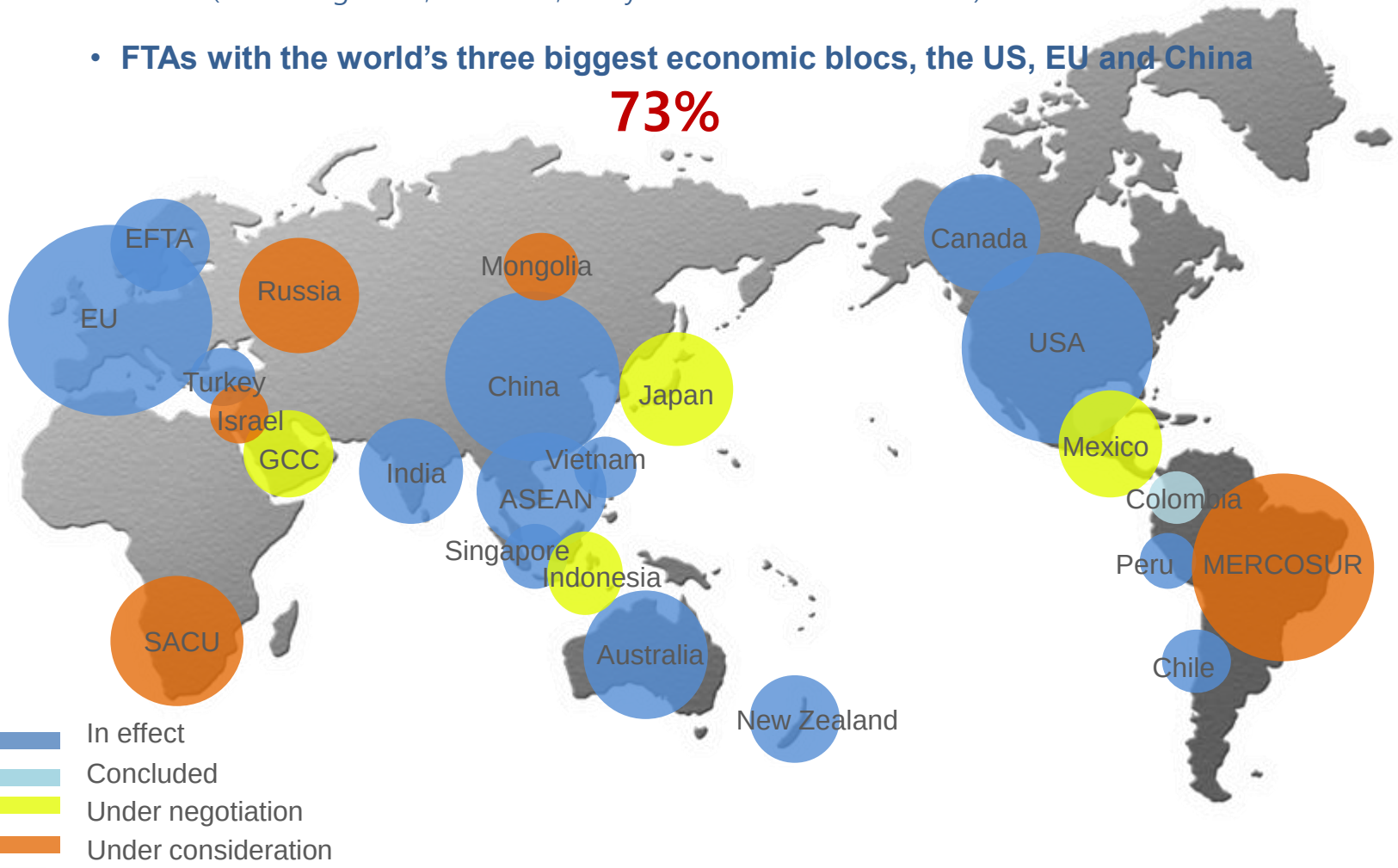


FTA Network

"Toray Advanced Materials is going to put carbon fiber from its Gumi plant on the markets of Europe and the United States, where aircraft are produced. Toray Advanced Materials has a 20-percent price competitiveness now with the U.S. and EU FTAs in effect"

(Lee Young-kwan, President, Toray Advanced Materials Korea)

- **FTAs with the world's three biggest economic blocs, the US, EU and China**



Initiatives for 4th Industrial Revolution

- Control Tower
- Industrial Policy
- Educational & Legal Policy
- Science & Technology Policy

Control Tower for the 4th Industrial Revolution

- The government's committee, 'the 4th Industrial Revolution Committee', devoted to fostering Korea's Fourth Industrial Revolution, launched in August 2017
- The committee consists of 19 members from the private sector and 6 members from the government(5 ministers and the Science and Technology Assistant to the Presidential Secretariat)

Industrial Policy Directions for the 4th Industrial Revolution

Intellectualization of Industries

- Manufacturing
- Transportation (self-driving cars, drones)
- Energy
- Logistics
- Farming

Smart Public Services

- Healthcare (From Prevention to Nursing)
- City (Against Urban Problems)
- Welfare (Assistance for Life)
- Environment (Pollution Forecasts, Unmanned Monitoring)
- Safety

Deregulation for Innovation

- Regulatory sandbox
- Negative regulatory system

Supports for Startups

- Promoting spin-off from Research Institutes
- Vitalization of crowdfunding
- Growth capital funding
- Protection of Intellectual Property

Educational & Legal Policy Directions for the 4th Industrial Revolution

Innovation of Education System

- "Creativity" Problem-Solving education, Flexibilization of teaching methods/school system
- "Global Talent" Strengthening software education, supporting core researchers
- "Platform" Spreading K-MOOC*, Developing a customized learning platform

Actions for the Job Market

- Vocational Training in new industries such as ICT sector and computing
- Supporting career changes
- Strengthening Employment Safety Net

Legislation and Ethics

- Enactment for 4th Industrial Revolution
- Human-oriented 4th Industrial Revolution Ethics

* K-MOOC(Korea-Massive Open Online Course)

Science & Technology Policy Directions for the 4th Industrial Revolution

Technological Competitiveness

- Strategic investment toward the R&D sector
  - Intellectual technology (AI, computing), Robot, Basic technology (Brain Science)
- National R&D Output Sharing
  - Database of R&D outcomes
  - Introduction of open R&D system

Data Production & Utilization

- Ecosystem for the entire lifecycle of data production-distribution-utilization
  - Turn public data into AI-learning data
  - Establishing national Big Data network

Hyper-connected Intellectual Network

- Data Resource
  - Building IoT, 10 Giga internet, and 5G network
  - Provide frequency for new industries,
  - Lower the entry barriers for new network service providers

Innovative Growth

- 13 Growth Engines
- Details of
  - Smart Factory
  - Future Vehicles
  - Startups

13 Innovative Growth Engines

Early Commercialization
- Deregulation
- Pilot project
- Demand creation

+

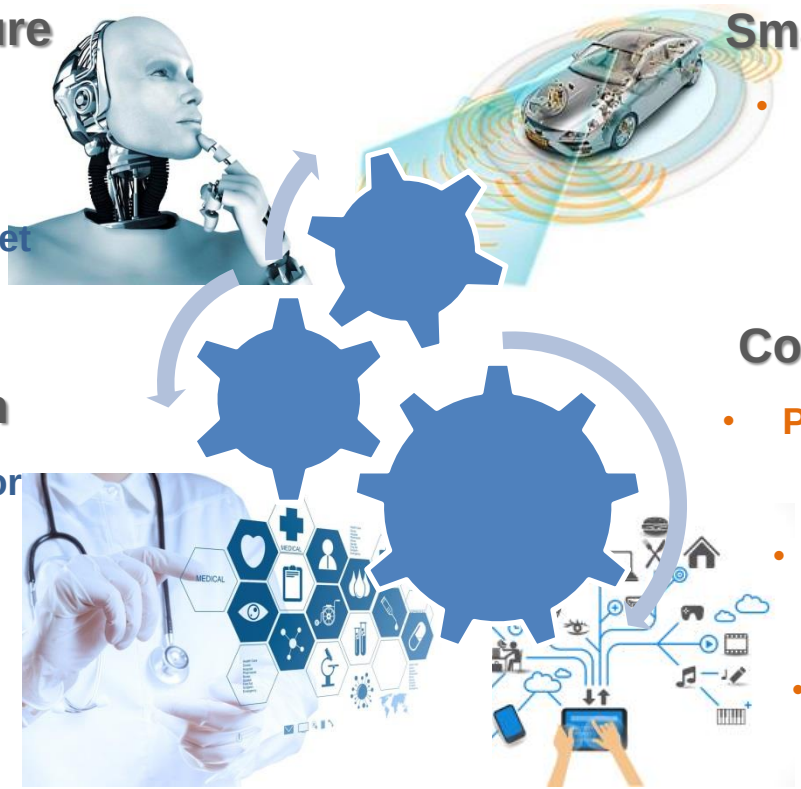
Development of Original Technology
- R&D fund
- Open collaborative platform

Intelligent Infrastructure

- Big Data
- Artificial Intelligence
- 5G Networks and Internet of Things

Industrial Foundation

- Intelligent Semiconductor
- Advanced Materials
- Innovative Medicine
- Renewable Energy



Smart Transportation

- Self-driving Vehicles
- Drones

Converged Services

- Personalized Healthcare
- Smart City
- Augmented/Virtual Reality
- Intelligent Robot

1 Big Data

Create data value

As Is (2017)	To Be (2022)
• Data market size: 6.3 billion USD • Experts: 107,000 • Technology competitiveness compared to advanced country: 78.2%	• Data market size: 10 billion USD • Experts: 150,000 • Technology competitiveness compared to advanced country: 90%

- Roadmap for R&D

2018	2019	2020	2021	2022
(R&D) Develop big data edge analytics				
		(Infra) Operate open data platform		

■ Status

- R&D funds to improve technologies for big data edge analytics and database self-replication
- Voice fishing detection service with deep learning
- ‘My Data Pilot Project’ to allow citizens to download their own information directly from public and private institutes
- Launch a large-scale pilot project in the fields of medicine, finance and telecommunications, which will enable an individual to download the results of medical checkups from a hospital to his or her smart phone and use them for healthcare
- (Infrastructure) Upgrade data store to CKAN based Open Platform

** CKAN(Comprehensive Knowledge Archive Network): international open source platform, widely used in federal/local governments and scholar groups in the US/UK*

** Korea Data Agency upgraded the data store to CKAN based open market, which is data trading platform for SMEs*

2 Artificial Intelligence

Secure world-class core Technologies to commercialize AI service in finance, law, medical sectors.

As Is (2018)	To Be (2022)
• 34 Companies specialized in AI • 1.8 years in Technology gap	• 100 Companies specialized in AI • Commercialize world-class AI service

- Roadmap for R&D

<table>
<tr><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th></tr>
<tr><td colspan="2" rowspan="2">Based on Big Data, develop the application system to interpret professional texts in real-time</td><td rowspan="2">• Develop AI software technology enabling prediction, analysis, finding out causal relationship, etc.
• Develop video interpretation technology</td><td colspan="2">Develop software application in special domain(finance, law, patent, etc.)</td></tr>
<tr><td>Develop a platform to handle large video files</td><td>Develop prediction system based on Big Data</td></tr>
</table>

2 Artificial Intelligence

■ Status

- (R&D) Speech recognition, language processing technologies, training human resources in AI sectors, supporting convergence projects between AI and other sectors (2017-2022)
- (Building Infrastructure) “AI Open Innovation Hub” – AI service development platform, providing the data for machine learning, AI software, and computing power
- Number of AI specialty companies has increased (2016: 27 → 2017: 35), and performance of venture companies benefited from technology transfer has been improved

■ Success Stories

Saltlux Communicating Knowledge

ADAMs

Launched AI Platform with the largest knowledge base(1.5billion) in Asia, utilized in the consulting system of Woori bank and NH bank for financial instruments

Integration of voice and linguistic intelligence, creating profits in various fields such as AI customer service, Chat Bot, English education.

MINDs Lab
Artificial Intelligence Platform Firm

3 5G Networks and Internet of Things

Build a hyper-connected intelligent network infrastructure

As Is (2018)	To Be (2022)
• The world's first 5G commercialization (March, 2019) • 10Gbps Internet commercial services (2018) • 16million IoT devices	• Nationwide 5G network • 10Gbps Internet to cover 50% in 85 major cities • 30million IoT devices

- Roadmap for R&D

2018	2019	2020	2021	2022
Joint International R&D for 5G core technologies(EU)*			Develop core technologies beyond 5G	
Develop compact/ultralight/low-cost IoT technologies				

*** 5G Champion project consortium**
- A Korean/European collaboration framework to develop key enabling technologies of 5G
- 8 European and 13 Korean partners from industry, research institute and university

■ **Status**

- (R&D) Hyper-connected intelligent network technology, appliance and components suitable for mmWave, 5G/B5G(beyond 5G) technologies including interoperability test for 5G convergent service testbed
- (Pilot Projects) Start 5G related pilot projects (June, 2018)
- (Infrastructure) Opened the global IoT test and certification center (November, 2017), international standards-based test and certification environment for IoT service, platform, network, appliances(May, 2018), Opened software-based trial networks in major four cities.

4 Self-driving Vehicles

Commercialize Highly Automated Driving on highways by 2020 (Level 3)
Commercialize Fully Automated Driving by 2030 (Level 4)

As Is (2018)	To Be (2022)
• Commercialize Partly Automated Driving (Level 2)	• Commercialize Highly Automated Driving (Level 3)

- Roadmap for R&D

	2018	2019	2020	2021	2022
Deregulation			Institutionalize safety standards and insurance	Construct National Security System	
Build infra	Establish K-City for test-bed	Set the evaluation system for components of self-driving vehicle	Develop precise road maps		Construct smart roads

* (Level 1) Driver Assistance: driver assistance systems support the driver, but do not take control
* (Level 2) Partly Automated Driving: systems can also take control but the driver remains responsible for operating the vehicle
* (Level 3) Highly Automated Driving: in certain situations, the driver can disengage from the driving for extended periods of time
* (Level 4) Fully Automated Driving: the vehicle drives independently most of the time. The driver must remain able to drive, but can, for example, take a nap
* (Level 5) Full Automation: the vehicle assumes all driving functions, the people in the vehicle are only passengers

4 Self-driving Vehicles

■ Status

- (Infrastructure) Construct test bed, 'K-City*' (2018), develop comprehensive infrastructure like C-ITS** and precise road map (2016-)

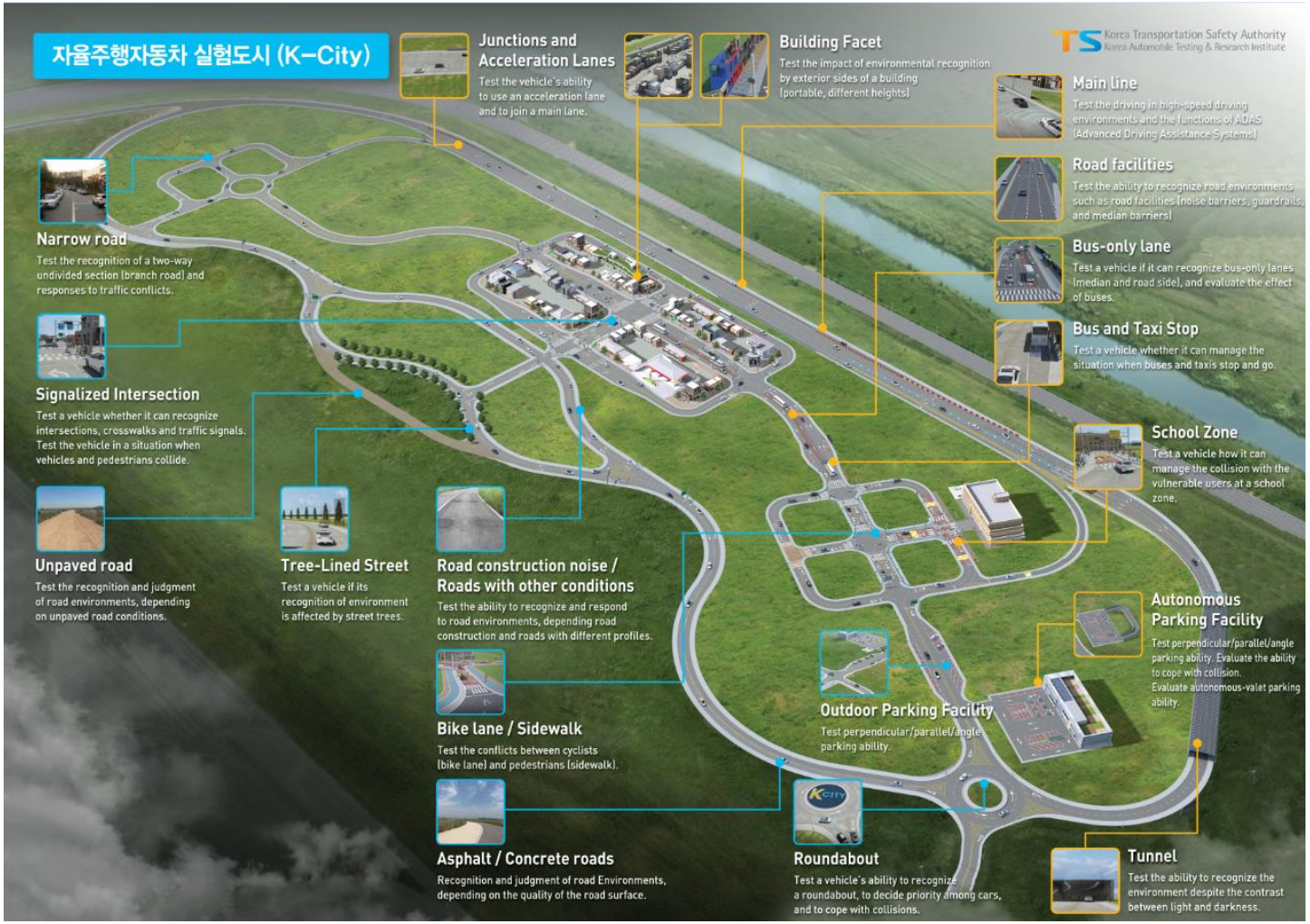
** Experimental city with the scale of 320,000㎡ in Hwaseong, Gyeonggi province, imitating real environment like highway, urban, suburban*

*** C-ITS: Cooperative Intelligent Transport System*

- Complete first pilot project of C-ITS from Daejeon to Sejong
- Develop a precise road map of 1,351km
- Revise Road Traffic Act to enable remote automatic parking (Feb, 2018)
- Plan smart highways (Jan, 2018)
- R&D for vehicle platooning technology based on V2X (Feb, 2018)
- Develop 9 main components(Rader, Lidar sensor, Image sensor module, Accident Data Recorder (ADR), Communication module, Precise digital map, Hybrid positioning module, Driver-Vehicle interface module), and core technologies including self-driving SW, and security system (2017-2022)

Test-bed infrastructure: K-CITY

- **The world's largest test bed for self-driving where self-driving cares can repeat their tests in various scenarios and road environments**



5 Drones(UAVs)

Create public demand to make an initial market

As Is (2018)	To Be (2022)
• Domestic market size of business drones: 70million USD • 7th in Technological competitiveness (2015) • 3,500 business drones in Korea	• Domestic market size of business drones: 1.4billion USD • 6th in Technological competitiveness • 28,000 business drones in Korea

- Roadmap for R&D

	2018	2019	2020	2021	2022
Demand Creation	Public demand creation, Foster leading institutions, Open private and public joint committees, Increase exports				
Pilot Projects	Set up standards and certifications for technologies				
	Improve radio environment				

5 Drones(UAVs)

■ **Status**

- Create public demand to make an initial markets, total 4,000 drones for five years

  * 1,300 Police, 900 Territorial Survey, 250 Farm Monitoring, 1,150 Local Governments

  ** No. of drones (Accumulated) : 300 (Sep, 2017) → 800 (Mar, 2018) → 4,000 (2021)

- Regulatory sandboxes (2018.3 ~)

- Open flight test centers

  * Drone pilot test centers: 3 places in 2017, 2 places in 2018

6 Personalized Health Care

Develop personalized disease prevention, treatment, health promotion and advanced medical devices

As Is (2018)	To Be (2022)
• Health care service based on limited personal health information like clinical information and lifelog • 7 medical devices that exports more than 100M USD each	• Provide personalized health care service based on integrated health information • 12 medical devices that exports more than 100M USD each

- Roadmap for R&D

2018	2019	2020	2021	2022
Develop precision medical technology (Develop cancer diagnosis method and treatment)				
Develop Precision medical Hospital Information System(P-HIS)				

6 Personalized Health Care

■ Status

- (Precision medicine) Establish Precision Medical Project Group for personalized healthcare (Sep, 2017)
- Develop big data-based personalized health care service

  ** Develop customized health care system based on PHR(Personal Health Record): Set pilot model of health care service (April, 2018) → Select conducting operator (Aug, 2018)*
- (P-HIS) Devise P-HIS's main function and module through gathering opinions from healthcare workers (Sep-Dec, 2017) and develop demonstration version(Jan, 2018-)

  ** Devise 38 modules(24 common, 14 selective) available in all Korean hospitals*
- (Big data) Promote Pilot project of health and medical big data platform
- Launch bio health big data project group for standardizing Electronic Medical Record(EMR) into Common Data Model(CDM) and building a data-sharing network (May, 2018)

7 Smart City

Implement sustainable smart city model/platform

As Is (2018)	To Be (2022)
• Local government manage urban infrastructure applying ICT technologies	• Effectively solving urban problems using city data

- Roadmap for R&D

2018	2019	2020	2021	2022
Develop data hub model	Massive IoT, Semantic sensing	Open data hub	Simulate big data-based prediction	Validate technology services

7 Smart City

■ Status

- (Demonstration city) Smart City committee designates two cities (Jan, 2018)

  ** Sejong 5-1(master developer: LH), Busan Eco-delta city(master developer: K-Water)*

- (Technological development) R&D on new service using city data (2018-2022)

■ Success Stories

LH 한국토지주택공사

- Export 'Korean Smart City' model to Middle East and Asia
- LH signed MOU on developing Kuwait Abdullah smart city (May, 2016)
- Now LH is on designing (April 2017- April 2019, 43 million USD)

- Develop IoT-based Waste disposal system and export to 42 countries(80 cities)
- Recently signed a contract of $15M with Baltimore, US

ECUBE Labs

8 Augmented/Virtual Reality

Promote convergence between VR·AR and other industries
(medical, manufacturing, defense)

As Is (2018)	To Be (2022)
• 2 Global leading companies (Samsung Electronics, CJ CGV)	• Foster 10+ global strong SMEs with annual sales over 10 million USD • Develop 20+ VR/AR convergence services (medical, manufacturing, national defense)

- Roadmap for R&D

2018	2019	2020	2021	2022
Develop AR ball sports training platform				
Develop heavy equipment/medical operation training service				

8 Augmented/Virtual Reality

■ Status

- (R&D) Develop low light 3D Camera(June 2016 - Dec. 2019) and popularize it in military operation, medical operation, and entertainment
- (Pilot projects) Develop VR/AR devices available in medical and retail industry

  ** (Medical) Smart Goggles for image guided minimal cancer resection*

  ** (Retail) Develop virtual sensing device for experience marketing*
- Develop flight training simulator
- (Experience zone) Combined contents of VR/AR technology and sports (Bobsleigh, Ski jump, etc.) displayed in 2018 Pyeongchang Olympic ICT center
- (Virtual training) Commercialize virtual training simulator for heavy machinery (excavator, crane)
- (Flagship project) Launch flagship projects of digital contents such as contents for ship sailing, contents for safety in construction sites

9 Intelligent Robot

To popularize collaborative robots by 2020 and provide medical, rehabilitative and social security services using robots

As Is (2018)	To Be (2022)
• Robots utilized in process industry	• Popularize intelligent manufacturing robots • Commercialize service robots supporting the aged and the disabled, and smart medical treatment

- Roadmap for R&D

	2018	2019	2020	2021	2022
New market creation	Establish a consultative organization of robot projects				
Building an infrastructure	Trial version of collaborative robots	Popularize collaborative robots			

9 Intelligent Robot

■ Status

- Korea's industrial robot density(Robot installation per 10,000 employees): 531 (World's highest)
- World's 4th Industrial robot production
- World's 2nd biggest market of Industrial robots
- Competitiveness of service robots is relatively low compared to that of manufacturing robots
- (Collaborative robot) In order to promote the development and popularization of collaborative robots, establish a "Consultative organization of cooperating robot projects(February, 2017)" for coordinated responses and information exchange

  ** 24 organizations participated (including cooperating robot companies, component manufacturers, System Integration companies, etc.)*
- Develop Disaster Response Robot and construct test facilities (2016-2021)
- Develop robot system for special manufacturing environment (2015-2019)

10 Intelligent Semiconductor

Develop core technologies for intelligent semiconductor

As Is (2018)	To Be (2022)
• Global market share 3% • High-speed, High-density	• Global market share 7% • Super-intelligent, Ultra-low-energy consuming, Ultralight

- Roadmap for R&D

2018	2019	2020	2021	2022
(Technology) Many-Core Processor and Software based on Hypervisor				
(Technology) Pattern recognition system device based on synaptic devices				
(Infra) Platform to support power semiconductor R&D				

10 Intelligent Semiconductor

■ Status

- Deep-learning processor to enable AI system in low-energy-consuming and high performance mode on mobiles, developed by KAIST Lab

  ** Energy efficiency x4 than Google's AI semi-conductor (TPU), Changeable Artificial Neural Network to adjust energy-efficiency and accuracy to the target*
- System-on-Chip for mobiles, home-appliances, vehicles
- 4 channel scanning LiDAR sensor for autonomous driving cars
- 150 patents for next-generation semiconductor devices (111 patents in 2017, 39 patents in 2018)
- Korea-China System IC Collaboration Research Institute in Shenzhen, China
- Support commercialization of power semiconductor
- Establish partnership between major semiconductor enterprises and SMEs through Automotive Electronics Alliance (May, 2018) and Semiconductor Co-development committees

11 Advanced Materials

Develop advanced materials optimized for value-chain by 2022

As Is	• (Strength) High share in end products such as automotive, shipbuilding, semiconductor, display, smartphone, yet heavily rely on imported core materials • (Weakness) Lack of fundamental material technologies compared to advanced countries including US, German, and Japan.
To Be	• High-end advanced materials to meet new demands, and build an infrastructure to support commercialization and marketing − Titanium-based aerospace components, aluminum panels for vehicles, material for transportation industry • Well-developed infrastructure for development of technology and evaluation of processing system

Development of 10 core chemicals

5 Industries and 10 Core Materials

5 Demand Industry	Major Companies	10 Chemical & Materials
Displays	LG Display Samsung Electrics	Optical Films Luminescent dyes
Semi-conductors	Samsung Electrics SK Hynix	Photo chemical Precursor
Electronics	LG Electrics Samsung Electrics	Adhesive Flexible PCB
Automobile	Hyundai	Complex Materials Coating, Film
Energy	LG Chemical Samsung SDI	Li Battery Solar films

Strengthening collaborative R&D with conglomerates

- Encourage conglomerates to participate in collaboration with SMEs from the product development stage

Conglomerates	Capital, HR	Co-R&D	Secure material sourcing & domestic demand
SMEs	Specialty Technologies		Secure technology competitiveness & market

- Concentrate R&D budget on 10 core materials, giving plus points for partnership R&D between demand company and material supplier

Establishing complementary relationship in markets & technologies between large fine chemical companies and SMEs

- Ex) SKC developed 10 sorts of semi-conductor materials by co-development with SMEs like Dongjin semichem, D&F, E&F technologies. (Feb, 2015)

12 Innovative Medicine

15 innovative medicines in global market by 2022

As Is (2018)	To Be (2022)
• 85 new drug candidates (2015) • Exports in Bio-health: 10.2b USD	• 129 new drug candidates • Exports in Bio-health: 13b USD • Improve bio production technology by 30%

- Roadmap for R&D

2018	2019	2020	2021	2022
Support developing new drug candidates	Long-term R&D plan to discover new drug candidates			
Support R&D in new promising medicines	Long-term R&D plan for new promising medicines including cell/gene therapy products			
Support the development of platform technologies for new drug research				

■ Status

- R&D projects to discover new drug candidates

* Technology Transfer

DiNonA → Leukemia treatment (80 million USD) → APROGEN

DONG-A ST → Alzheimer's treatment (5million USD, 24% share of NeuroBo) → NeuroBo PHARMACEUTICALS

* Orphan Drugs & Fast Track by FDA

PharmAbcine (Antibody Therapeutics for Life): FDA Orphan Drug designation granted to TTAC-0001 for Glioblastoma Multiforme

ENZYCHEM LIFESCIENCES: Fast Track Designation for the compound to prevent and treat chemo-radiotherapy induced oral mucositis by the U.S. FDA

** Orphan Drug: A pharmaceutical agent that has been developed specifically to treat a rare medical condition, the condition itself being referred to as an orphan disease*

- Pilot Project "New Medicine Development Platform based on AI & Big Data" since June, 2018

13 Renewable Energy

Renewable energy rates up to 20% by 2030
“Renewable Energy 3020”

As Is (2018)	To Be (2022)
• Portion of Renewable energy: 7%(2016)	• Portion of Renewable energy: 10.5%

- Roadmap for R&D

2018	2019	2020	2021	2022
(Deregulation) Reduce national property rental fee (5% → 1%)				
R&D in original technologies - photovoltaic, wind power and ESS				

■ Status

- (Diversification of photovoltaic location) Promote Building Integrated Photovoltaic(BIPV), Road Integrated Photovoltaic, Offshore Photovoltaic, and Farming photovoltaic
- (R&D for overseas expansion) Develop customized technology fitting overseas environment

  ** Offshore Photovoltaic in East Asia, Desert Photovoltaic in Middle East, Fuel cell for buildings in Europe, etc.*
- (Technology Development) Develop cell separation and combination technology for low cost, high efficiency module (2016-2019) , technology to improve rate of output reduction(2018-), and lead-free Perovskite material and module (2018-)
- (Wind power) Build test site of offshore wind power to make an initial market and secure track record
- (Wind power) Develop Offshore Wind Power system over 7MW and Floating Offshore Wind Power

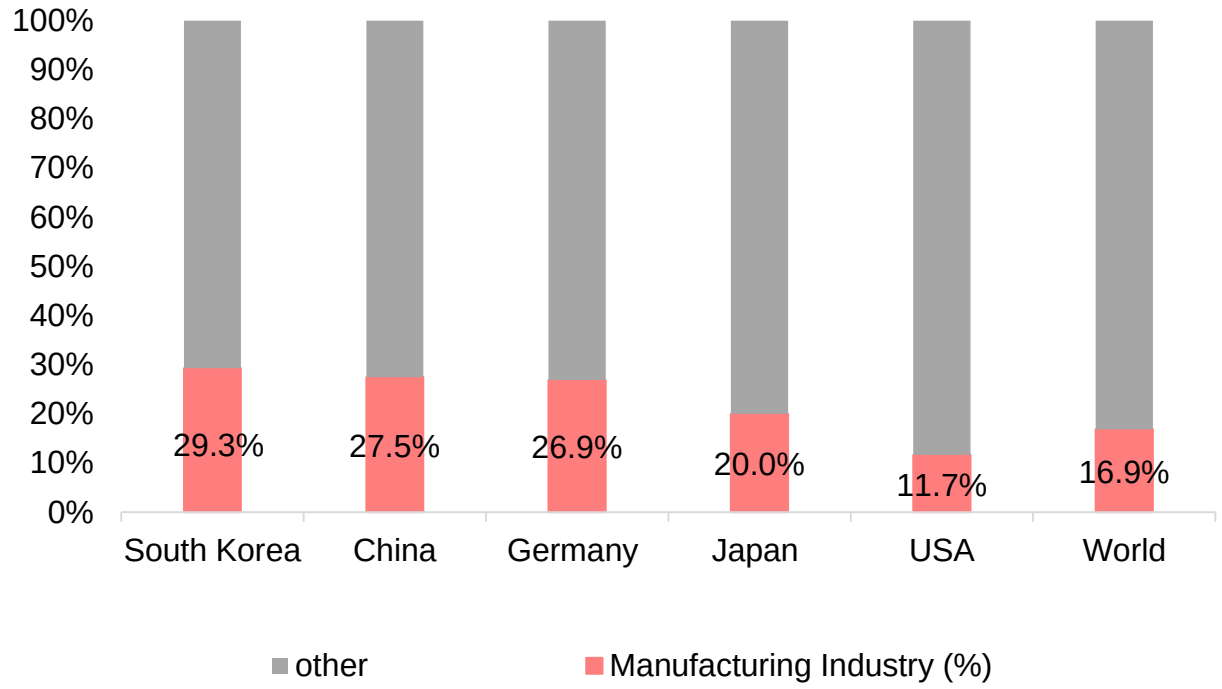
  ** Develop Offshore Wind Power system over 7MW (2018-2022), repowering technology of wind power plant(2018-2019), and Pilot plant of Floating Offshore Wind Power for middle depth of ocean (750kW)(March, 2019)*
- (Incentive System) Introduction of special FIT system for small businesses

Details of **Smart Factory**

1. SMART FACTORY, background of smart factory in Korea

- **Manufacturing industry is an important industrial sector in Korea**
- **The portion of manufacturing industry in Korea is higher than that of major developed countries**

Portion of manufacturing industry of GDP in major countries (2016)



1. SMART FACTORY, background of smart factory

Contribution to economic growth

- Contribution to economic growth of the manufacturing industry is **32.2%** in 2010~2017 and service industry is 49.5%.
- However, considering the effect of household income through the creation of good jobs and effect on upstream and downstream industries, the actual contribution rate of manufacturing industry to economic growth is **over 50%.**

Quality of job

- As of 2017, the number of work force in the manufacturing industry was **4.5million**, which is **16.7%** of total work force (27million) in Korea

- However, manufacturing industry is creating **good jobs** as the wage level is relatively higher than service industry
  * As of 2016, proportion of the income earner of over 3 million KRW per month is **47%** in manufacturing sector, which is higher than in the service sector (38%).

2. SMART FACTORY, vison and target of smart factory

- In 2015, the Korean government established a public-private partnership dedicated to supporting the nation's SMEs so that they can digitize their factories
- According to the partnership, the Korean Smart Factory Foundation supported roughly 5,000 SMEs to partly digitize their factories (2014 ~ 2017)
- Aim at transforming 20,000 SMEs into smart factories by 2020

3. SMART FACTORY, current status of smart factory

The level of most of SMEs' smart factories (76.4%) is at the basic stage computerized systems can track and document the transformation of raw materials to finished goods

Level of SMEs' Smart Factories

Division	Main contents	Proportion
Basic	Digitalization of production information Management of product's production history	76.4%
Middle1	Real-time collection and analysis of production information	21.5%
Middle 2	Production process control through system	2.1%
Advancement	Customized flexible production and intelligent factory	-

4. SMART FACTORY, current status of smart factory

S/W technologies such as MES, SCM are relatively superior, but the competitiveness of **H/W technologies such as sensors and robots is low** (40% of developed countries)

Technological competitiveness by sector (% of developed countries, %)

PLC controller	CNC controller	Manufacturing Executive System	Enterprise Resource Planning	Product Life Management	Supply Chain Management	Sensor	Robot
80	60	70	60	20	90	40	40

5. SMART FACTORY, outcome of smart factory

- **Increased productivity, reduced defect rate, cost reduction**
- **Employment increased by 2.2 persons per company**

Case 1. Korea Nanotech (a SME which specializes in powder and liquid coating)
Turned profits from sales growth into wages of employees

Case 2. Frontech (a SME which specializes in information system integration)
Employed women with career cuts due to improved productivity (11 → 45)

- **Safety of working environment**
  - Rate of industry accidents cut by 22% in average

Case 1. Korens
Expanded global market share of EGR cooler(Exhaust gas reduction device)
* Increased productivity by 15%, decreased defect rate to 1/30

Case 2. PJ Electronics
Reduced defect rate by 32% and improved deadline compliance rate by 13%

6. SMART FACTORY, challenges ahead

Level upgrade

- Financial support to upgrade the level of smart factory through installation of sensors, robots and production information system, etc.
- Support the establishment of cloud based smart factories that can be used jointly by SMEs (‘18)

Technology development

- Provide R&D fund to the developer of smart factory technology
- Develop “Korean Smart Factory Model” based on Big Data, AI, 5G, Cloud, VR/AR, and etc.

Manpower

- To smooth operation and upgrade the level of smart factories, train professional manpower through job transfer education of SME workers

Promotion policy

- Establish a regional smart factory support center
- Set up a demonstration smart factory by industry type and size so that SMEs can benchmark
- If a large company builds a smart factory in cooperation with SMEs, the government will support a part of the construction cost.

  * Cost burden ratio (%) : Government : Large Enterprise : SME = 30: 30 : 40

7. SMART FACTORY, example of smart factory

Smart Factories at Korean companies

Company	Status
POSCO (Steel maker)	• Sensors and cameras attached to machines at its steel plate factory in Gwangyang, collect terabytes of data everyday • "The software equipped with analytical ability helps managers locate defects on the line and come up with solutions, cutting the work of the company's software engineers by half"
LS Industrial Systems	• Production system at its facility in Cheongju is automated from part delivery and assembly to final packaging • Cameras combined with big data analysis help check product quality
Hanwha Techwin (Aircraft engine maker)	• A Bluetooth sensor installed in each jet engine it produces at its factory in Changwon helps keep track of production and eliminates the need for barcodes • "The new sensors connected via IoT technology make the final product delivery and management process more efficient and precise"
SK Innovation	• Sensors, machine learning technology and big data analysis at its factory in Ulsan help prevent possible breakdowns
Hyundai Motor	• Smart tags' wireless communication chips with sensor technology will be applied to cars to monitor the overall production process starting with its factory in Gwangju
J&H (Set-top box and car audio maker)	• Sensors that check the temperature, humidity and vibration levels of core production machines • System collects data from sensors and deliver them to the cloud-based management software so that employees can view on their smartphones and tablets to track machine conditions in real time

Details of **Future Vehicles**

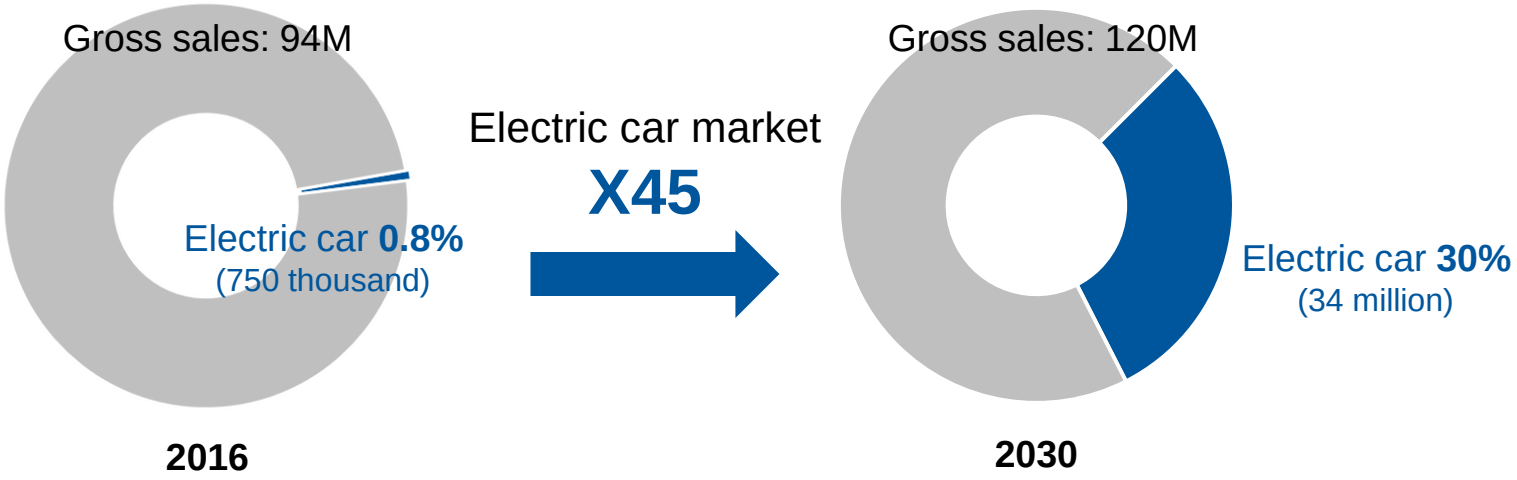
FUTURE VEHICLES, current status of global car industry

- **CASE** Evolution, after 130years since__

- Non-conventional and innovative companies (Tesla, Google, Uber) have joined the market, intensifying the competition for the leading position

FUTURE VEHICLES, current status of global car industry

- Electric and autonomous car markets are expected to grow rapidly despite low-growth

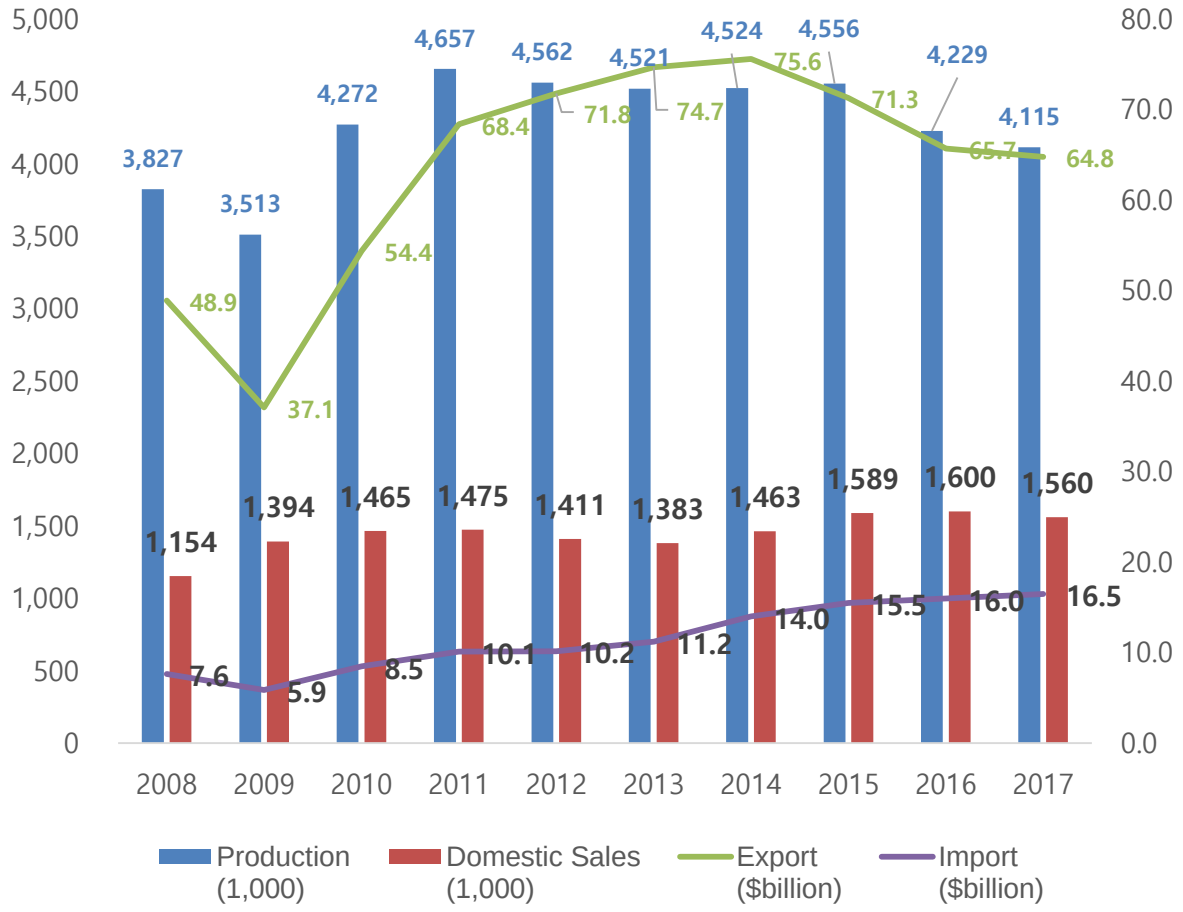


- Highly Automated Driving cars will be commercialized around 2020
- 4 out of 10 new cars will be autonomous in 2030
- Related service markets will be booming: 30 billion USD (2015) → 1500 billion USD (2030)
- Hydrogen cars begin to grow around 2030: 50,000(2018) → 260,000(2022) → 2.2 million(2030)

FUTURE VEHICLES, current status of Korean car industry

- Korea, as a latecomer in car production, is now ranked 6th in the world within a short time.

  * Front-runners : Germany/France 1880s-1890s, America 1910s, Japan 1930s



Contribution of Automotive Industry

- Production 13.9%
- Value-added 11.2%
- Employment 9.1%
- Exports 11.3%

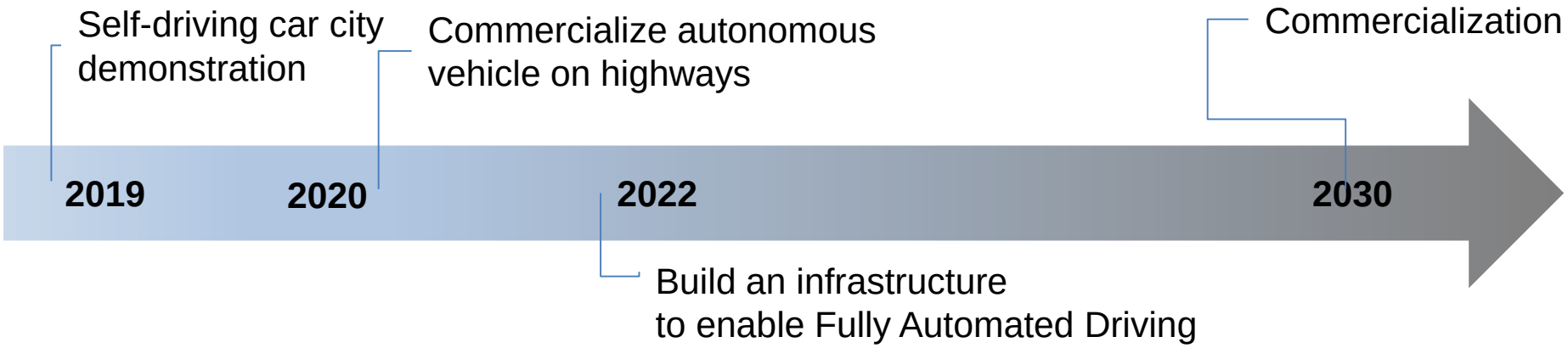
(Out of the entire manufacturing industry)

FUTURE VEHICLES, Korea's Visions and Goals

Electric Car

- Popularization: 250,000(2017) → 350,000(2022) → 3million(2030)
- Production: 30,000(2017) → 1.5million(2030)

Self-driving



FUTURE VEHICLES, challenges ahead

Longer travel distance

Cover over 500km on one charge (2021)

* Density of battery energy 30% ↑ (230KW/kg → 300KW/kg)

** Domestic production of power semiconductors

Hyundai-KIA “Soul EV”, 200km (2014), “Niro EV”, 400km (2018)

Electric car charging infrastructure

* Residential area(normal speed): install 12,000 chargers/year

** Main locations- big malls, service stations(fast charge):

2,531(2017) → 4,000(2018) → 10,000(2022)

Fast charging

“Super charger” two times faster than existing charger

* Charging capacity: 50KW (2017) → 200KW (2020)

Hydrogen cars

Technology to reduce costs

* ex) Technology to save platinum in fuel cells

Hydrogen fueling stations

12 stations (current) → 30 (by the end of 2018)

Promotion Policy

Maintain subsidy until 2022

*Extend the incentives(50% off highway toll fees) (under review)

** Incentives: Ioniq(11,260$), Soul EV(11,270$) GM BOLT EV(12,000$), Tesla modelP 100D(12,000$)

Mandatory purchase of greener cars in public sectors (2018: 70% → 2022: 100%)

FUTURE VEHICLES, challenges ahead

Develop key technologies toward the self-driving car

Develop core components, Korea currently heavily relies on imports

- 9 main components(Rader, Lidar sensor, Image sensor module, Accident Data Recorder (ADR), Communication module, Precise digital map, Hybrid positioning module, Driver-Vehicle interface module), Self-driving SW, and security system (2017-2022)
- Technological development of AI, automotive semiconductor by 2023

* Real-time, high-speed communication module/SW for vehicles

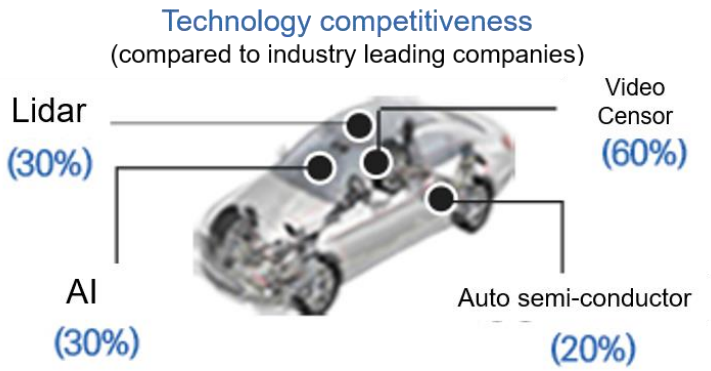
* Introduce test-bed for automated and cooperative driving cars in downtown Seoul

* Precise(HD) maps: highways(2020) → all roads(2025)

* High-precision GPS: commercialize GPS with a position error of less than 1m (assumption: 100km/h speed)

Infrastructure

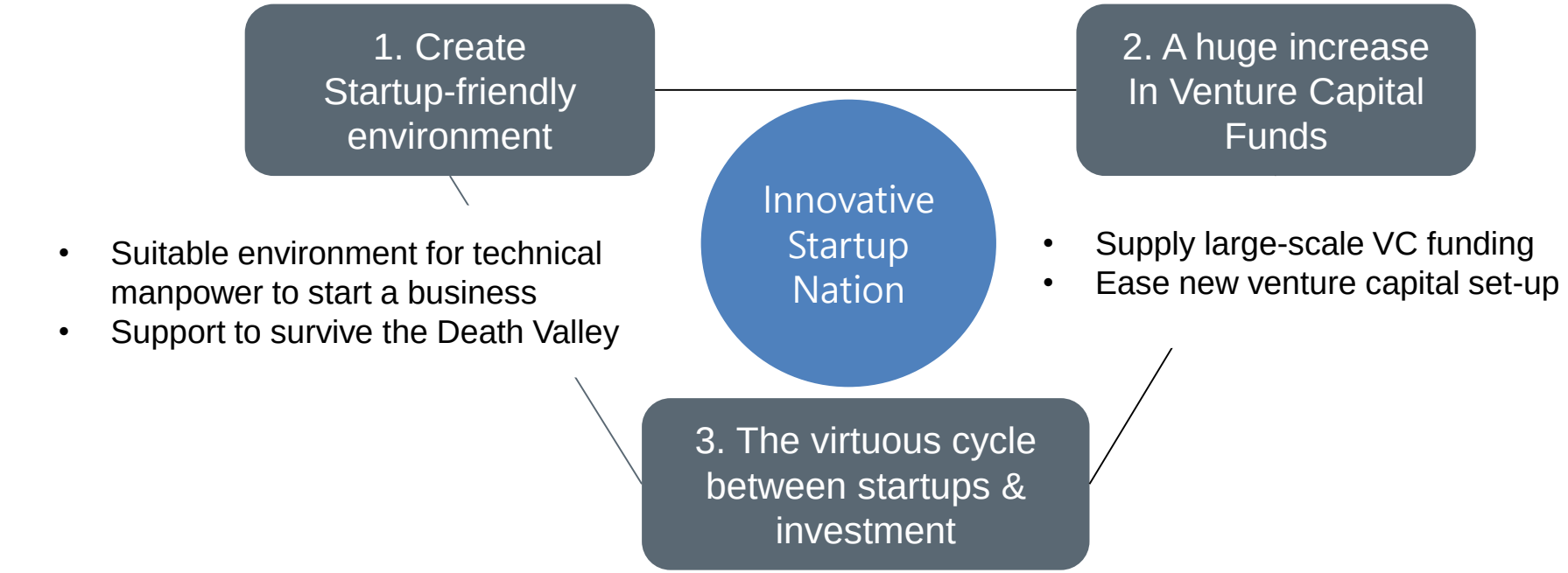
- Regulatory sandboxes applied in two designated places.
- Design smart cities electric car and self-driving car friendly from initial stage



Details of **Startups**

STARTUP, Korea's vision

"Innovative Startup Nation"
where a high quality workforce can easily start a business, and grow their businesses into global enterprise by attracting venture capital investment.



STARTUP, Korea's strategies

1. Create Startup-friendly environment

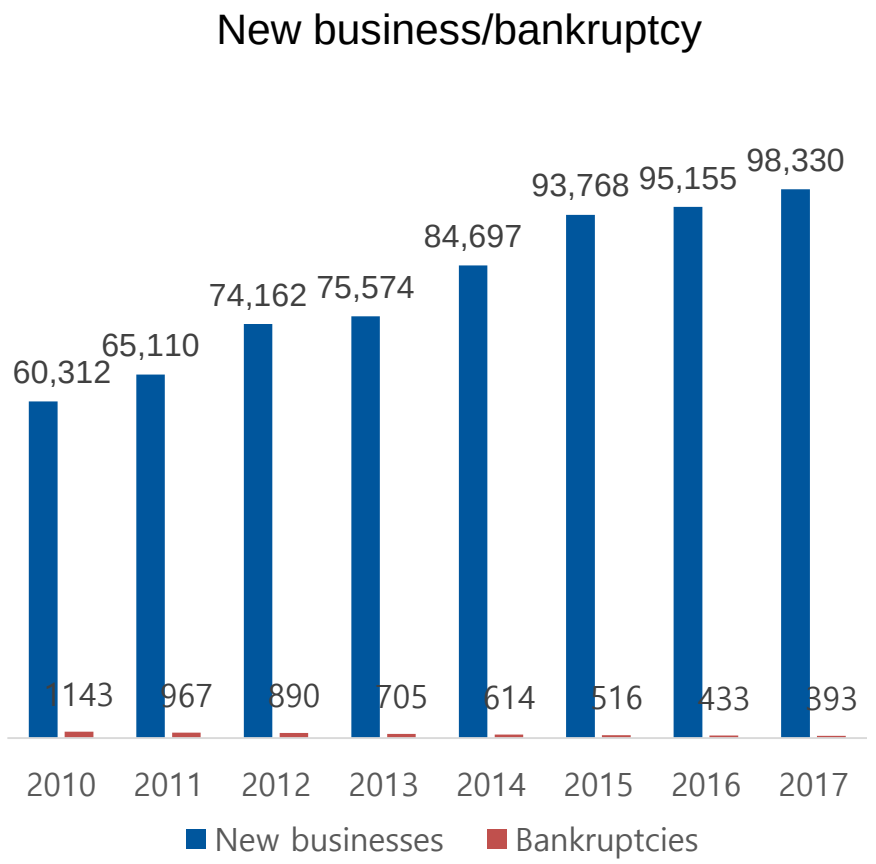
- Step by step assistance program in order to foster In-house corporate venture, and spin-off from the initial stage
- Encourage technology financing to expand loans to innovative companies

- Support to survive the Death Valley*

* *Death Valley: A span of time from when a start up firm raises an initial capital investment till it starts generating revenues*

- Expand the budget for "Death Valley Jumping Package*" to support 3 to 7-year-old companies

* *Death Valley Jumping Package: comprehensive support to innovate business model, sales and marketing, entry to global market, R&D, etc.*



STARTUP, Korea's strategies

2. A huge increase In Venture Capital Funds

- Raise "Innovative Venture Capital" of 10billion USD for next 3 years
- More tax incentives for angel investment in early stage businesses
- Expand crowdfunding opportunities innovative start-ups

3. The virtuous cycle of startups, investment, and exit

- Vitalize IPO markets such as KOSDAQ, KODEX, K-OTC
- Promote foreign capital to invest in Korean M&A markets

** ex) Korea-China Joint fund*

STARTUP, venture capital Investment

Investment by business duration

		2014	2015	2016	2017	2017.6	2018.6
Less than **3** years since establishment	# of companies	438	511	568	570	291	306
	share(%)	46.8	47.2	46	43.7	49.2	42.6
	Investment (million USD)	504.5	647.2	790.9	779.6	369.3	482.7
	share(%)	30.8	31.1	36.8	32.7	36.9	29.9
3-7 years since establishment	# of companies	231	283	334	363	164	234
	share(%)	24.7	26.1	27	27.8	27.7	32.6
	Investment (million USD)	406.9	582.8	615.6	664.1	291.7	580.2
	share(%)	24.8	27.9	28.7	28	29.2	36
7+ years since establishment	# of companies	266	289	336	373	138	179
	share(%)	28.5	26.7	27	28.5	23.1	24.8
	Investment (million USD)	727.9	855.8	743.8	936.6	340.6	552
	share(%)	44.4	41	34.5	39.3	33.9	34.1

STARTUP, venture capital investment

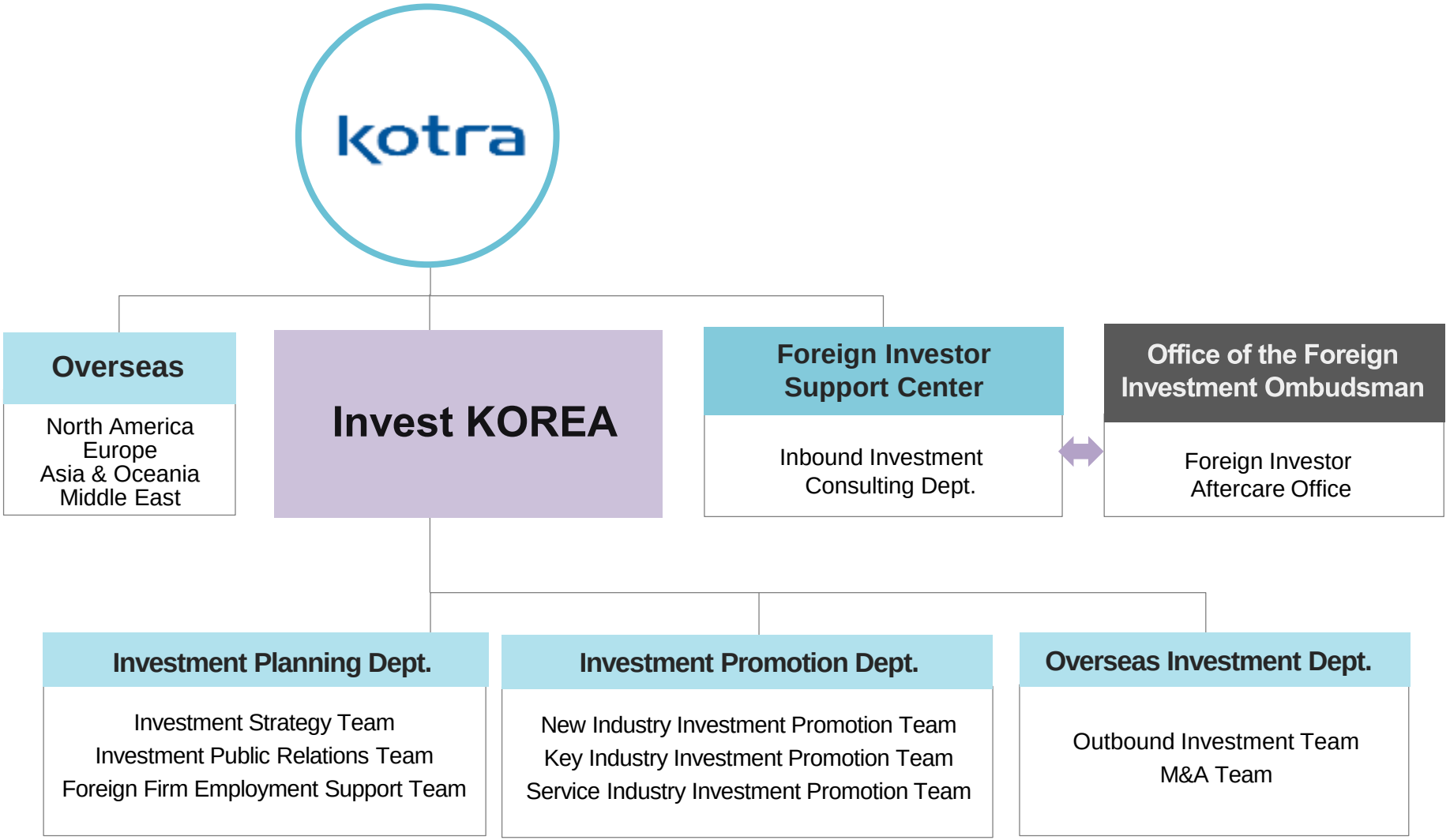
Investment by industry

		2014	2015	2016	2017	2018.6
ICT manufacturing	# of companies	86	71	66	96	48
	Investment (mil USD)	195.1	146.3	95.9	156.6	96.6
ICT Service	**# of companies**	**153**	**252**	**252**	**283**	**162**
	Investment (mil USD)	**191.3**	**401.9**	**406.2**	**515.9**	**353.3**
Electronics/ Equipment	# of companies	86	78	97	121	63
	Investment (mil USD)	156	162	212.5	240.7	105.4
Chemical/ Materials	# of companies	47	67	67	54	32
	Investment (mil USD)	82.7	148.6	150.2	127	81
Bio/Medical	**# of companies**	**87**	**114**	**159**	**137**	**103**
	Investment (mil USD)	**292.8**	**317**	**468.6**	**378.8**	**413.9**
Video/Performance/ Albums	# of companies	208	205	233	260	109
	Investment (mil USD)	279	270.6	267.8	287.4	133.3
Game	# of companies	137	123	99	76	37
	Investment (mil USD)	176.2	168.3	142.7	126.9	73.4
Logistics/Service	# of companies	119	144	149	178	109
	Investment (mil USD)	204.6	304.3	249.4	418.7	272.9
Others	# of companies	38	54	71	64	45
	Investment (mil USD)	61.6	166.8	157	128.3	85.1
SUM	# of companies	901	1,045	1,191	1,266	708
	Investment (mil USD)	1,639.3	2,085.8	2,150.3	2,380.3	1,614.9

KOTRA

- Organization
- One-Stop Service
- Global Alliance Project Series
- Invest Korea Market Place

Organization



One-Stop Service

INVEST KOREA

Overseas Network of 36 KBCs
(Korea Business Center)

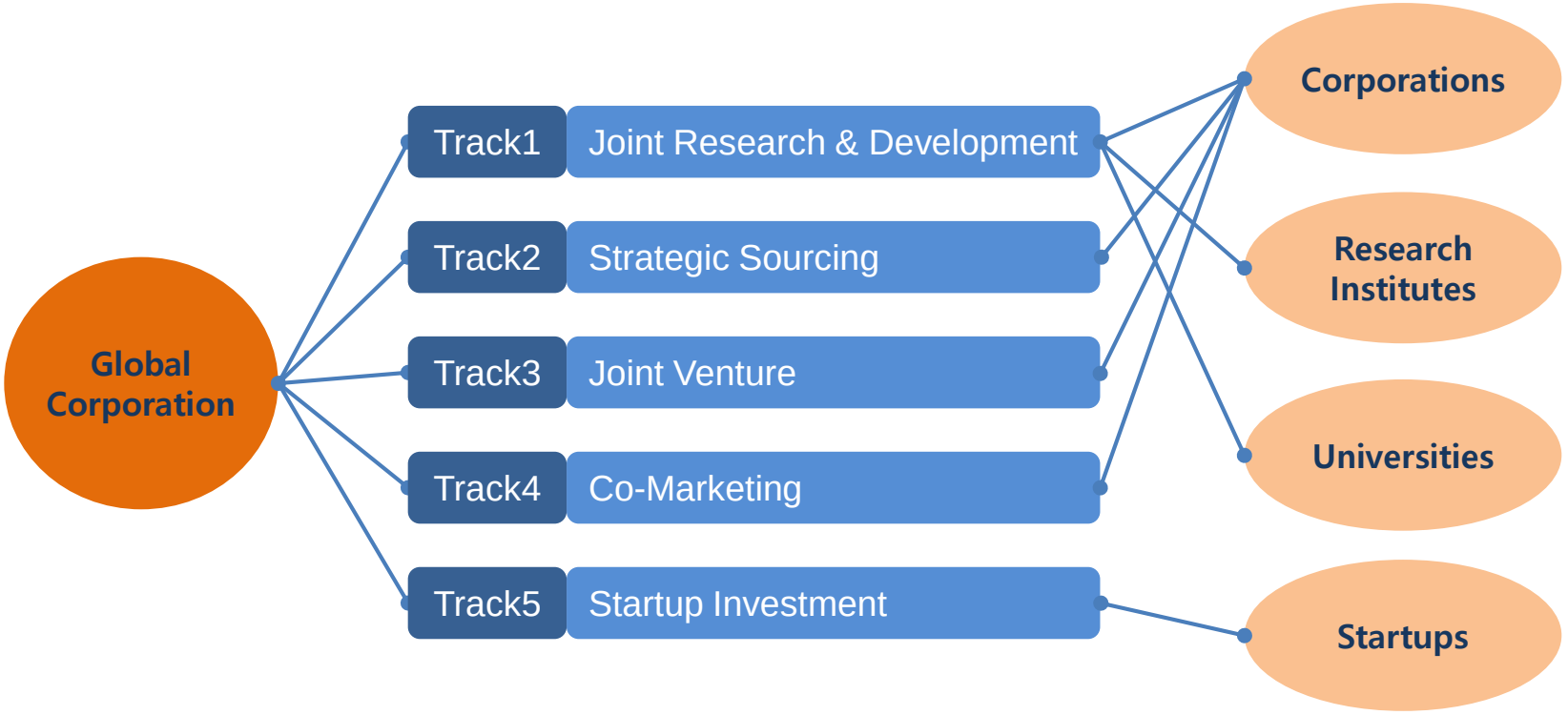
Pre-Investment Stage	Investment Execution Stage	Post-Investment Stage
Provide information and administrative support	Support site surveys, partner search and incentive negotiations	Resolve investors' grievances / Improve business and living environment

Project Manager System

Foreign Investment Ombudsman

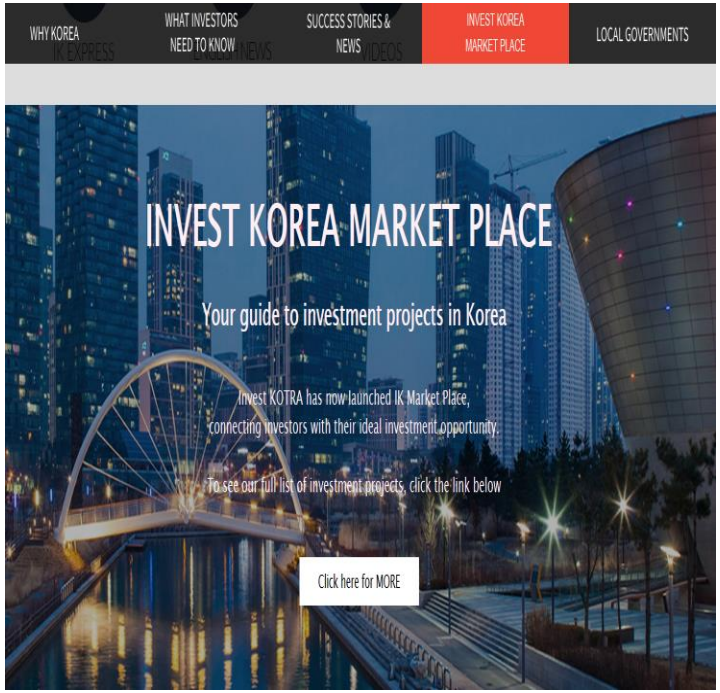
GAPS(Global Alliance Projects)

- Customized program for global corporations who are keen to establish business partnerships with Korean companies or R&D institutes
- New opportunities to invest in Korean startups and companies, perform joint R&D activities, purchase products, and build co-marketing partnerships



IKMP(Invest Korea Market Place)

- As of April 2018, 260 companies and development projects uploaded



Industry	#	Industry	#
ICT	65	Business Services	25
Bio/Healthcare	27	Contents	17
Automotive/Machinery	26	Energy /Environment	15
Consumer products	21	Chemicals /Materials	4
Banking	16	Aviation	2
Electronic/Electric	18	Logistics	3
Development Projects	18	Robot	3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April 27, 2018