



# 2019 Research & Development Strategy

## To become a global innovation leader

26 June 2019

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General Manager, Research & Development Group

General Manager, Corporate Venturing Office

Hitachi, Ltd.

# Contents

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- 1. Vision for 2021MTP**
- 2. Strengthen global co-creation of solutions**
- 3. Generate world No.1 technology for solutions / products**
- 4. Promote exploratory research resolving societal issues**
- 5. Summary**

# Contents

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- 1. Vision for 2021MTP**
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3. Generate world No.1 technology for solutions / products
4. Promote exploratory research resolving societal issues
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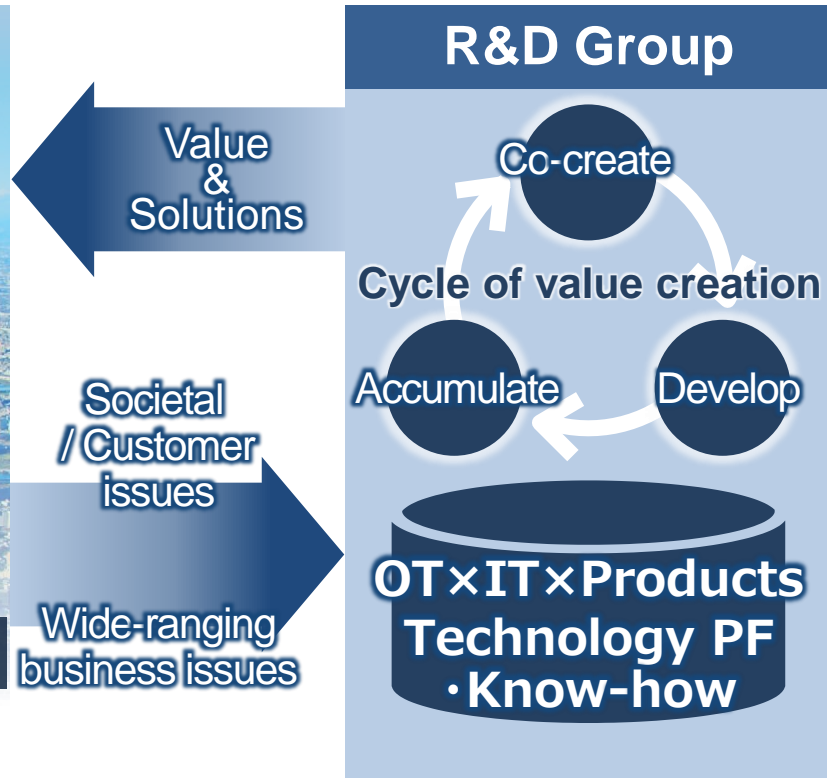
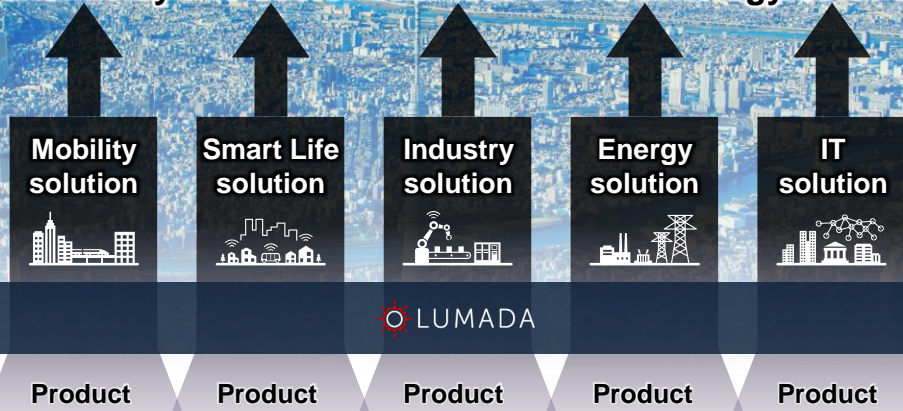
# 1-1 2021 Mid-term Management Plan

## To be a global innovation leader in Society 5.0/SDGs fields

To improve the Quality of Life and add values for customers



To increase the three values of social, environmental and economic by five-sector business and technology solutions



# 1-2 FY2015 R&D structural realignment

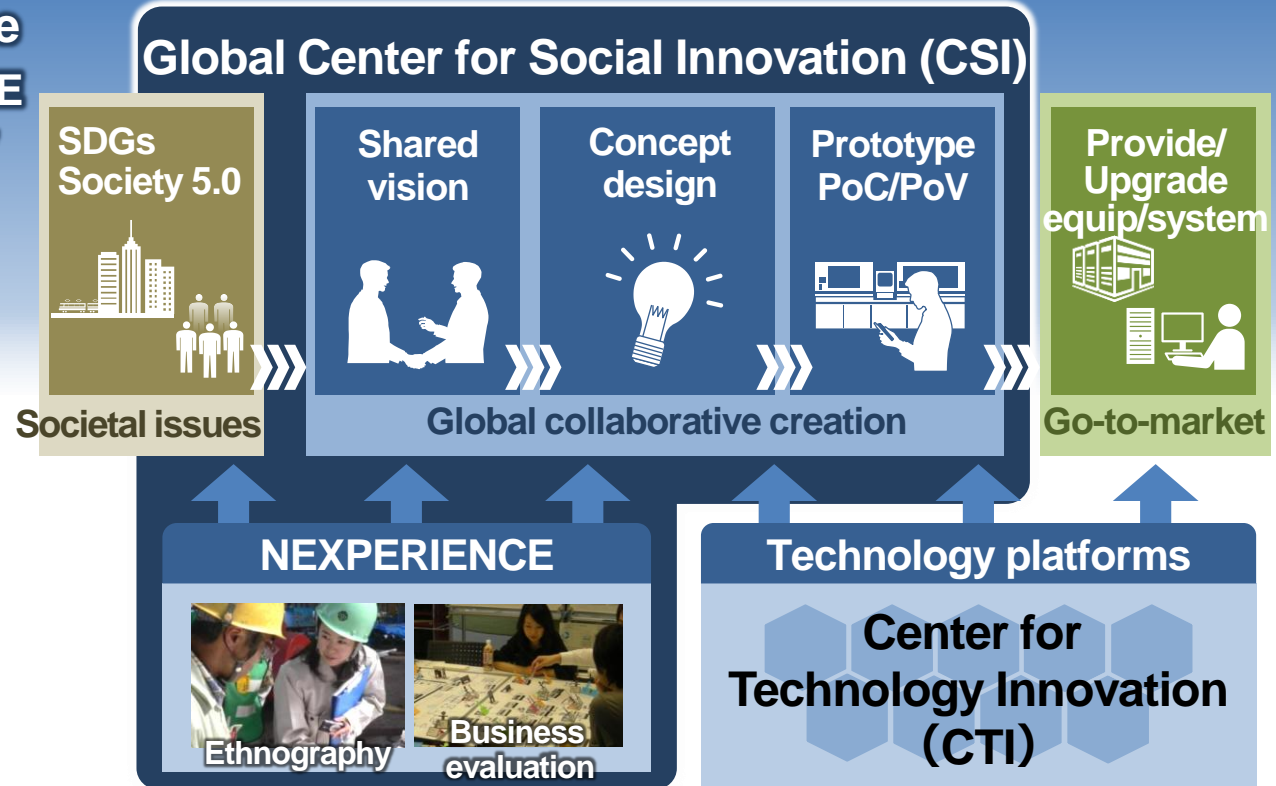
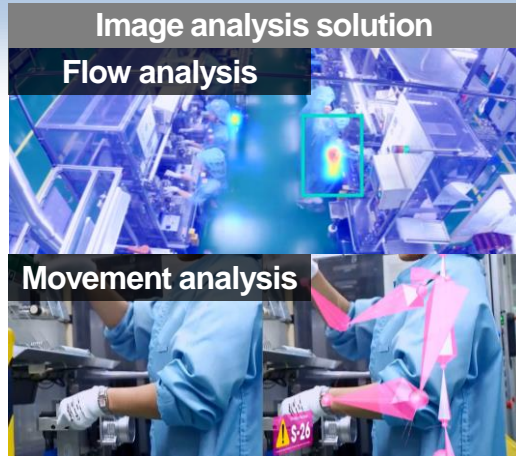
FY2015~

FY2016~FY2018

FY2019~FY2021

## Estab. global CSI structure

- Systematized NEXPERIENCE  
- a co-creation methodology
- Co-creation activities



FY2015~

FY2016~FY2018

FY2019~FY2021

## Collaborative creation using Lumada

- Leverage NEXPERIENCE
- Expand customer case
- Develop AI/IoT clusters

Operation video analytics



Daikin & others

People flow visualization



Tokyu & others

M&R solution



Penske & others

Logistics solution



HTS & others

Methodologies  
& Tools

**NEXPERIENCE**

Ethnography

Discovering opportunities ·  
business evaluation

Showcase

**IoT platform**

Solution core  
Customer case

Studio

Edge

Core

Analytics

Foundry



# 1-4 2021MTP Creating the three value propositions

FY2015~

FY2016~FY2018

FY2019~FY2021

**Foster an open innovation ecosystem**

**Established**

- *Kyōsō-nc-Mori*
- **Corporate Venturing Office**
- Fusion of co-creation and technology development
- Collaboration with startups
- Build-up industry-academia-government ecosystem

Social values

Environmental values

Economic values

Improve QoL

Add values for customers

**Social innovation by Lumada**

June 2019  
Established  
new funding company  
for corporate  
venturing



Open Laboratories  
(U.Tokyo, Kyoto U.,  
Hokkaido U., U.Cambridge,  
Tsinghua U.)  
/ WEF-C4IR

**Open innovation ecosystem**

Startups

Customers/Partners

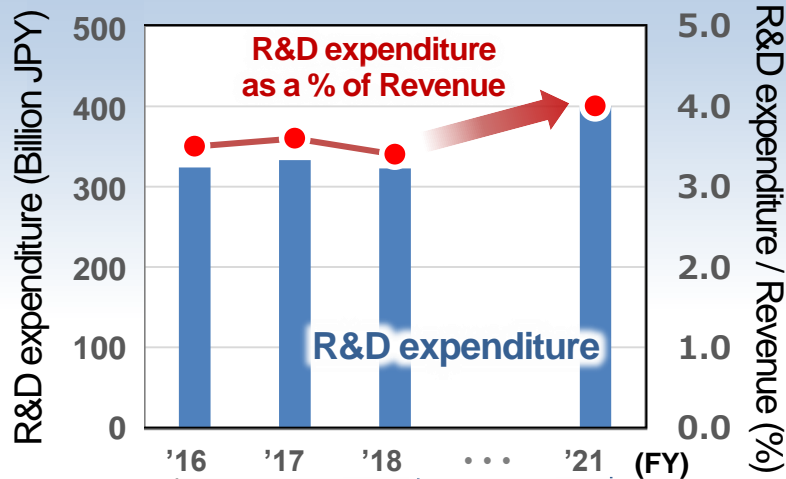
Academia



# 1-5 Hitachi Gr. investment in R&D

Invest 1.2 trillion JPY in R&D through 2021MTP, continuously improve R&D efficiency

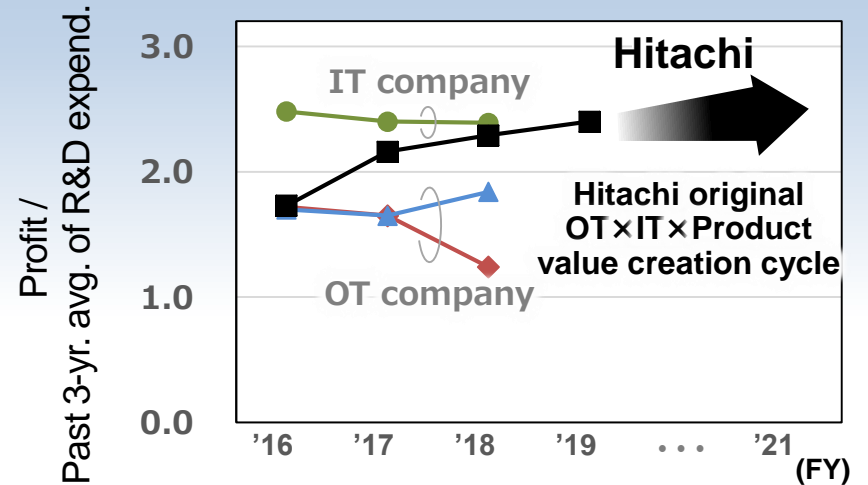
## Investment in R&D



Ratio of adjusted operating income to revenue

	Target				
	6.4	7.6	8.0	...	10.0
	(%)				

## R&D efficiency

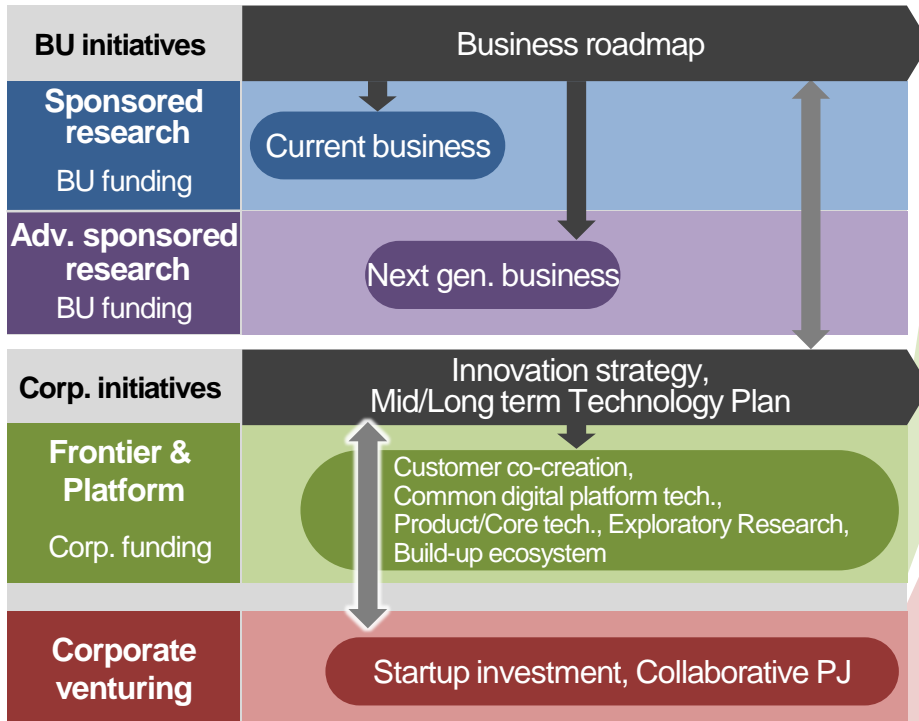




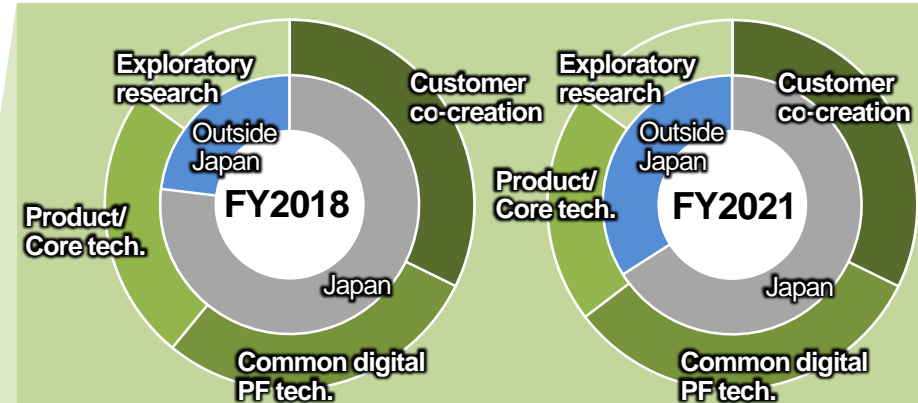
# 1-6 Corporate R&D portfolio

## Accelerate R&D by building ecosystem, strengthen resources outside Japan

### Research target



### Strengthen co-creation/digital technology research and R&D resources outside of Japan

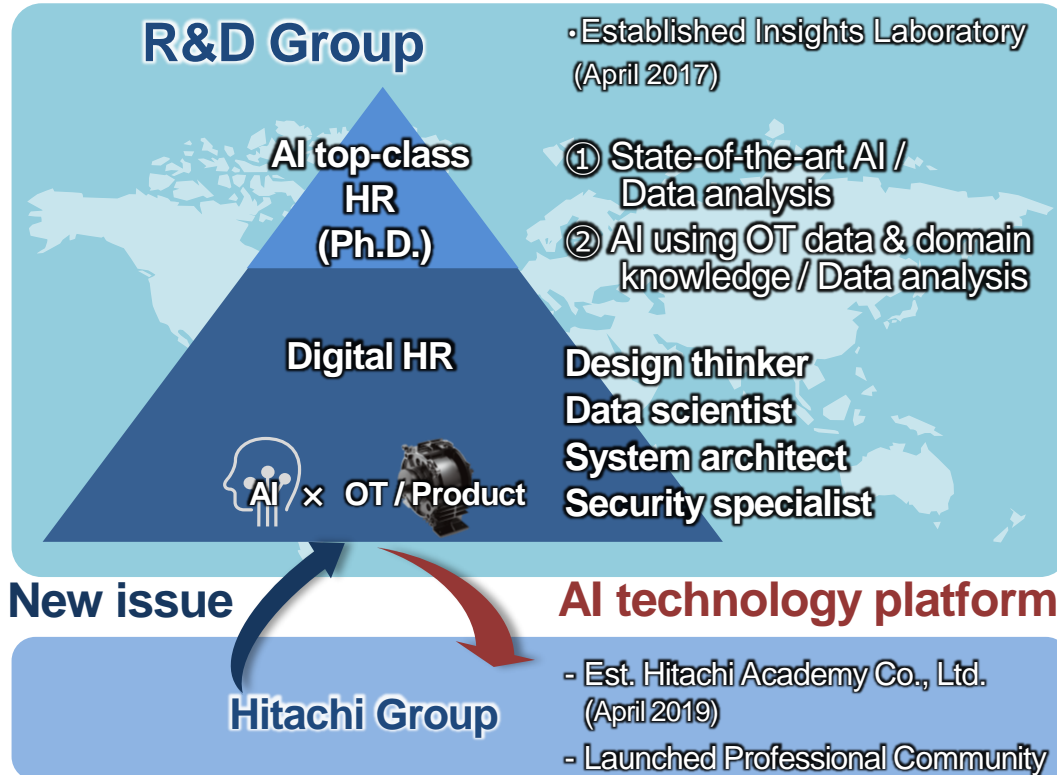


### Integrating business models & disruptive technology from startups

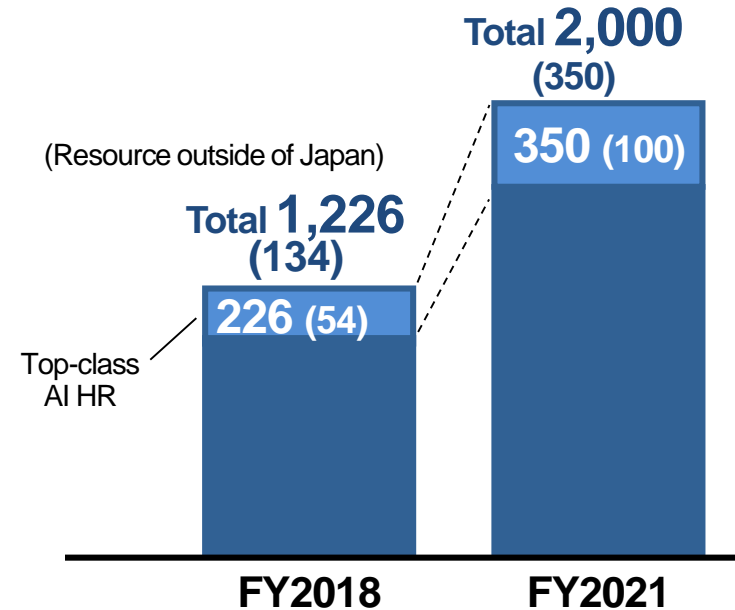
- Established Hitachi Ventures GmbH
- Hitachi Ventures Fund, investment scale 150 million USD

# 1-7 Enhancing digital HR

## Enhance digital HR including top-class AI researchers for the Hitachi Group



### R&D Group plan to enhance digital HR



# 1-8 FY2018 External recognitions

## High-speed train



National Commendation for Invention  
— The Imperial Invention Prize  
Japan Industrial Techniques Grand Prix  
- Judges' Special Prize

## Particle beam therapy equipment



Medal with  
Purple Ribbon

## High resolution open MRI



Okochi Memorial Prize  
National Commendation for Invention  
MEXT Ministerial Awards: Prize for S&T

## Storage equipment



「Hitachi Virtual  
Storage Platform  
Family」  
Midrange model

Best 10 New Products Award

## X-ray fluoroscopy



The Ichimura Prizes in Industry  
- Meritorious Achievement Prize

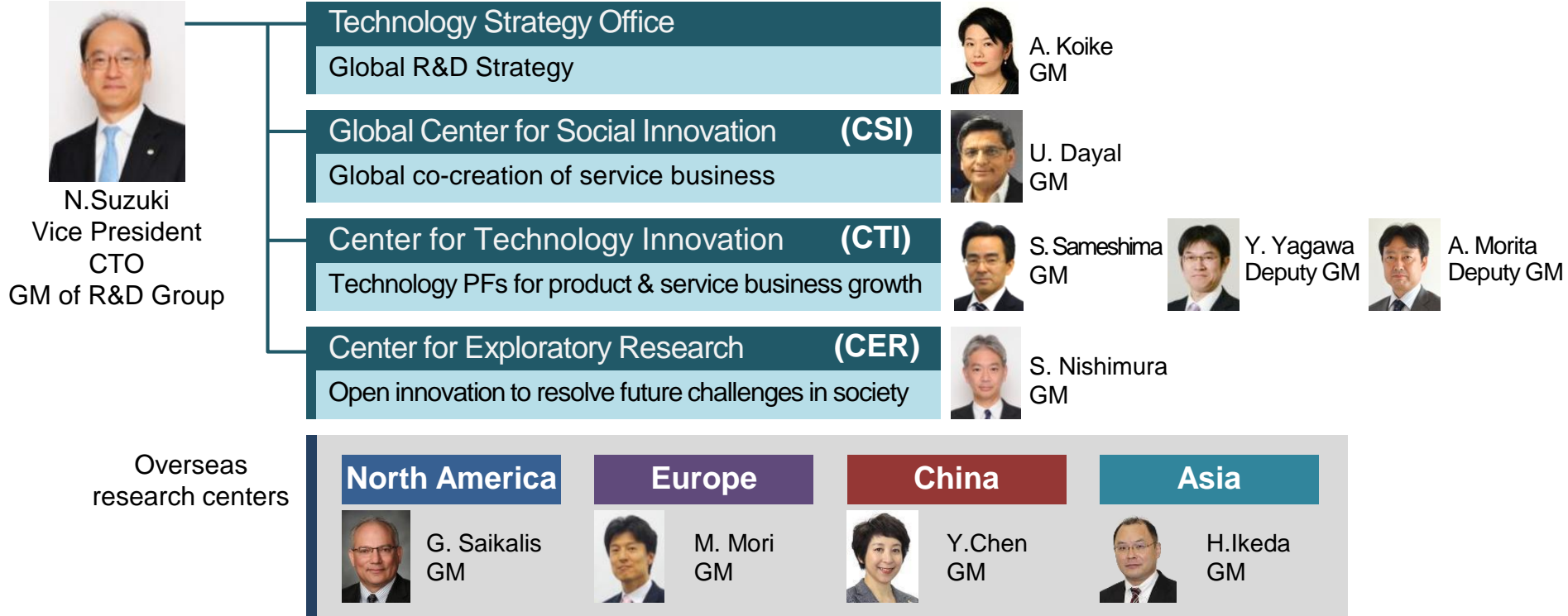
## Semiconductor measurement equipment



Electrical Science & Technology Encouragement Prize  
MEXT Minister's Prize

# 1-9 FY2019 R&D Group organization

## Global R&D driving new growth in Social Innovation Business



## Become a global innovation leader in the fields of Society 5.0 and SDGs

### CSI

#### Co-creation of global solutions

- Pioneer business models using CV, ideathons / hackathons
- Promote open co-creation in priority solutions & focus regions

### CTI

#### Creation of global No.1 technology for solution/product

- Value-based creation of global No.1 Technology
- Build-up Lumada ecosystem, incorporating OT × IT × Products

### CER

#### Exploratory research resolving societal issues

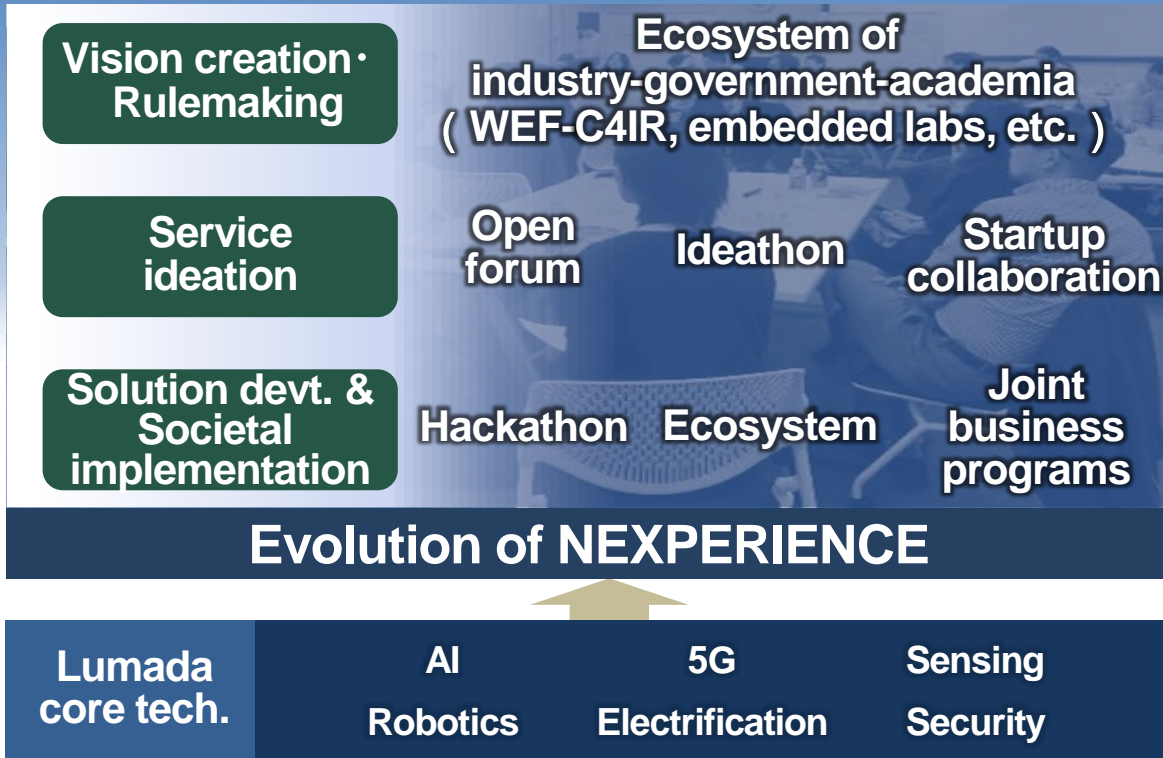
- Generate human-centric value through research resolving societal issues
- Promote the Society 5.0 concept worldwide

# Contents

---

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## Co-creation through open innovation with stakeholders



## 2-2 *Kyōsō-no-Mori*: Establish societal consensus

Vision creation  
· rule making

**HITACHI**  
Inspire the Next

◆ Opening ceremony: 11<sup>th</sup> April 2019

◆ Panel discussion: “The Future of Asia and Pacific Smart Cities”

Discussed the value and meaning of smart cities initiatives in Asia and Pacific area

Moderator: Mr. Kojin Nakakita, Vice President and Executive Officer, Regional Strategies [APAC], Hitachi

Panelist: H.E. Hon. Mr. Bansarn Bunnag, Ambassador of the Kingdom of Thailand to Japan

The Hon. Mr. Richard Court, Australian Ambassador to Japan

Ms. Chizuru Suga, Head of the Centre for the Fourth Industrial Revolution Network, Japan

Dr. Atsushi Deguchi, Professor/Vice-Dean, Graduate School of Frontier Sciences, U.Tokyo

Dr. Shigetoshi Sameshima, General Manager, CTI, Research & Development Group, Hitachi





# 2-3 Ideation through open innovation

Ideation  
·materialization

**HITACHI**  
Inspire the Next

## Future Trust

Thinking about future trust, from the perspective of technical trends in trust, and changes in societal trends regarding corporate entities and individuals



Akasaka (5 March 2019)

## ASEAN region FinTech apps.

Generating ideas based on leading-edge activity in Singapore FinTech and trends in related businesses



Singapore (31 August 2018)

## Blockchain applications

Exploring ideas for applications of blockchain through joint hackathon with startups and universities in China



Shanghai (23-24 March 2019)

# Open innovation using ideathons and hackathons

# 2-4 Joint business program

Solution devt.  
/ Validation

**HITACHI**  
Inspire the Next

## Societal implementation using Hitachi & partner technology, know-how and data

### Future Living Lab.

*Kyōsō-no-Mori*

Demonstrate a vision of Society 5.0 vision, and implement a solution bringing together technology, design and the power of citizens



Committing Trust to the Authority  
**Your Reliable City**

Appreciating the value little by little, leading to entrusting many important things to the city



Sharing Trust in the Community  
**Cycle of Change**

Create a "face-to-face" economy born between a citizen and a store

**Partner**

Kokubunji-shi and others

### 5G application

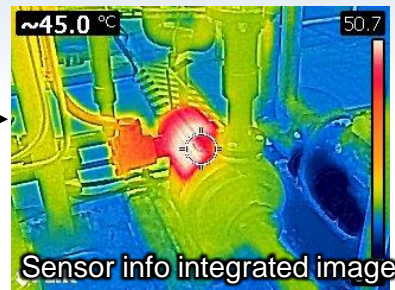
N.America

Co-creation of solutions (remote control & work support) using edge processing & real-time transmission of on-site information

**Example: Real-time remote support & operation**



360° camera, wearable camera, various sensors



Sensor info integrated image

**On-site**

**Support center**

**Partner**

Telecommunications carrier in Japan, Major telecommunications vendors outside Japan, etc.

# 2-5 Global innovation network

## Extend the field for open innovation to accelerate innovation



●: R&D sites, Lumada Center, CV office

CSIRO: Commonwealth Scientific and Industrial Research Organisation

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---

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# 3-1 Development strategy for world No.1 tech. platforms

## Focus investment in “Sector’ x Lumada,” Lumada platform, and No.1 products

Sector	Mobility	Smart Life	Industry	Energy	IT
2021 MTP strategy	Pursue further global growth and operational transformation	Achieve structural reform / Establish Smart Life sector Lumada business model	Digitally-connected seamless solutions	Focus on energy solutions & high value-added services	Enhance Lumada and accelerate global expansion
Solution example	<ul style="list-style-type: none"> <li>Building facility management solution</li> <li>Smart ticketing</li> </ul>	<ul style="list-style-type: none"> <li>Connected car</li> <li>Smart therapy</li> <li>Smart city</li> </ul>	<ul style="list-style-type: none"> <li>Next generation manufacturing, Maintenance, and Logistics</li> </ul>	<ul style="list-style-type: none"> <li>Grid stabilization</li> <li>Automated distribution</li> <li>Energy management</li> <li>P2P power exchange</li> </ul>	<ul style="list-style-type: none"> <li>Solutions for financial institutions</li> <li>Predictive diagnosis simulation</li> </ul>
Lumada (Core tech.)					
Product	<ul style="list-style-type: none"> <li>Global rolling stock</li> <li>High speed elevator</li> <li>Service robot</li> </ul>	<ul style="list-style-type: none"> <li>EV components</li> <li>Diagnostic / Treatment system</li> <li>Home appliance / Air-conditioner</li> </ul>	<ul style="list-style-type: none"> <li>Air compressor</li> <li>Marking system</li> <li>3D printing</li> </ul>	<ul style="list-style-type: none"> <li>HV transmission syst.</li> <li>HVDC</li> <li>Breakers /Transformers</li> <li>Large-scale centralized power supply</li> </ul>	<ul style="list-style-type: none"> <li>Storage</li> </ul>

# 3-2 Mobility



## Deliver safe & comfortable mobility service to people

EU·CN

### × Lumada

### Mobility-as-a-Service

- Realize the seamless movement of people in cities which continue to grow in size and complexity in response to societal trends



### Mobility-as-a-Service

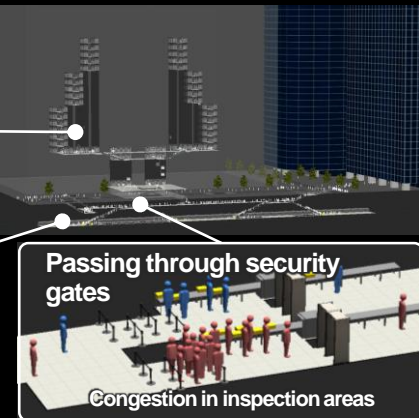
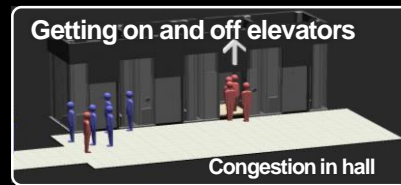


### Solution

### Modality/facility planning optimization

- Predict people flow taking into account the effect of users, trains, elevators, security gates, etc. on each other

Total city space (Building & Station): Control & operation of trains, elevators, and security gate



No.1 tech.

Integrated people flow simulation

## Contribute to improved QoL by realizing cities comfortable for everyone

Asia·JP

### × Lumada Smart Life Infrastructure aaS

- Generate societal and environmental value by continued technology innovation to realize healthy, safe and comfortable live

Social issues

Cancer

Traffic accident

Global warming

Aging

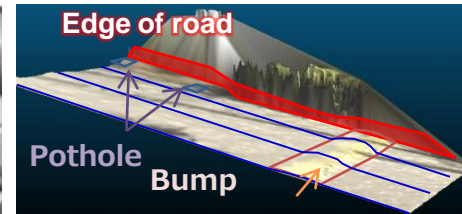
Urbanization

### Raising QoL

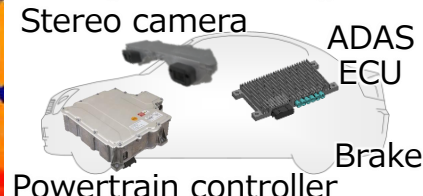
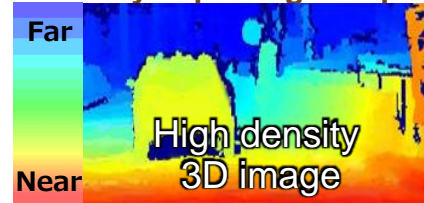


### Solution Autonomous driving / OTA solution

- Real-time recognition of the driving environment using high-density 3D imaging
- Apply latest functionality using OTA software updating



Realize safe & comfortable control by capturing bumps that may affect driving



No.1 tech. 3D analysis / System mgmt.

# 3-4 Industry



NA·JP


## Total solution that seamlessly connects site & management

× Lumada
Value chain optimization

- Reduce CO<sub>2</sub> emissions by improving product efficiency and service provision, and reducing product energy consumption

Collabo. w/ Robotic Sier (JR Automation, KEC)


Next gen. manufacturing



Production site

Production data


Next gen. maintenance



Industrial product


Operation data

Next gen. logistics




Warehouse

Work data



Solution
IoT Compass

- Accelerate cycle of improvement for productivity by simulation on digitized work process



Manager

Total data SI

Company A Industrial plant a
Company A Industrial plant b
Company A Industrial plant c

Data model

Operation, Process, Operator, Equipment, Material

Details of related data items

Operation history data by product

Product ID	Item	Start	End	Operator	Equipment	Material
2019051190000001	1. 検査1 > 設備 > 組立検査 > 操作シフトログデータ	2017-07-19 17:05:00.000	2017-07-19 17:05:00.000	4999999999997		
2019051190000002	2. 塗装 > 設備 > 塗装口作	2017-07-19 17:08:00.000	2017-07-19 17:08:00.000	4999999999997		
2019051190000003	3. フレス1 > 設備 > 組立	2017-07-19 17:08:00.000	2017-07-19 17:08:00.000	4999999999997		

Robot-use support

No.1 tech.
Auto generation & analysis of data models



# 3-5 Energy



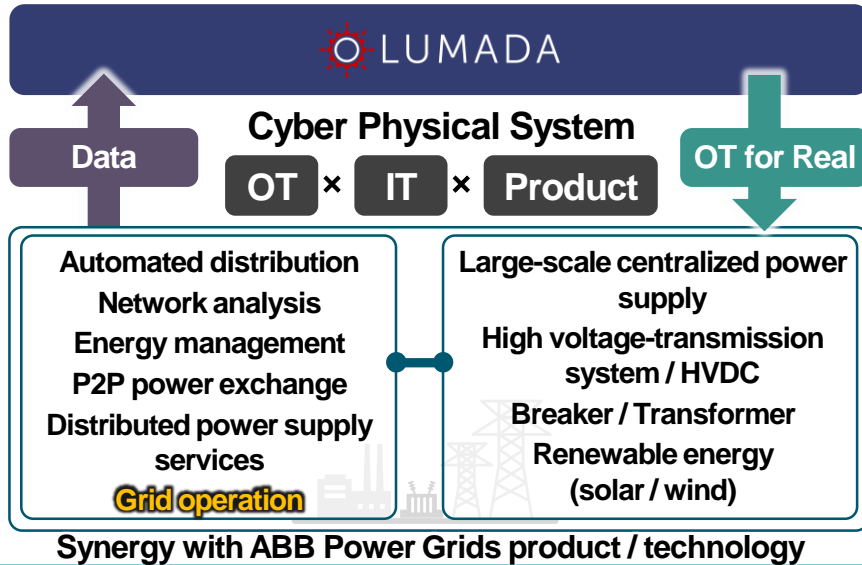
## Highly efficient & stable energy supply for a renewable energy era

EU·JP

### × Lumada

### Energy solution

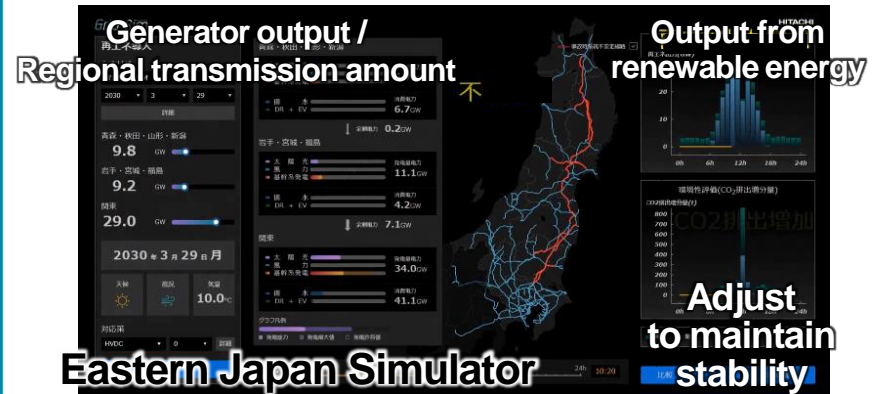
- Expand use of renewable energy to contribute to societal & environmental values
- Create services using on-site expertise & digital technology



### Solution

### Wide-area grid simulator

- Simulate power system stability for upcoming renewable energy utilization policy
- Evaluate practicality and benefit (power generated/environmental cost) of the policy



Collaboration with Hitachi U.Tokyo Lab.

System diagram model was uniquely generated by using public information

**No.1 tech.**

**High-speed grid stability simulator**

## Accelerate customer's innovation with advanced IT

NA • Asia • JP

### Solution Risk Simulator for Insurance

- Apply hospitalization period simulator for the 8 major lifestyle-related diseases in the devt. of insurance services

Life insurance companies		Application example
<b>Input Data</b> <ul style="list-style-type: none"> <li>Health check results</li> <li>Health disclosure</li> </ul>	<b>Value proposition</b> <ul style="list-style-type: none"> <li>Optimization of acceptance criteria</li> <li>Development of new product</li> </ul>	<ul style="list-style-type: none"> <li>Health insurance association</li> <li>Healthcare industry</li> <li>Financial institution</li> </ul>

**Payment risk analysis and prediction AI**

**Risk Simulator for Insurance**

**No.1 tech Payment risk analysis & predictive AI**

### Solution e-government & e-payment India • NA

- Create digital infrastructure business aligned with policy
- Expand opportunity for fee-based business from payment platform

**India**

2021 **Smart Life**

2019 **Smart payment**

Digital administration / Education

**e-Governance PF**  
(Collab. with Hitachi MGRM Net)

Digital payment / Digital payment analysis

**Next-generation Digital Payment PF**  
(Collaboration with SBI)

SBI's customer channels × Hitachi's AI platform

**NA**

**BPM solution using blockchain**  
(Hyperledger co-creation)

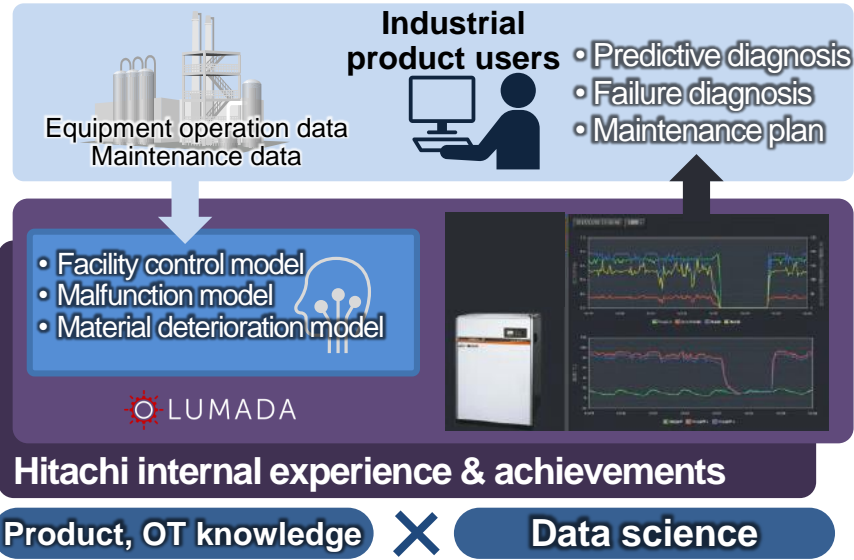
**No.1 tech PBI, Digital trust technology**

# 3-7 Core technology for Lumada (1)

## Core technology to link cyber space and physical space

### Predictive Failure Diagnosis for Industrial Equipment

Use AI based on OT knowhow, product design & maintenance technology to diagnose failure prediction



### Video and voice analysis

Realize people flow analysis, search & tracking by real-time analysis of facility or station camera images



Media processing

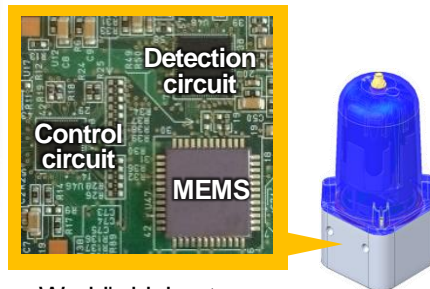
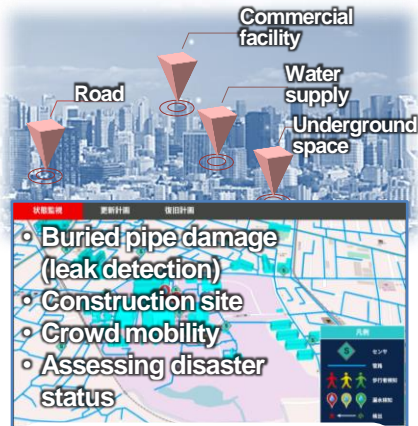
Field demonstration

## Core technology to link cyber space and physical space

### Sensing

Ultra-sensitive vibration sensor technology measuring minute changes in state in large spaces (>100m)

Digital city monitoring / super sensitive vibration sensor



• World's highest sensitivity\* (15ng/√Hz)  
Wide sensing range (> 100m)

Data analysis tech.

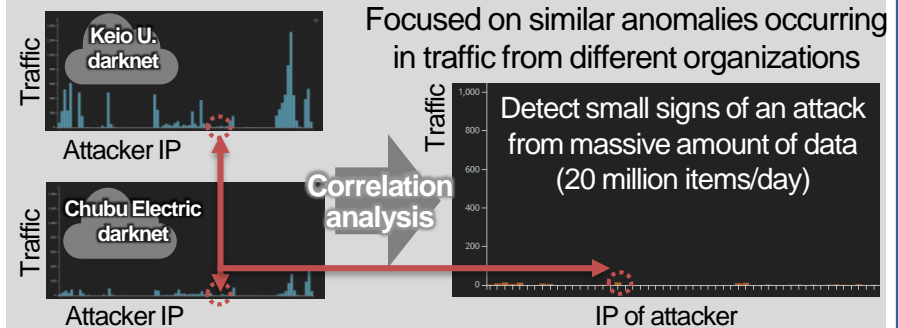


Semiconductor device tech.

### Security

Distributed security operation technology detecting and averting cyber attacks

#### Security integrated monitoring



Shared analytics & countermeasures to raise regional security

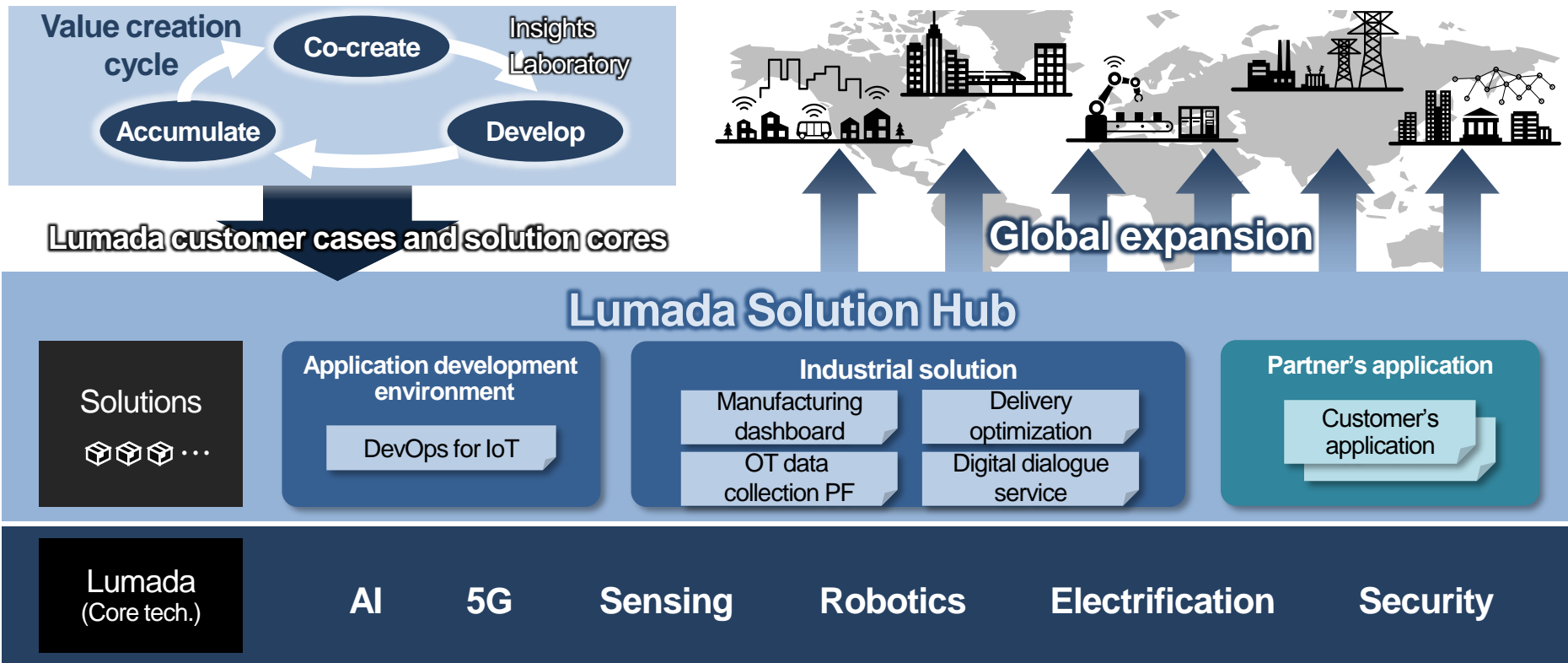
Darknet transmission: Transmission to an Internet address which is not designated to a specific computer

Hitachi: Security tech.



Keio U., Chubu Electric

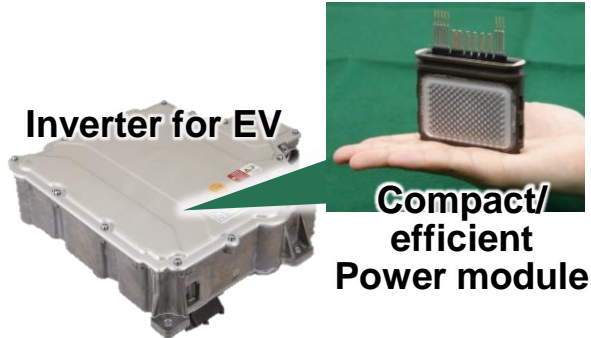
## Globally scale the developed solution cores



# 3-10 No.1 technologies for products (1)

## EV component (Inverter)

Double-sided cooled power module realizing world's highest-class power density\*1 in EV inverter



**Compact/  
efficient  
Power module**

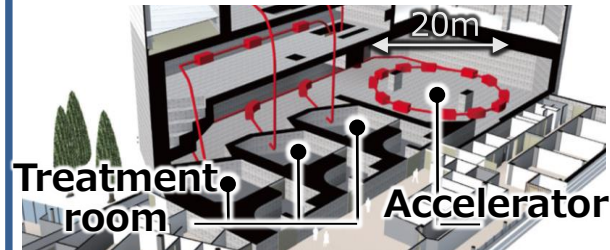
**Power density:  
160% of conventional**

**No.1  
tech.**

**Inverter cooling  
implementation**

## Particle beam therapy system

Realized world's smallest accelerator\*2 for heavy ion beam therapy system, and high-precision particle beam irradiation



**Heavy ion beam  
therapy system  
「HyBEAT」**



**No.1  
tech.**

**Particle beam  
trajectory control**

## Blood analyzer

All-in-one device combining biochemical, immunological and blood coagulation time analysis



**All-in-one  
automated blood analyzer**

**No.1  
tech.**

**Scattered light measurement  
/ contactless small amount  
stirring**

\*1 Output power density 54.3kVA/L (as mass production) \*2 Accelerator perimeter 56.8m (Smallest for heavy ion beam, 2019/6 Hitachi survey)

\*3 The system design, manufacturing and verification was realized with review and advice from QST.

(QST: National Institutes for Quantum and Radiological Science and Technology)

# 3-11 No.1 technology for product (2)

## Global rolling stock

Used design technology & analysis-led design for interior & exterior design to accelerate the development of rolling stock attractive to multiple regions worldwide

**No.1 tech.**

**Design concept and verification**



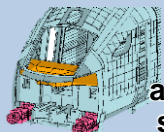
- 2019 National Commendation for Invention, The Imperial Invention Prize
- 48<sup>th</sup> Japan Industrial Techniques Grand Prix - Judges' Special Prize
- Good Design Award 2016
- Good Design Award 2018

### Lead vehicle design and safety/running performance

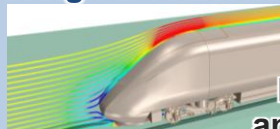


Analysis-led design

for smooth aerodynamic design & collision safety



Impact absorbing structure



Fluid analysis

### Interior design and comfortability

Assessment & validation from passenger perspective using VR of interior and temperature distribution analysis to increase comfort



Temperature distribution

# Contents

---

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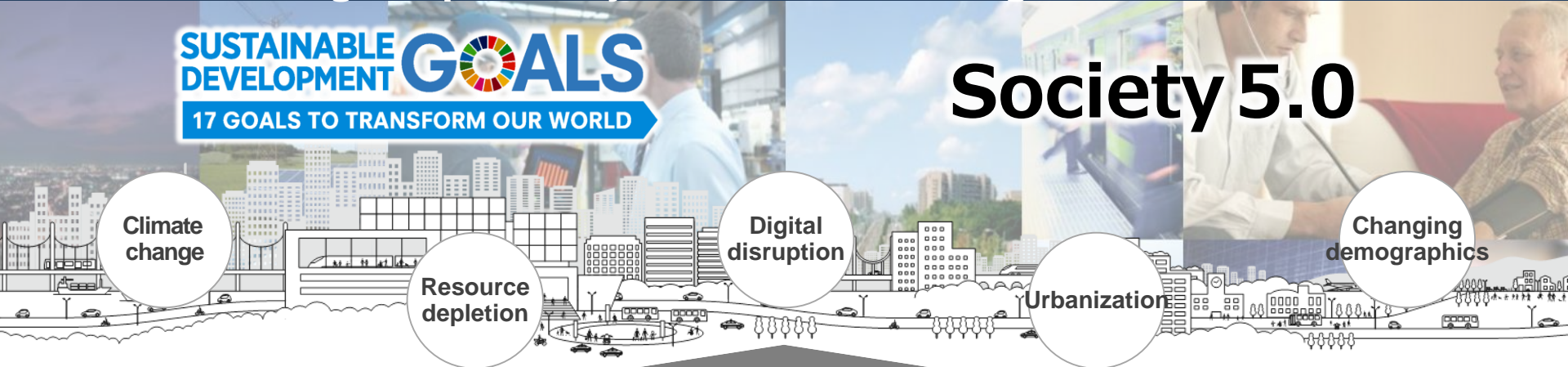


# 4-1 Promote exploratory research to resolve societal issues

Explore disruptive technology and business opportunities through exploratory research resolving societal issues



## Society 5.0



### CER research fields

Information sciences

Life sciences

Material sciences

Frontier

### Joint research sites

Hitachi U.Tokyo Lab

Hitachi Hokkaido U. Lab

Hitachi Kyoto U. Lab

Hitachi Kobe Lab

Hitachi Cambridge Lab

Tsinghua U. Lab

### Open innovation ecosystem

Research institutes

Public-Private initiatives

Academia

# 4-2 Sharing visions of the future globally

## Working with academia to globally share visions of societal and environmental value

**U.Tokyo Lab.** - Societal implementation of “Habitat Innovation”  
- Energy policy proposal



Demonstrate data-driven city planning with citizen participation

**Tsinghua Univ. Lab** Drive innovation in “digital city” and “energy,” and deploy globally



Create visions in China’s innovation ecosystem

**Kyoto U. Lab.** - Explore science for policy making  
- AI ethics proposal for human centric society



Foster values that harmonize economy, Nature and society, and validate in regional business

**WEF C4IR** Build consensus on international rules with leading partners and advanced regions



To realize “Data Free Flow with Trust”

\*World Economic Forum: White paper “Inclusive Deployment of Blockchain for Supply Chains,” 2019

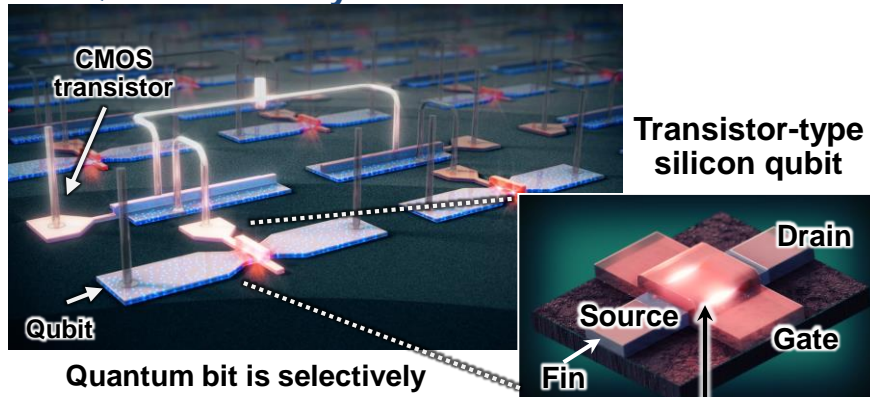
# 4-3 Creating disruptive technology

Hitachi Cambridge Lab

Silicon-based quantum computer

Realized qubit selection control using hybrid circuits toward commercial quantum computer using Si-based qubits enabling large scale integration

## Qubit/CMOS hybrid circuit



Quantum bit is selectively controlled via CMOS transistor

Spin quantum dots

Published in the June issue of Nature Electronics

"A CMOS dynamic random access architecture for radio-frequency readout of quantum devices", Nature Electronics vol. 2, pp. 236–242 (2019).

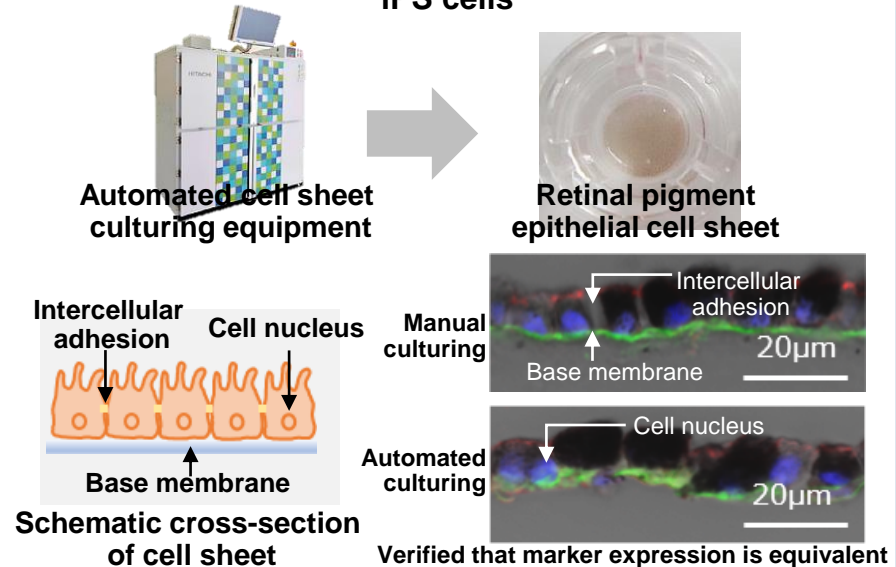
Partner: Cambridge Univ., LETI

LETI: Laboratoire d'électronique des technologies de l'information

Hitachi Kyoto U. Lab

Regenerative medicine

Succeeded in the world's first automated culture of retinal pigment epithelial cell sheets derived from human iPS cells



A part of the development of the automated cell sheet culturing equipment was implemented with support from the National Research and Development Corporation New Energy and Industrial Technology Development Organization (NEDO) and the Ministry of Education, Culture, Sports, Science and Technology.

Partner: RIKEN

# Contents

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1. Vision for 2021MTP
2. Strengthen global co-creation of solutions
3. Generate world No.1 technology for solutions/products
4. Promote exploratory research resolving societal issues
- 5. Summary**

Become a global innovation leader in SDGs, Society 5.0

To improve the Quality of Life and add values for customers

Society 5.0

SDGs

Social innovation by Lumada

Newly established  
corporate  
venturing fund



Open labs  
(U.Tokyo, Kyoto U.,  
Hokkaido U.,  
U.Cambridge, Tsinghua U.)  
/ WEF-C4IR

*Hitachi Social Innovation is*

**POWERING GOOD**

**HITACHI**  
Inspire the Next 