

Roles of Research Institutes for Supporting Digital Transformation: ITRI Cases

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Industrial Economics and Knowledge Center

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Industry Science and Technology International Strategy Center (ISTI) New Organization in 2018/8

2025 Vision:

*Inspire science-technology innovation and
value-up for Taiwan industries*

Technology
Scouting

Ecosystem
Networking

Strategic
Partnering

Capability
Boosting

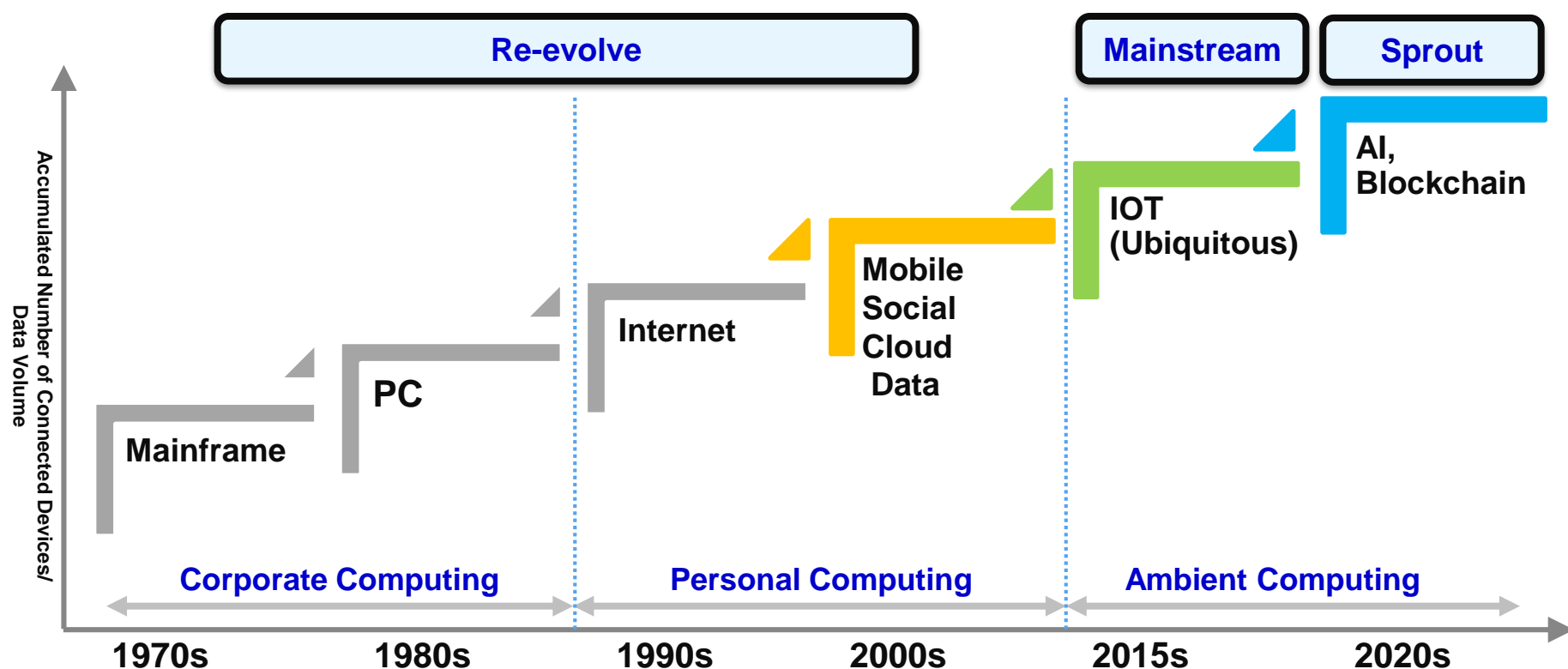


Agenda

- **Global Digital Technology Drives Industry Transformation**
- **Revolution of Manufacturing Sector**
- **Challenges and Opportunities of Taiwan Industry**
- **ITRI Cases for Supporting Digital Transformation**

Global Digital Technology Trends

- The applications are influenced by the **digital intelligence** to change the related industries and technical innovations.
- The values created by **user-centric ecosystem, IoT new infrastructure, digital intelligence by AI & big data, device mesh and 5G connected** will influence the future product and the network pattern.



Digital Technology Changes Economic Landscape of the Future

Digital Life Style



- In-depth use of cross-community social media
- Dialogue/interaction between human and machines
- Wide use of digital /virtual currency

Digital Business



- Global leaders in digital transformation
- Improve efficiency of business, reduce cost
- Form new digital business model through AI, IoT, Blockchain technology

Digital Society

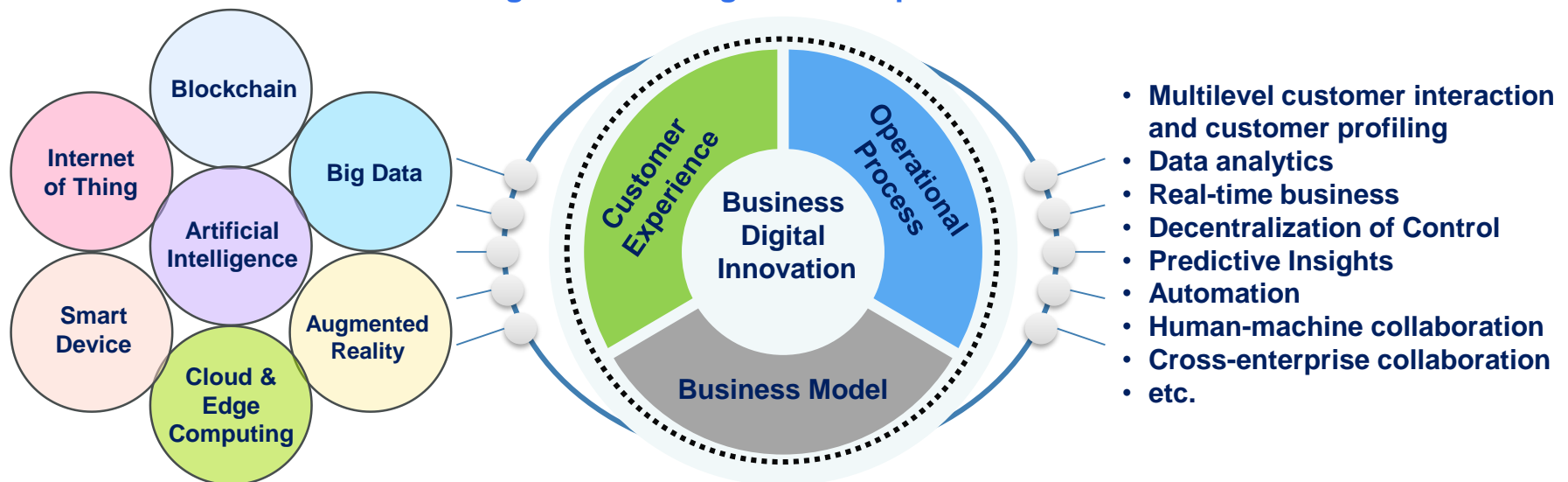


- Virtual v.s. real world interconnection
- Difficult to identify true and false messages in the virtual world

Business Innovation Based on “User Centricity” and “Solving Pain-Points”

- Value creation must be **based on user needs** and balance the interests of stakeholders and ecosystem participants
- Using breakthrough digital technology and solutions to **upgrade business capabilities**
- Integrate vertical and horizon value chains to **improve business efficiency or reduce cost, and** derive new **service-based business models**

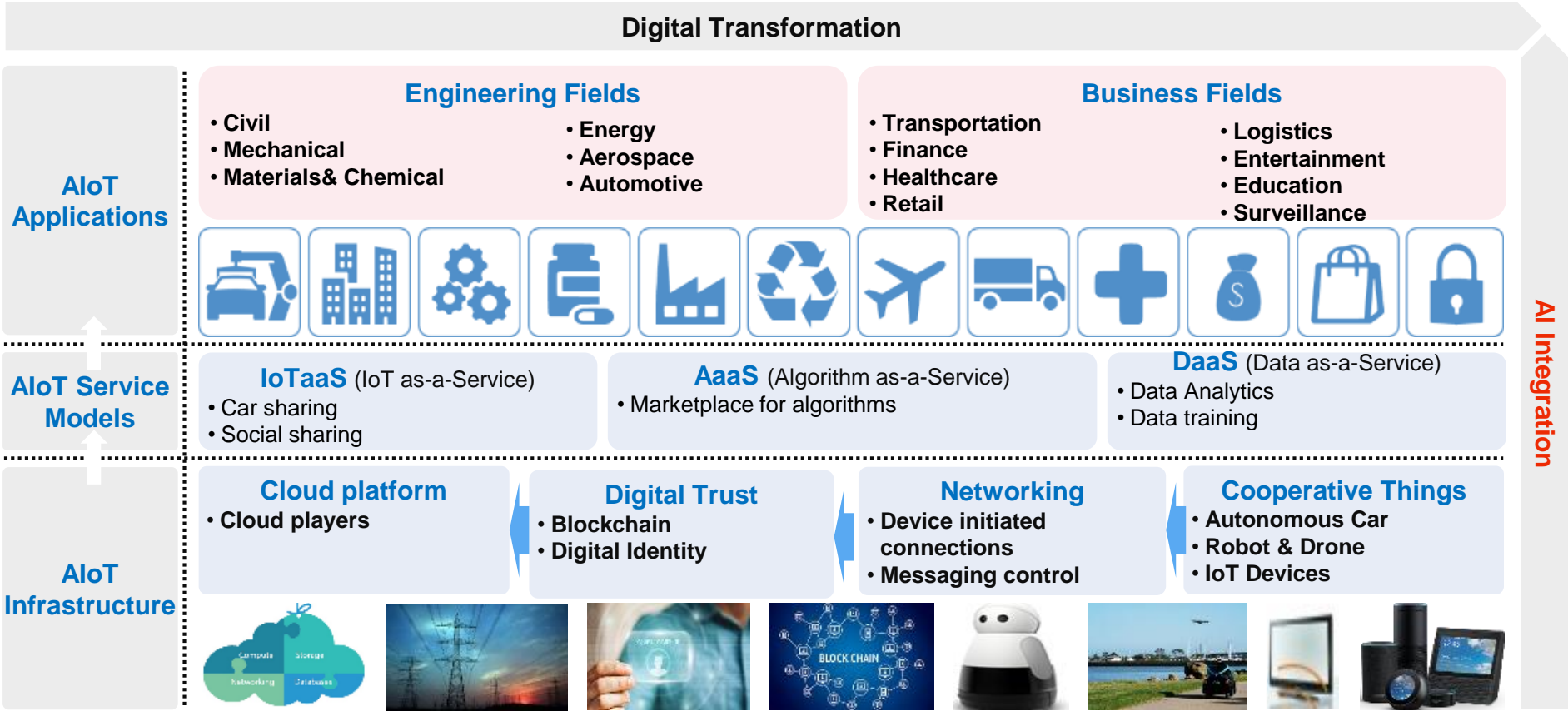
Digital Technologies and Capabilities



- Vertical operational processes : ex. product development, purchasing, manufacturing, logistics, services
- Horizon integration: suppliers, key partners, customers

Digital Technology Drive Industrial Innovation

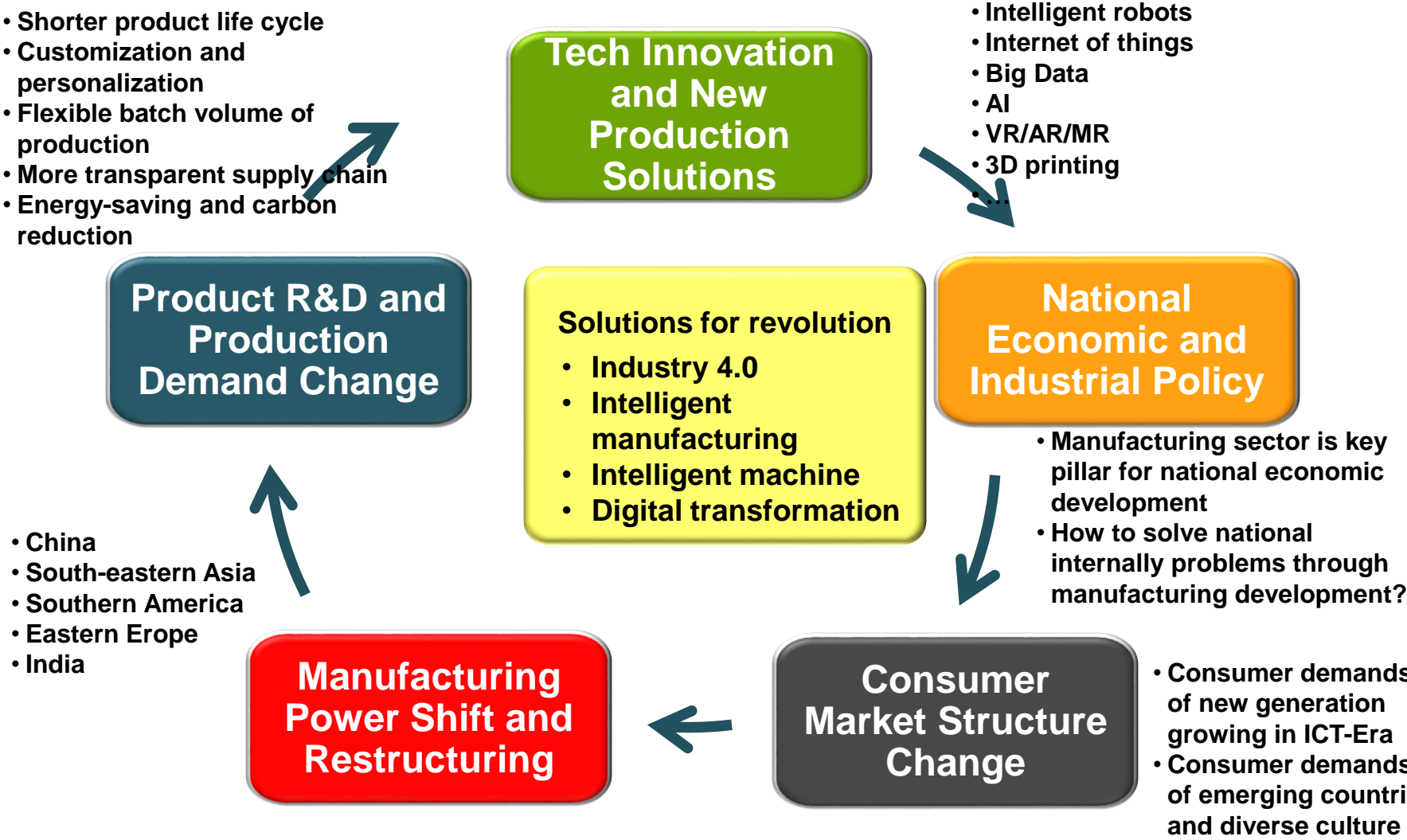
- Digital Technologies impacting within different field sectors, not only **create innovation of core business**, but also **generate new business**
- Derive **disruptive digital business models** such as IoTaaS, AaaS, DaaS



Agenda

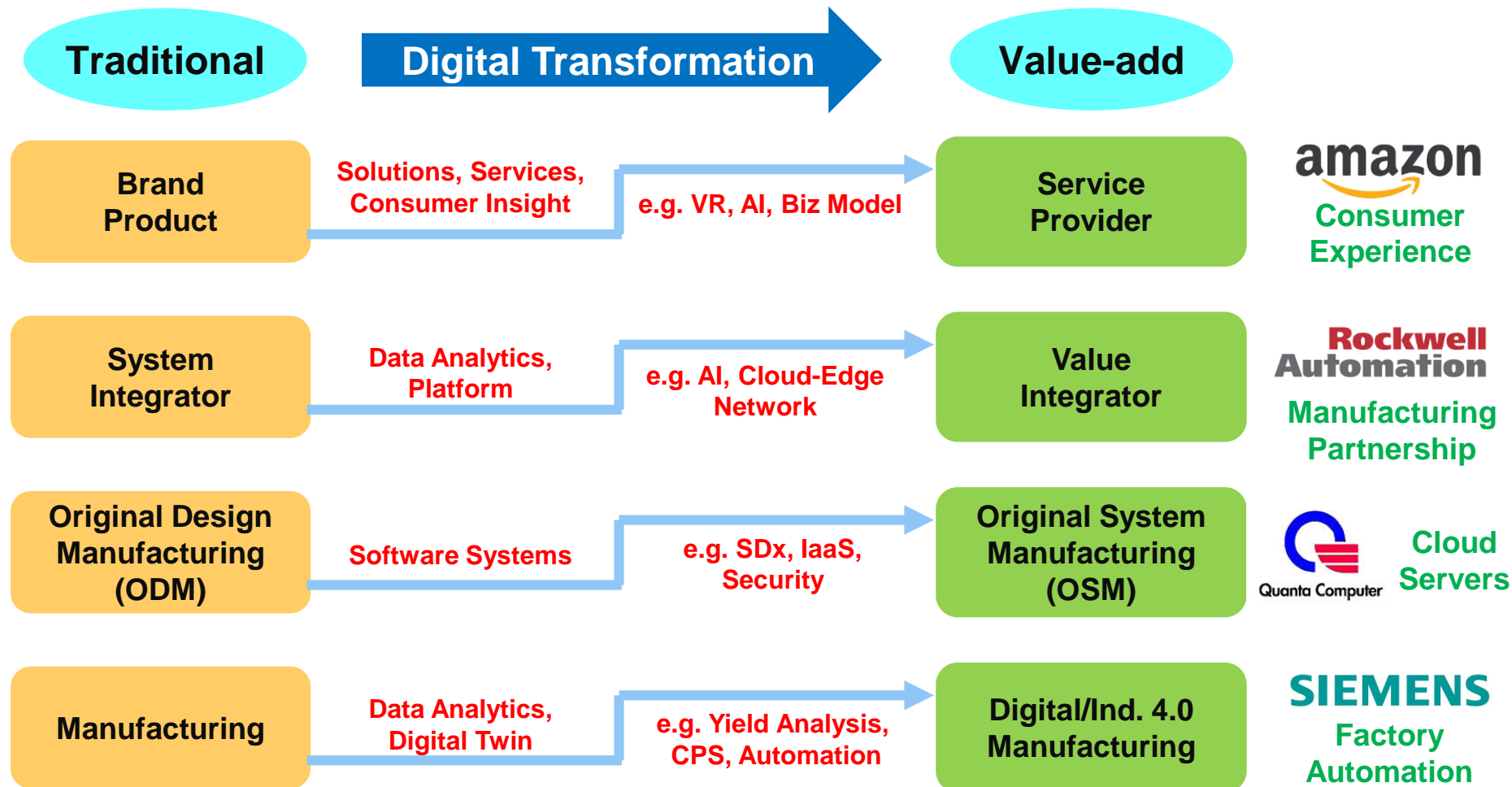
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Technology Development Drives Manufacturing Revolution and Evolution



Digital Transformation of Manufacturing

From Manufacturing to Infofacturing

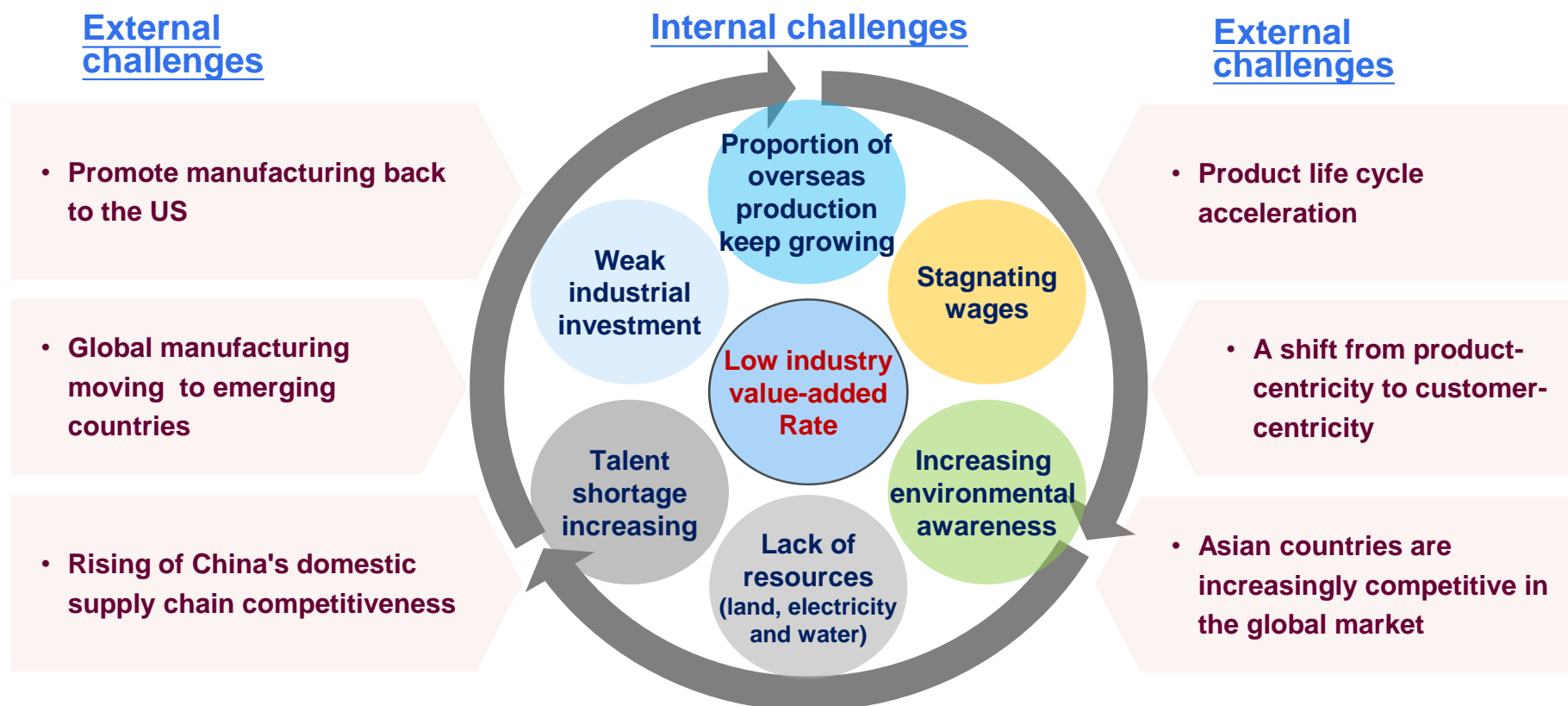


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Challenges for Taiwan Industrial Development

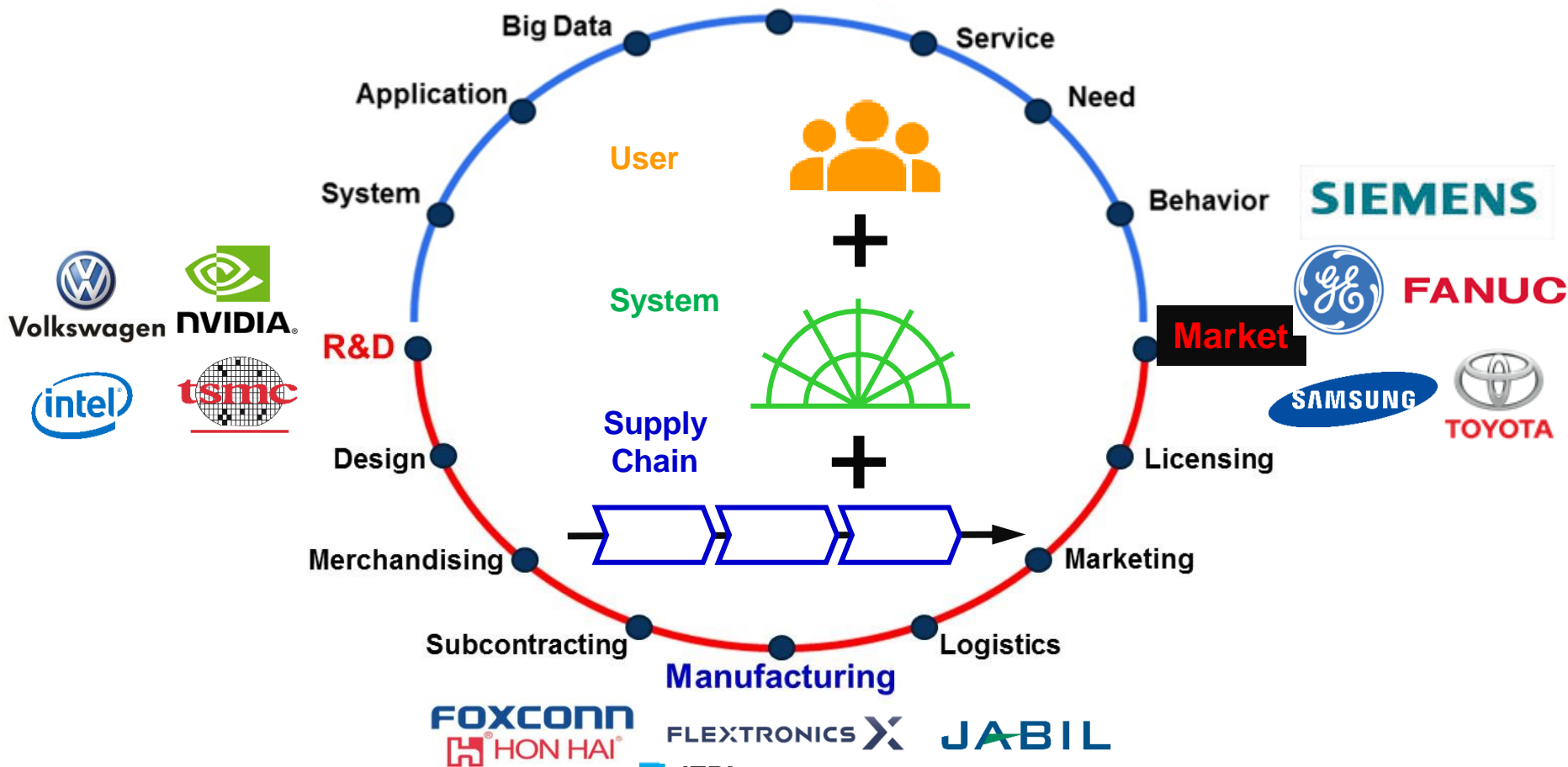
- Facing internal and external challenges, Taiwan industries are looking for new growth opportunities and innovative economic models



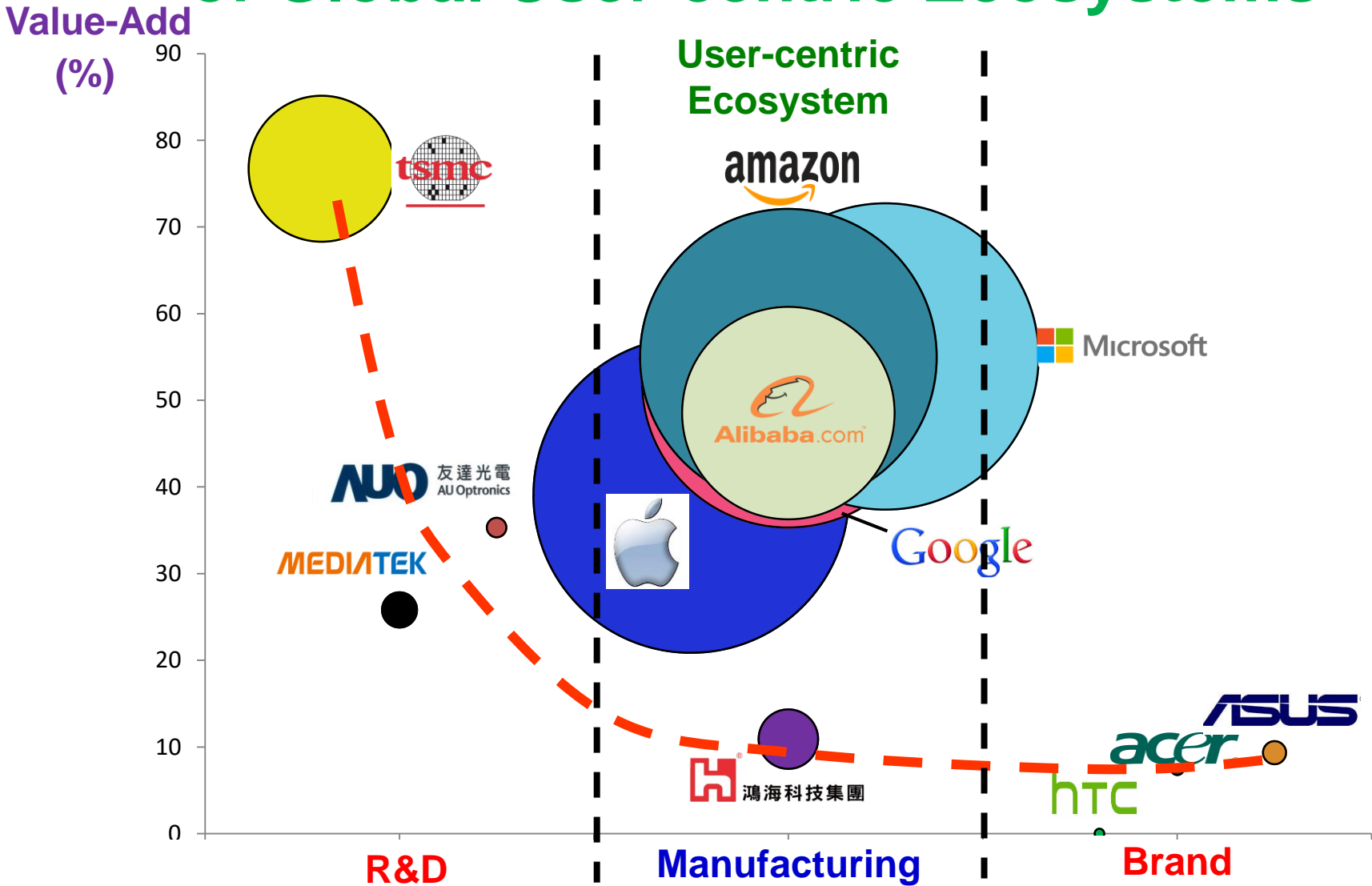
World: User-Centric Ecosystem

Taiwan : Inalienable Partner

2018全球
市值前十大

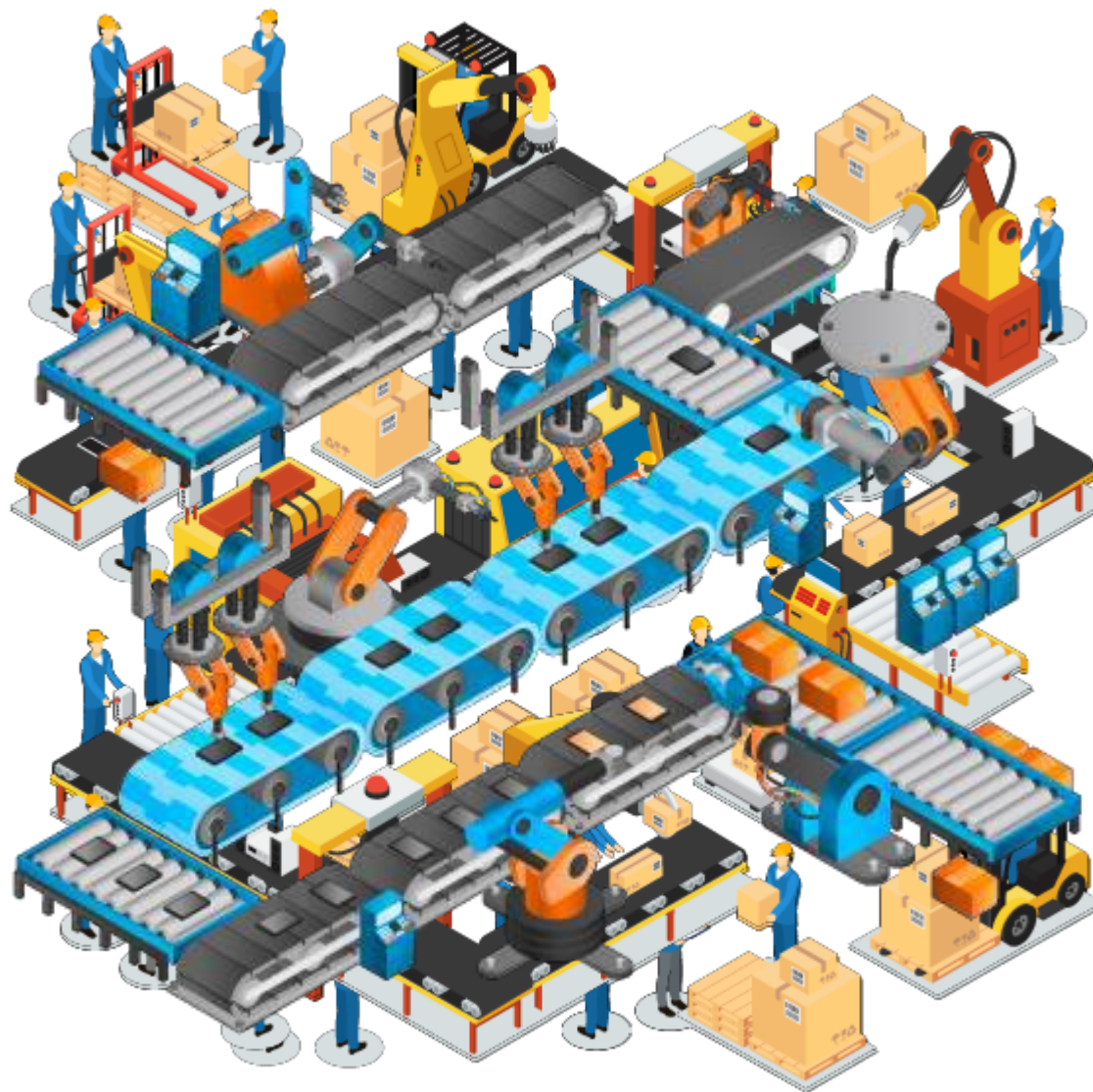


Key to Control High Point of Global User-centric Ecosystems

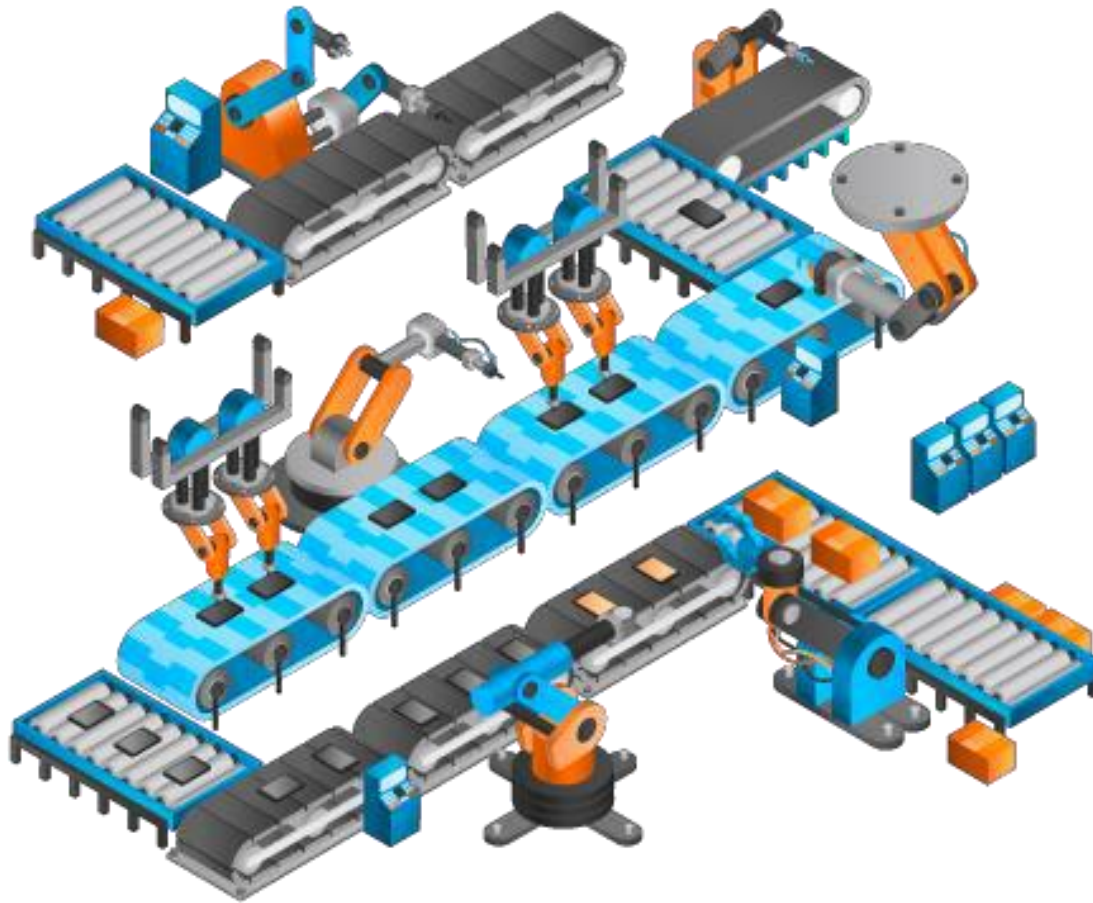


Note: Bubble size is market cap. Except for market cap which is as of 2018/11/22, all other financial indicators are 2017 data

Future Scenario of Industry 4.0?

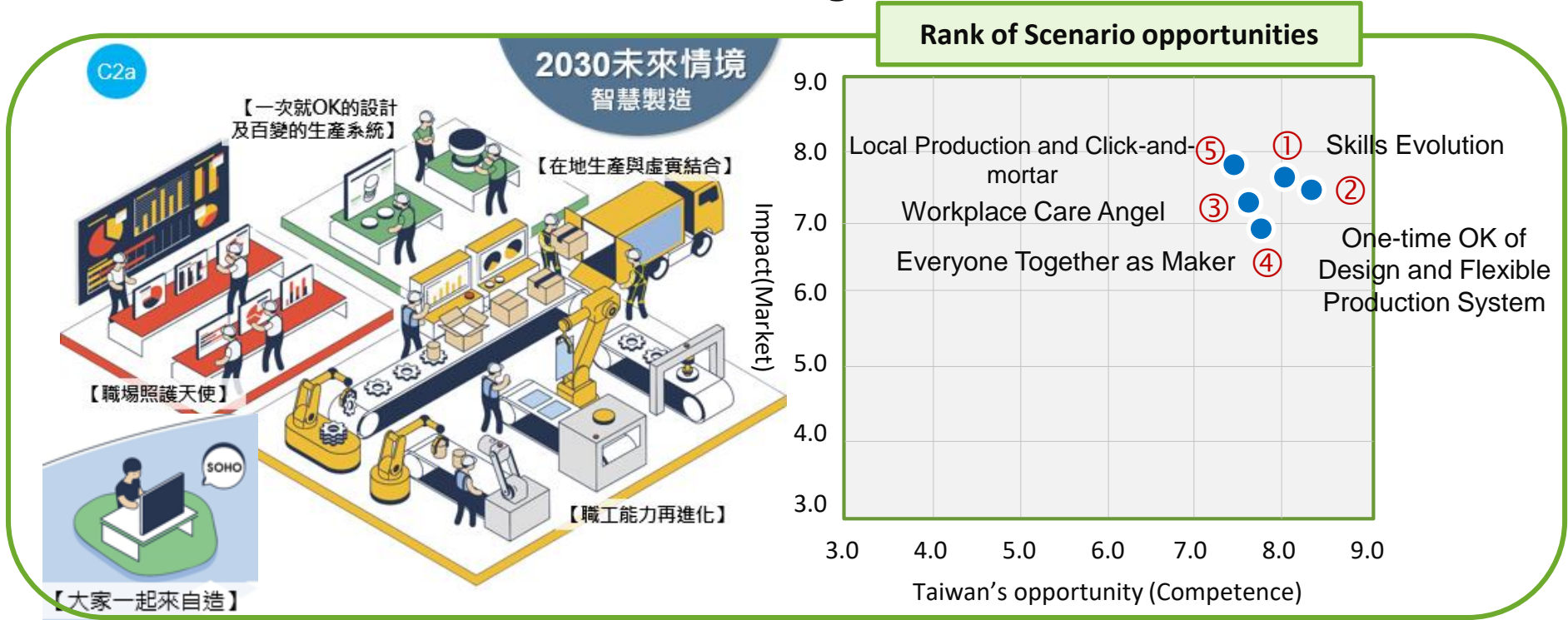


Ultimate Scenario of Industry 4.0?



2030 Smart Manufacturing Scenarios in Taiwan

- Elements of Smart Manufacturing in 2030 for sustainable environment:
 - Ability of advanced manufacturing and digitalization;
 - Convergence and collaboration with intelligent technologies
 - to strengthen manufacturing system for creating value of customers and sustainable manufacturing.
- Five scenarios of Smart Manufacturing in 2030



Five Scenarios of Smart Manufacturing in 2030

Skills Evolution



One-Time OK Design and Flexible Production System



Workplace Care Angel



Everyone Together as Maker



Local Production and Click-and-mortar



2030 Smart Manufacturing Scenario (1/5): Skills Evolution

Driven forces

- Aging on-line labors and difficult new recruits
- Continuous improvement and better quality for higher labor productivity
- Requests for flexible orders and customized products

Scenario description

Skills Evolution:

- Assist new recruit, aging and female workers to improve working efficacy
- Improve workers efficacy, quality and safety through human-machine collaboration and intelligent technology

Gap analysis

- Competence of key components and modules
- Capabilities of software, system integration and cross-disciplinary tech integration
- Production and test fields for vertical domains
- Join international enterprise's ecosystem

Required technologies

- Sensing, learning and decision technologies for human-machine collaboration
- Natural language understanding (NLU) for intelligent HMI
- Real-time synchronization system to integrate product data model and production data
- Intelligent tools for decision aids

Graphical scenario



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ITRI Funding for Multidisciplinary Breakthrough S&T

資訊、通訊

Information and Communications Research

- Next Generation Communication Technologies
- Internet of Vehicle Technology
- Electronic System-Level
- Commercial and Manufacturing Data Analytics
- Machine Learning
- Network and Mobile Virtualization

機械、系統

Mechanical and Mechatronics Systems Research

- Intelligent Machines and Robots
- Intelligent Mobility
- Advanced Green Manufacturing Machinery
- Intelligent Mechatronic System

材料、奈米

Material and Chemical Research

- Green Energy & Energy Saving
- High Value-added Materials
- Materials for Next Generation ICT
- Social Welfare & Sustainable Resource

電子、光電

Electronic and Optoelectronic System Research

- Flexible Electronics Technology
- Intelligent Vision System
- Advanced Lighting Technology
- IoT Sensing System
- Multiplex microsystem
- Flexible Display Technology

生醫、醫材

Biomedical Technology and Device Research

- Medical Device and Diagnostics
- Combination Device and Orthopedic
- Targeted Drug Development

綠能、環境

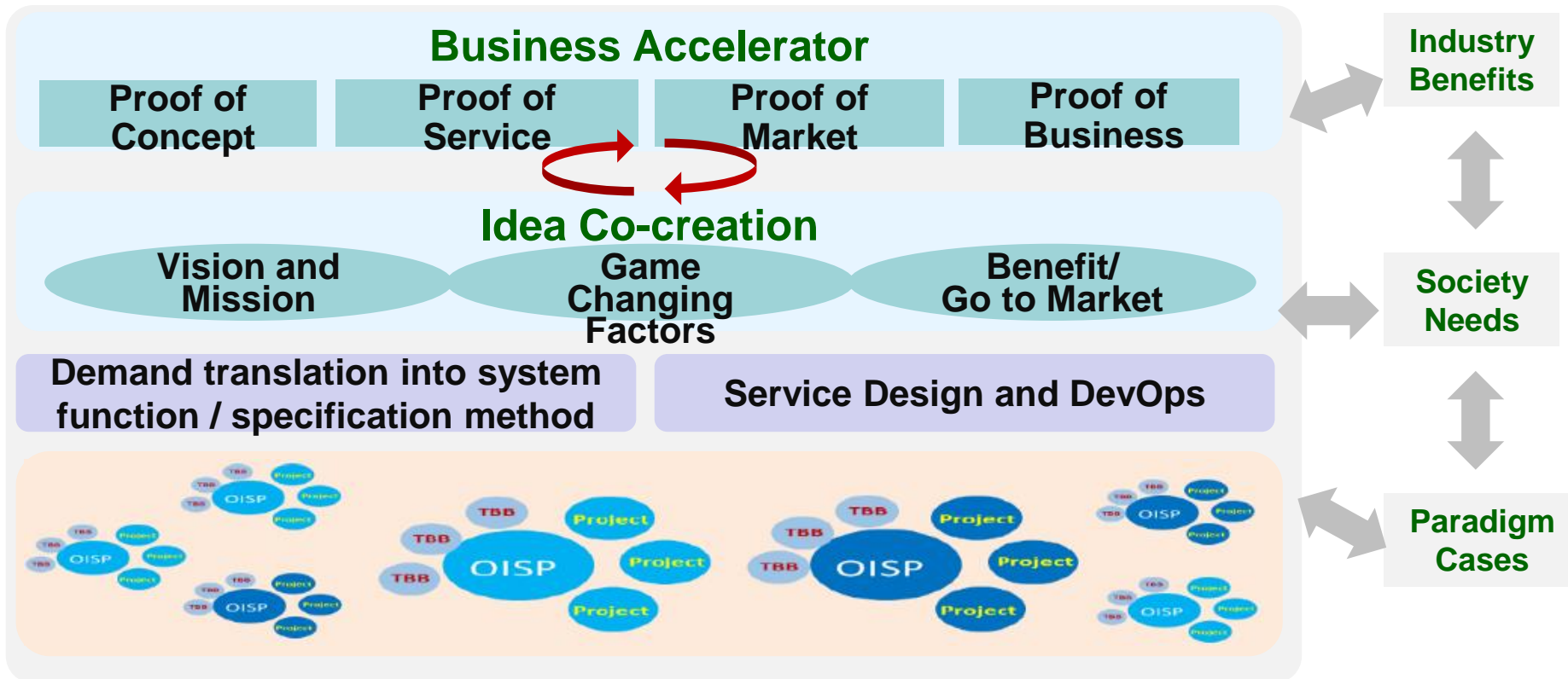
Green Energy and Environment Research

- Low Carbon Technology
- New and Renewable Energy
- Energy Efficiency and Conservation



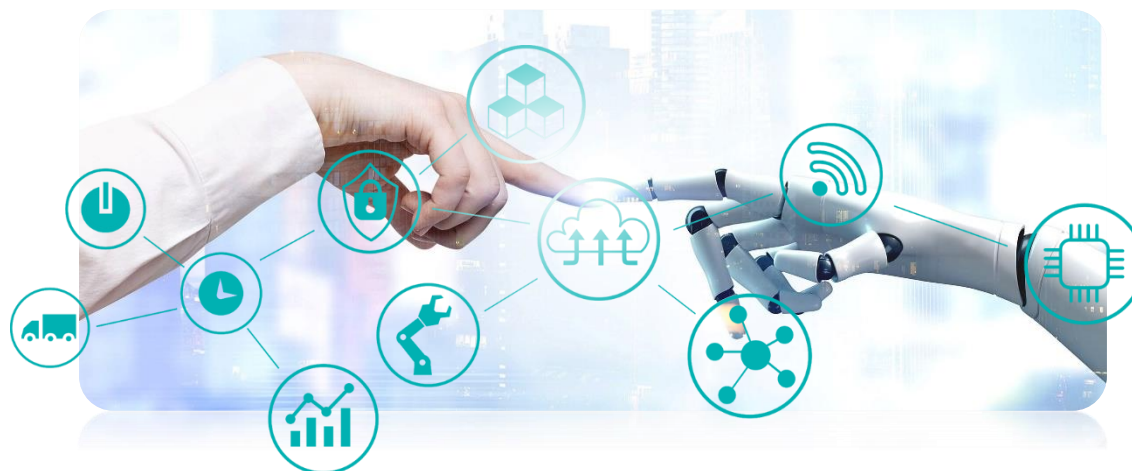
ITRI Open Innovation System Platform (OISP)

- Over 100 unique and cross-disciplinary OISPs within ITRI
- Collaborate with domestic and international leading industry players to capture commercial opportunities



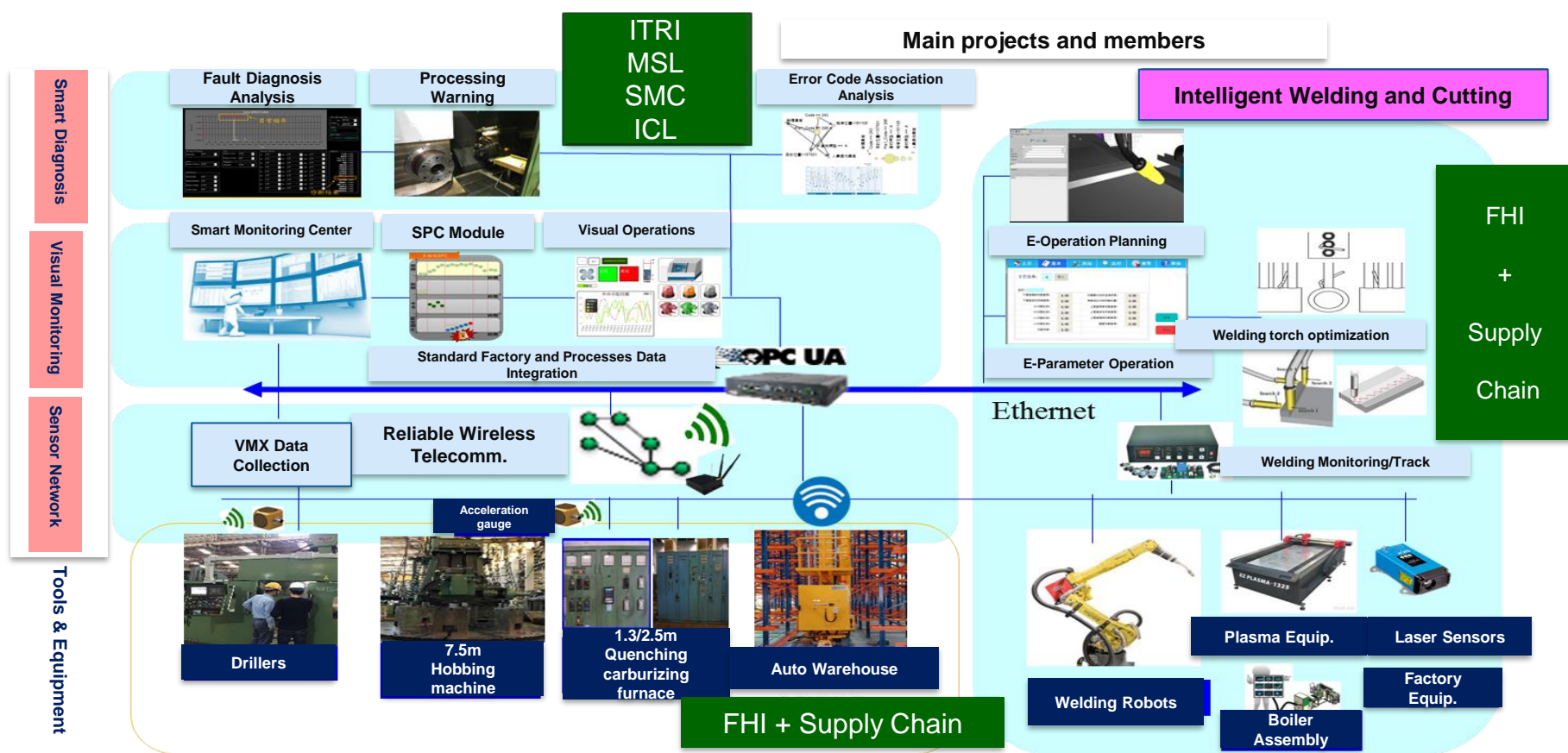
From Technology Innovation to Value Innovation

- Technology breakthrough does not guarantee a successful business
- What **smart machinery** can offer to enable smart manufacturing, e.g. :
 - Data analytics enables process optimization
 - Machine learning enables self-correction
 - Machine-to-Machine enables flexible execution
 - Virtual Factory (VF) enables fast production simulation through the product life cycle



ITRI Case: Smart Manufacturing Implementation with Formosa Heavy Industries

- Role of ITRI Labs: Methods of data collection + Implementation of AI in factory + System integration
- MSL & ICL: Smart Diagnosis, Visual Monitoring, and Sensor Network
- ICL: data collection via wireless telecommunication, OPC UA Standard for factory integration, and identify outlier by Data Association Analysis
- MCL: Failure Precursors
- MSC: Processing Warning & Workpiece Repositioning



4

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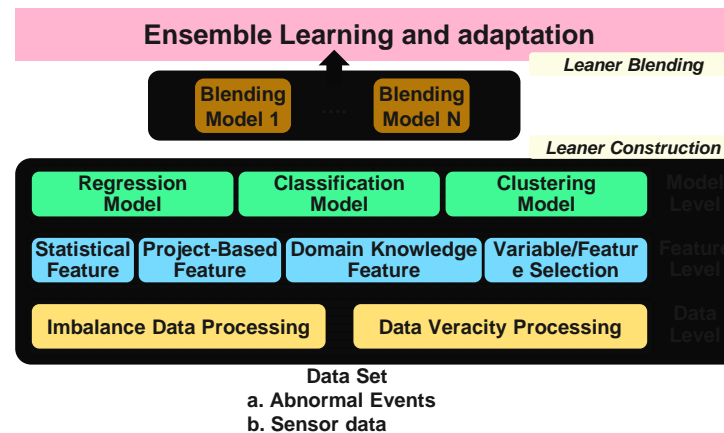
ITRI Case: Prognostic & Health Management (PHM) in Semiconductor Industry

- Ensuring production **yield rate is critical** in semiconductor industry
- **Fault prognosis** for semiconductor manufacturing developed for over 20 years, the prediction accuracy has **not met the requirements** of manufacturers
- PHM based on AI and machine learning, it analyzes the process data generated by the machine, monitors and predicts in real time, and presents with visualized data
- For workers, **the prediction of upcoming faults** address issues earlier, lessen the pressure and risks of inspection and repairing, and **improve work safety**
- PHM can predict equipment failure and component wear in semiconductor manufacturing, machinery, medicine, and power sectors

Requirements : Fault prognosis for semiconductor manufacturing



Four levels of PHM's primary technology operating flow



Data Visualization

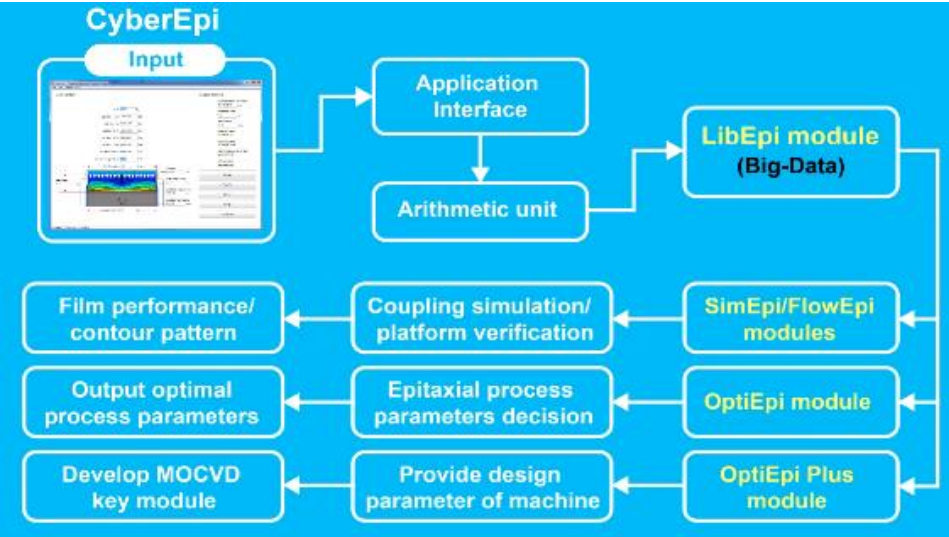




ITRI Case: CyberEpi Optimizes Epitaxial Manufacturing Process

- CyberEpi is software through multi-physical and chemical coupling **simulation analyses**, as well as heat flow field **visualization technology**
- CyberEpi can **reduces** the control time for the epitaxial process **from weeks to hours** of **manual trial-and-error experiments** formerly required and performed only by epitaxial manufacturing experts
- CyberEpi **Serves as a Digital Twin** of MOCVD systems; shortens R&D and product launch cycles of LEDs, solar cells, and high-power integrated circuits

CyberEpi Operation Architecture

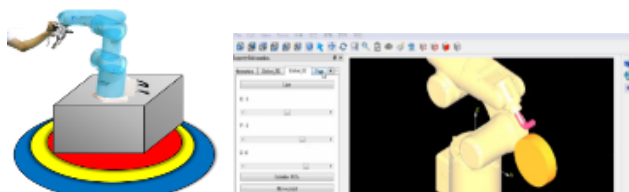


CyberEpi Performance Comparison

	Traditional → CyberEpi	Improvement
Control time	Reduces 1 Week→ 2 hours	98% ↑
Uniformity (Epitaxial manufacturing process)	Increases 92%→ 95 %	3% ↑
Time to market	Faster 3 Month→1 Month	66% ↑

ITRI Case: etherCAT-Motion Intelligence Orchestration (eMIO)

- The traditional aerospace component manufacturing is mainly based on CNC machines, and the machining accuracy needs to be improved.
- The eMIO integrate **3D vision positioning and detection technology**, effectively improve robotic accuracy and meet the requirement of the **international aerospace level ($\pm 0.25\text{mm}$)**
- Robot can automatically generate machining path for eliminating the inconvenience of manual teaching.
- Provide flexible, automated and accurate solutions for various industries such as aerospace, automobile etc.



- Robot and automation **simulator (Automatic generation of simulated surface trajectories, robotic arm movements, singular point detection and other simulation functions)**
- Robotic arm **precision enhancement** software module
- **Visual hand-eye coordination** software module
- Robotic **safety tactile** sensing module

4 Extendable smart module



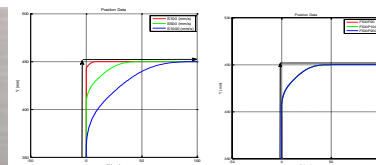
EtherCAT

3 EtherCAT High speed network control (eMIO)

- Support for **EtherCAT** networks, international communication standards agreement
- Support Industry 4.0 networking and self-diagnostics
- Full digital real-time network connection, flexible electronic control wiring

1 Basic motion control (MIO)

- Robot-specific **RCL motion library**
- Special functions such as **singular point speed modulation**, **space collision avoidance**, **constant speed trajectory**, etc.



Motion Intelligence Orchestration

2 Advanced motion control (MIO+)

- Support **speed control**
- Support **torque control**
- Support **lead-through**, **compliance in teaching**



Source : ITRI/Mechanical and Mechatronics Systems Research Laboratories

ITRI Case: “Aldea” Artificial Intelligence Collaboration Platform

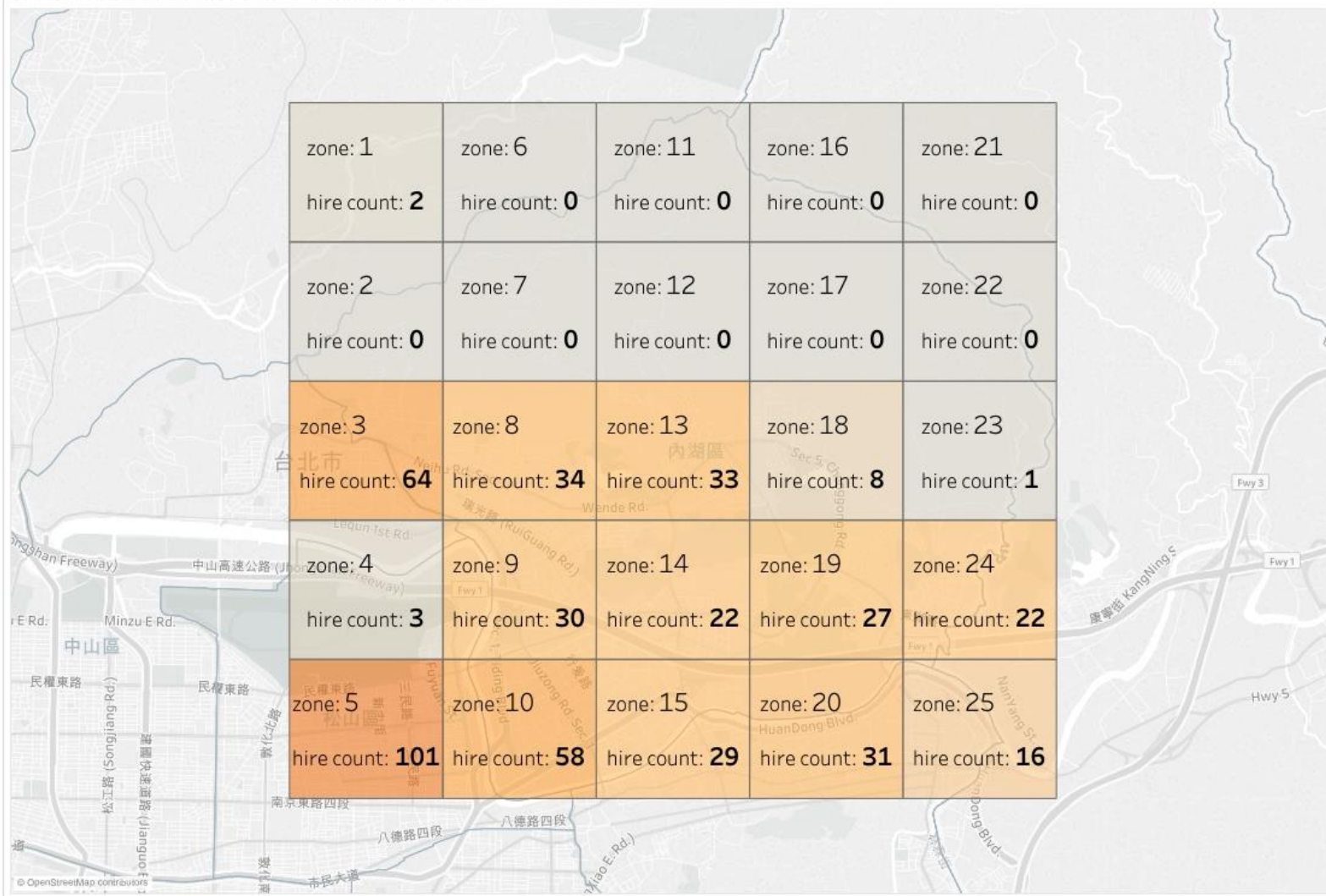
A Bridge between Industries & AI Academy/Start-up

- ITRI builds infrastructure to hold AI crowdsourcing competitions to get the best solution for each one of the specific industry issues



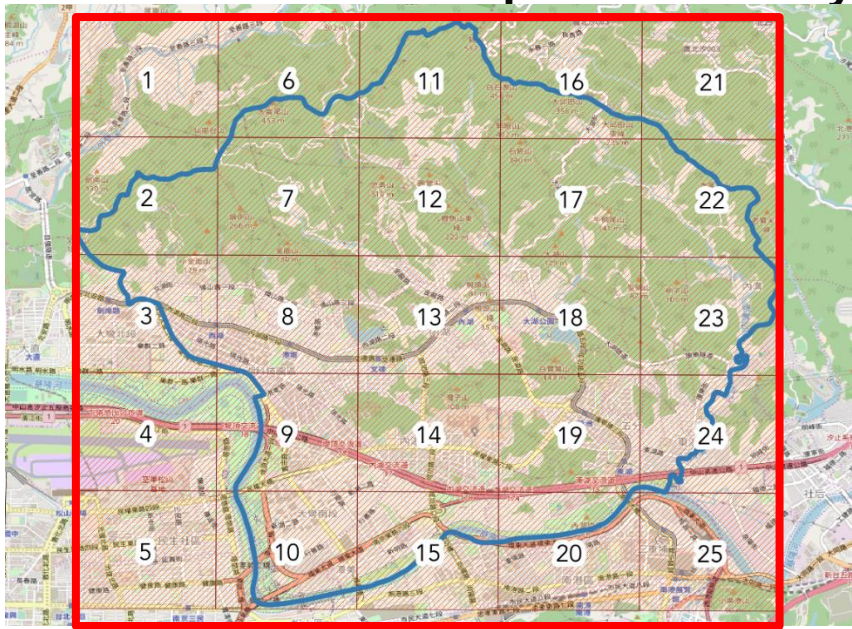
“Aldea” Case: Taipei City Taxi Demand Prediction (1/2)

區塊乘車數(hourly) - 2017年1月1日 上午12

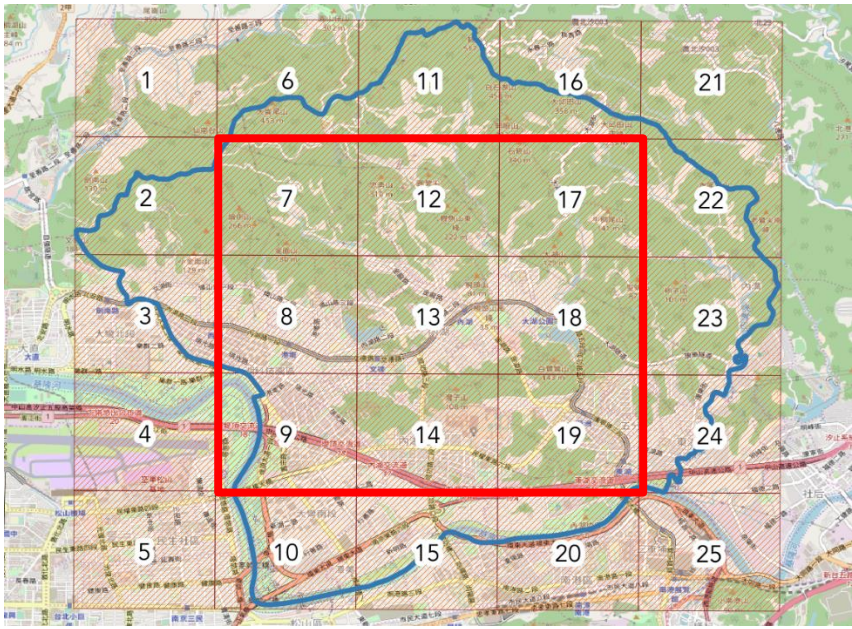


“Aldea” Case: Taipei City Taxi Demand Prediction (2/2)

- Results of solution competition:
 - 95% prediction accuracy within 2.2 square km.
 - Top solution providers made use of calendar, weather, u-bike and other information to improve accuracy



Training



Testing

1 year

2016-02-01
08:00:00
2019/8/26

2017-01-31
23:59:59

1 month

2017-02-01
00:00:00

2017-02-28
23:59:59

Ultimate Goal of Aldea Platform

Sustainable AI Matchmaking Platform with Unique AI Issue, Dataset, and Talent Collection

The best place to search industry datasets in Taiwan



Academy/Start-up

The best place to practice AI application solutions in Taiwan



Aldea

The best place to help enterprise to adopt AI in Taiwan



Industry/Enterprise



Appendix

2030 Smart Manufacturing Scenario (2/5): One-time OK Design and Flexible Production System

Driven forces

- Shorter product life cycle caused by fierce market competition
- Continuous improvement and better quality for higher labor productivity and total cost control
- Requests for flexible orders and customized products

Scenario description

One-Time OK Design and Flexible Production System:

- Higher production flexibility and quick response to reduce costs of design and production planning change
- One-time complete product design and production planning
- Quick response of production line for product specs change

Gap analysis

- Lack of core software R&D capability of digital system
- Low digitalization rate of industrial data and knowledge
- High R&D investment risk for individual organization
- Join international enterprise's application ecosystem

Required technologies

- Uses of digital design and simulation tools on application platform
- Set up digital product and manufacturing system models
- Production equipments with Self-Tuning Regulator for real-time measurement and control feedback

Graphical scenario



2030 Smart Manufacturing Scenario (3/5): Workplace Care Angel

Driven forces

- Aging on-line labors and difficult new recruits
- Ensure labor rights, physical and mental safety
- Loss reduction caused by lack of labor safety and industrial safety

Scenario description

Workplace Care Angel:

- Detect and early warn the harmful factors to labor physical & mental safety in workplace
- Quick awareness and warning related people and organization to prevent professional disaster

Gap analysis

- Readiness of regulation on Environment, Health and Safety (EHS) and wearable devices at workplace
- Lack of capability to capture and response to diverse real-time information of labors, equipments and environment

Required technologies

- Diversified sensing technology of physiological and environmental disasters
- Digital model for people, equipments and environment interaction
- Identification of real-time information analysis and risk factors

Graphical scenario



2030 Smart Manufacturing Scenario (4/5): Everyone Together as Maker

Driven forces

- Increasing demands of small amount of diversity and personalized products
- Trends of customized & on-demand manufacturing
- More product design participated by consumers; more expected sales of the product designed through consumer participation
- From subtractive manufacturing to additive manufacturing in green manufacturing era

Scenario description

Everyone Together as Maker:

- Consumer can design and make product by him/her self
- Consumer can participate in new product R&D or improvement process with enterprise
- Enterprise can quickly & economically make products by customer demands

Gap analysis

- Lack of ease-use and reliable personalized design tools
- Immature low-cost manufacturing service platform, network and business model
- Lack of high-speed & low-cost rapid manufacturing system

Graphical scenario



Required technologies

- Digital design tools (3D scanning/modeling)
- High-speed, high yield rate and low cost additive manufacturing solutions (equipment/material/system integration)
- Testing standard of additive manufacturing

2030 Smart Manufacturing Scenario (5/5): Local Production and Click-and-mortar

Driven forces

- Rebuild manufacturing capability in advanced countries and restructure of supply chain
- Change of global consumer landscape; need to satisfy various customer demands for market competition
- Less manufacturing carbon footprint for global climate change

Scenario description

Local Production and Click-and-mortar:

- Combination of cross-country supply chain and local production
- Small and medium manufacturing system for urban or regional product specifications
- Physical manufacturing across enterprises to support e-business and on-line procurement

Gap analysis

- Insufficient capability of collaboration and intelligent supply chain
- Lack of constructed rapid regional manufacturing capability
- Low level of cyber physical integration of supply chain

Required technologies

- High-efficiency, intelligent and customized integration system of supply chain, warehouse and delivery
- Intelligent supply chain management tools and operation platform
- Rapid constructed modulated & automatic production system
- Quick-response & low-cost additive manufacturing solutions

Graphical scenario



Stephen Su

VP & General Director

Industry, Science and Technology International Strategy Center

Industrial Technology Research Institute (ITRI)



Professional Experiences

- **Principal, Roland Berger Strategy Consultants, Shanghai**
- **Sr Director, Consumer Electronics BU, Primax Electronics Ltd Taipei**
- **Director, Corporate Development, Primax Electronics Ltd Taipei**
- **Case Leader, Boston Consulting Group, Hong Kong**
- **Applications Engineer, Semiconductor Group, Motorola, Phoenix**

Professional Specialty

- **Strategy, operations Improvement, organization change management, business process redesign, new product development and marketing, investment due diligence, manufacturing management**
- **Chairman of Committee on Policy and Legal, Cloud Computing IOT Association in Taiwan (2010-Present)**
- **President, Asia Pacific Industrial Analysts Association (2017-Present)**
- **Consultant Committee of Science Technology Policy Research and Information Center (2015-Present)**
- **Taiwan Food and Drug Administration(TFDA) Food Safety Technology Project Performance Evaluation Committee**
- **Ministry of Economic Affairs(MOEA) Industrial Development Advisory Council**
Multiple patents in power switching control and mobile phone applications

2025 Vision:

Inspire science-technology
innovation and value-up for
Taiwan industries



IEKTopics 2018

Thank you

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