HITACHI
Inspire the Next

2018 R&D Strategy

Driving the evolution of Hitachi towards further globalization

28 June 2018

Norihiro Suzuki, Ph.D.

Vice President & Executive Officer
Chief Technology Officer
General Manager, Research & Development Group
Hitachi, Ltd.

R&D 100th Anniversary

~ New challenges for the next 100 years ~

Mission

Contribute to society through the development of superior, original technology and products

Hitachi Founding Spirit

Harmony・Sincerity・Pioneering Spirit

For invention and discovery

“We must have the ethos of those entering a deep untrodden mountain”

(Quote from article in Tokyo Asahi Shimbun, 1930)

Founder & First Director of the Research Unit

Namihei ODAIRA

First General Manager of the Hitachi Research Laboratory & the Central Research Laboratory

Kumeo BABA

HITACHI
Inspire the Next

Contents

HITACHI
Inspire the Next

Contents

HITACHI
Inspire the Next

An Innovation Partner for the IoT Era

Accelerate collaborative creation with customers through advanced Social Innovation Business

Four Focus Business Domains

Power・Energy

Industry・Distribution・Water

Urban

Finance・Social・Healthcare

Growing need for Social Innovation Business

The United Nations has adopted "SDGs."

It is now the challenge for global enterprises to realize an "Inclusive Society" and their own business growth.

SDGs market: USD 12 trillion/year
(Forecast up to 2030)*

IoT: Internet of Things, SDGs: Sustainable Development Goals
* BSDC "Better Business, Better World"

1.2 FY2018 R&D Group organization

HITACHI
Inspire the Next

Global R&D driving new growth in Social Innovation Business

N.Suzuki
Vice President
CTO
GM of R&D Group

Technology Strategy Office
Global R&D Strategy

M.Akatsu
GM & Head of Strategy Planning Center

Global Center for Social Innovation (CSI)
Global co-creation to create service business

K.Funaki
GM

Center for Technology Innovation (CTI)
Technology PF for product & service business growth

M.Aoki
GM

Y.Yagawa
Deputy GM

S.Sameshima
Deputy GM

Center for Exploratory Research (CER)
Open innovation to resolve future challenges in society

S.Yamada
GM

Newly appointed Hitachi Fellow

Kazuo Yano

April 2018 ~
(Artificial intelligence)

Newly appointed Corporate Scientist

Shizu Takeda

April 2018 ~
(Regenerative medicine)

PF: Platform

1.3 R&D for Social Innovation Business

HITACHI
Inspire the Next

Hitachi's Social Innovation Business

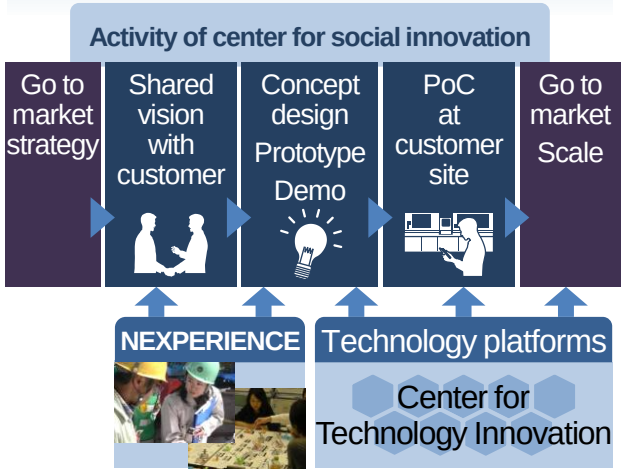
- For a sustainable society
- Co-create digital innovations with customers
- Global deployment of solutions

Step 1 (FY2015～)

Co-create with customers

Estab. global CSI structure

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

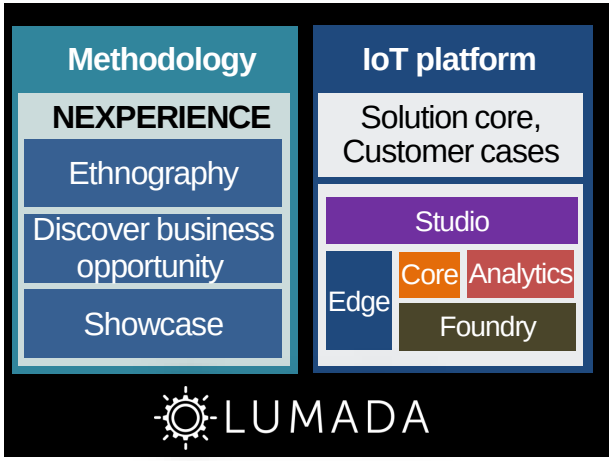


Step 2 (FY2016～FY2017)

Digital innovation

Co-creation using Lumada

- Utilize NEXPERIENCE
- Increase customer cases & solution cores
- Develop AI/IoT tool sets

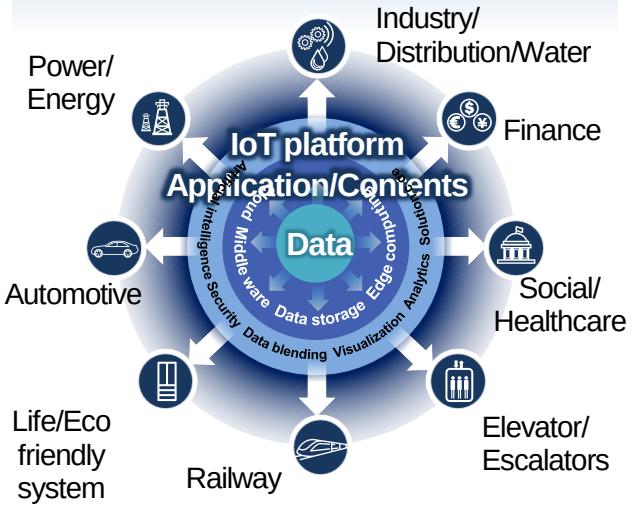


Step 3 (FY2018～)

Scale up globally

Accelerate with open innovation

- Expand co-creation centers
- Establish industry-government-academia eco-system



AI: Artificial intelligence, IoT: Internet of Things

1.4 Enhancing global co-creation

HITACHI
Inspire the Next

Utilize regional co-creation centers to contribute to Lumada business


Mori GM

CSI-Europe


Chen GM

CSI-China

CSI-Tokyo


Kitagawa GM


Saikalis GM

CSI-North America

CSI-APAC


Harada GM

December 2017
New Beijing office & co-creation space,
New Open Automation Lab in Guangzhou

GM: General Manager

1.5 Contributing to Lumada business

HITACHI
Inspire the Next

		FY2016		FY2017		FY2018
R&D Group	Number of NEXPERIENCE customer cases	175	»	502	»	1,000
	Number of Lumada customer cases (R&D Gr/ Hitachi Gr)	9 /200	»	98 /500+	»	150
Hitachi Group	Lumada core business revenue (JPY 100 billion)	1.2	»	2.3	»	3.1
	Lumada business revenue (JPY 100 billion)	9.0	»	10.1	»	10.7

1.6 World's No.1 technology through co-creation

HITACHI
Inspire the Next

World-leading products & services through No.1 technology for societal needs

Railway systems

Autonomous decentralized system/
Analysis lead design

High-speed elevators

World's fastest elevator*1
1,260m/min.
2 June 2017
News release

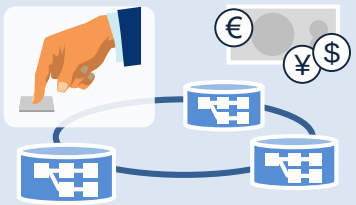
Streamlined car structure

Particle beam therapy*2

Tumor tracking /
Spot scanning irradiation

■ Focus area

Block chain

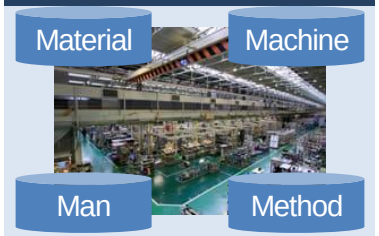


Service for supply chains

Autonomous driving

Connected car

Smart Manufacturing



Digital solutions for manufacturing sites

AI

Maintenance & Repair

Robotics

Service-support robot

Develop world No. 1 technology through open innovation

*1 June 2018 Hitachi internal survey
V2V: Vehicle-to-vehicle
*2 A part of this technology was developed with the Hokkaido University Graduate School of Medicine under the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program) initiated by Council for Science and Technology Policy (CSTP) of the Cabinet Office, Japan.

1.7 Allocation of R&D Group funds

HITACHI
Inspire the Next

Strengthen R&D investment in digital solutions and open innovation

Step 1 (FY2015～)
Co-create with customers

Increase co-creation funds
➔ Improve product/service success rate

New organization from FY2015

CSI: Co-creation	500 HC*1
CTI: Technology	2,000 HC
CER: Exploration	100 HC

Step 2 (FY2016～FY2017)
Digital innovation

Expand investment in Lumada
➔ **Leverage digital for increased efficiency**
Accelerate global deployment

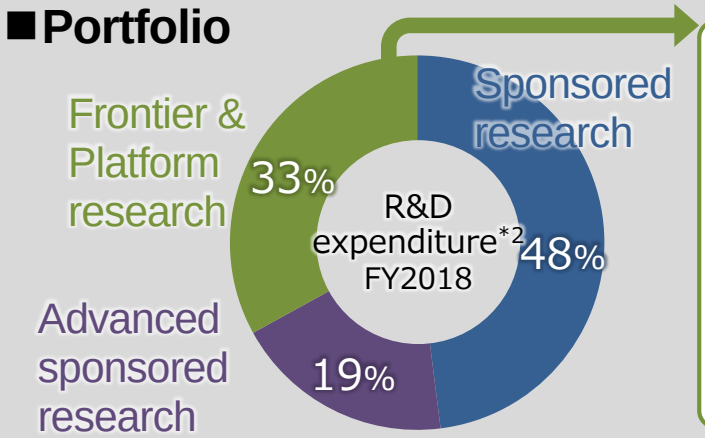
CER
CTI Tech Platform
CSI NA
CSI EUR
CSI APAC
CSI CHN
CSI TKY
Insights Laboratory

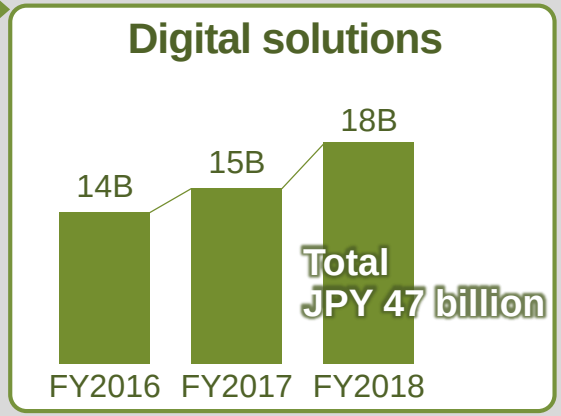
Step 3 (FY2018～)
Scale up globally

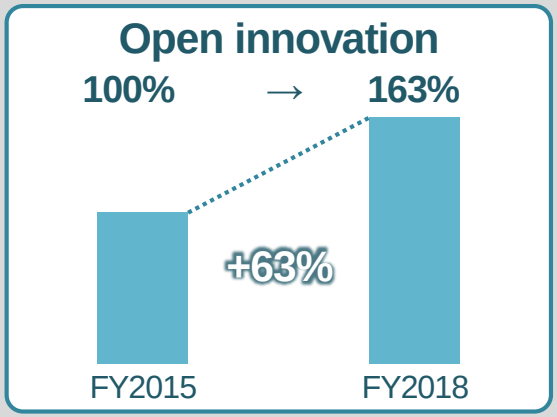
Expand investment in open innovation to build eco-systems

Partners
Hitachi
- Stanford University/U. Tokyo, Kyoto U., Hokkaido U.
- Hyperledger/ Edgecross Consortium
- ⋮

■Portfolio







*1 Outside of Japan included
*2 Roughly 20% of total Hitachi Gr. R&D expenditure

1.8 Digital transformation in R&D

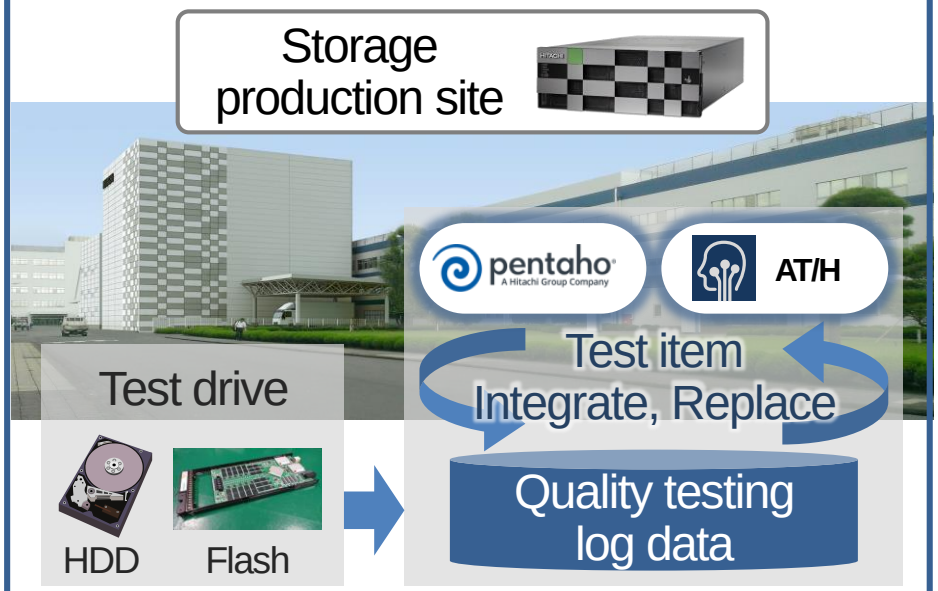
HITACHI
Inspire the Next

Drastically reduce product development time with Lumada & AI

Improved productivity in storage

Optimize test process by analyzing vast inspection item data using AT/H

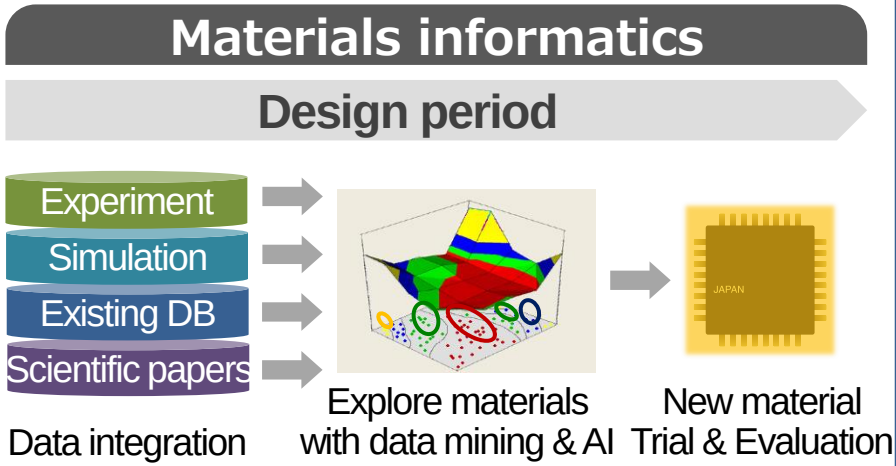
Drive testing time	75% improved Conv. Method 196hrs ➡ 49hrs



Improved development efficiency in innovative materials

Highly efficient design & devt. of innovative materials with material informatics (MI)

Materials design time	80% improved Conv. method 24 mos. ➡ 4 mos.



Examples of innovative materials
- Semiconductor sealing material
- Lead-free solder, etc.

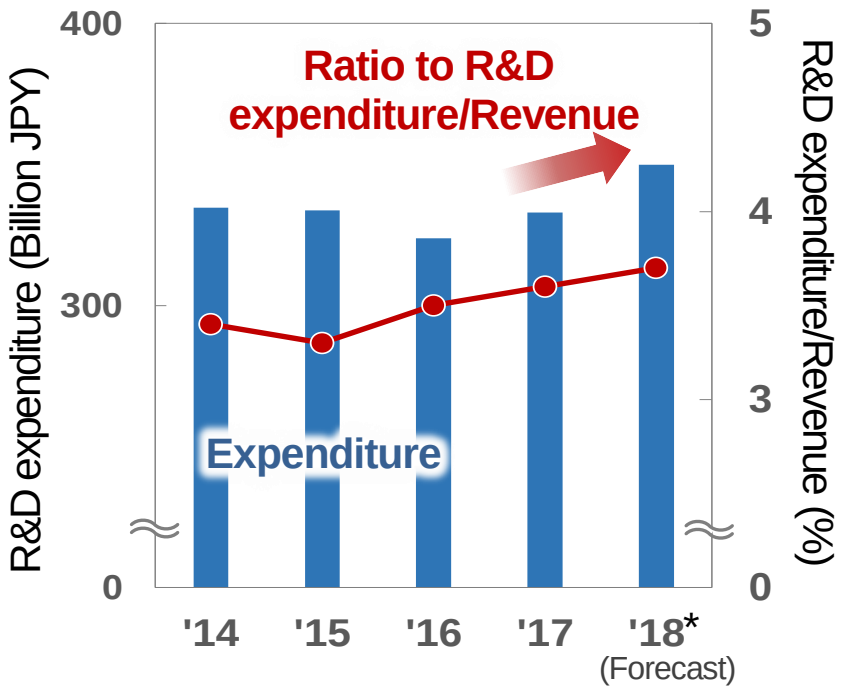
AT/H: Hitachi AI Technology/H, MI: Materials Informatics

1.9 Hitachi Gr. investment in R&D

HITACHI
Inspire the Next

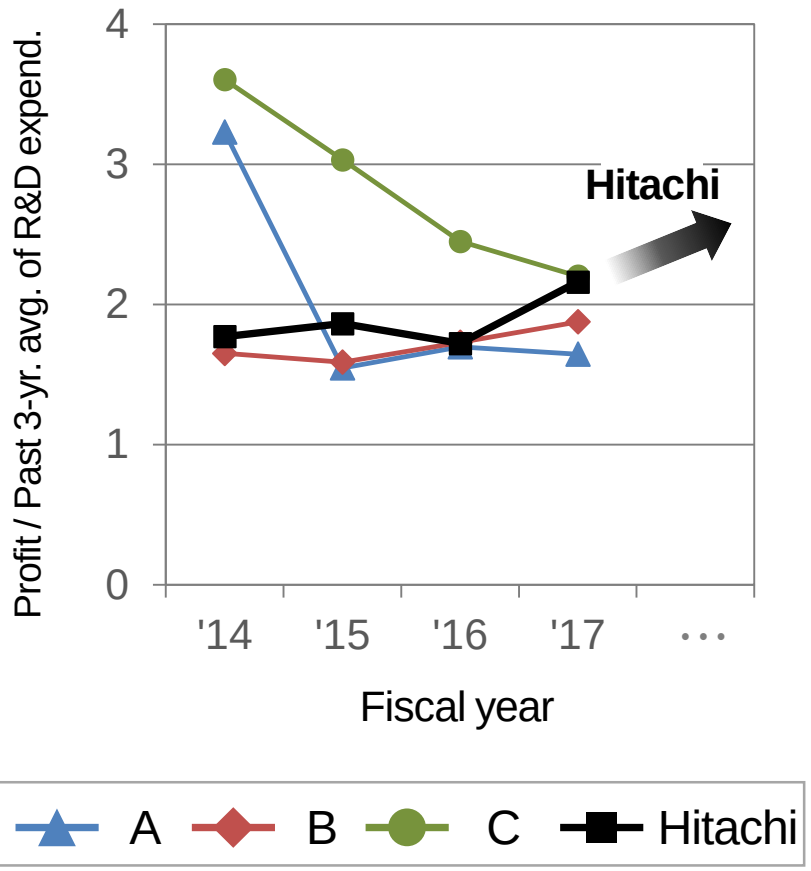
Raising R&D efficiency to contribute to Hitachi's profitability

Investment in R&D



Adjusted operating income ratio to revenue (%)	'14	'15	'16	'17	'18*
	6.6	6.3	6.4	7.6	8.0*

R&D efficiency



*Forecast figure for FY2018

1.10 Major awards and recognitions

HITACHI
Inspire the Next

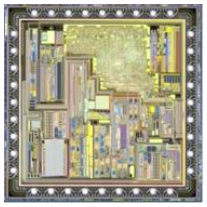
Major products & services awarded external recognitions especially in the Four Focus Business Domains

Four Focus Business Domains

Oil-free scroll compressor*1 w/ integrated amorphous core motor

Japan Industrial Technology Award: Grand Prix, Prime Minister's Prize

IoT sensor



Monodzukuri Nippon Grand Award: Prime Minister's Prize

Particle beam therapy equipment*2

National Commendation for Invention: Imperial Invention Prize

iPS cell mass culture equipment*3

Nikkan Kogyo Shimbun Best Ten New Products Award

Platform

IoT platform

LUMADA

2018 IoT Breakthrough Award Enterprise IoT
MMRI award 2017

Products/Materials

Immunodiagnostic Analyzer e801

Okochi Memorial Technology Prize

Image processing module for home air-conditioner

Image processing module
Infrared LED, image/temperature camera

"Cho" Monodzukuri Innovative Parts and Components Award: Joint Chairs' Prize

Dedicated battery for "idling-stop"

JACI GSC Award: Minister of METI Prize

Design

Vision Design PJ

iF Design Award 2018: "Professional Concept" discipline

Yokohama Open Lab.

30th Nikkei New Office Awards: New Office Promotion Prize

*1 A part of this work was supported by The New Energy and Industrial Technology Development Organization (NEDO), Japan, program for the development of practical technology to substitute or reduce rare metals. In the practical implementation phase, technology was developed to respond to the need for further reduction in power consumption.
*2 A part of this technology was developed with the Hokkaido University Graduate School of Medicine under the FIRST Program initiated by CSTP of the Cabinet Office of Japan.
*3 A part of this research is supported by the "Project focused on developing key evaluation technology: Evaluation for industrialization in the field of regenerative medicine" from Japan Agency for Medical Research and development (AMED).
iPS: induced pluripotent stem, GSC: Green Sustainable Chemistry

1.11 Basic stance in FY2018

HITACHI
Inspire the Next

Become a global innovation leader to drive the evolution towards a global company

Hitachi challenge		Directives
Monetizing capability aimed at creating SIB	»	**Enhancing co-creation of global solutions** • From individual solution to connected industries • Focus on growth domains & regions
Increasing world-leading products and services	»	**Creating and focusing on world-leading technology** • Create top technology to support SIB • Accelerate open innovation
Participating and engaging with global communities	»	**Promoting basic research to resolve societal issues** • Create disruptive technology • Create visions to lead Society 5.0

SIB: Social Innovation Business

HITACHI
Inspire the Next

Contents

2.1 Co-creating global solutions

HITACHI
Inspire the Next

Expand co-creation in Social Innovation Business and strengthen global deployment

Directive

1. Expand from point solutions to “Connected Industries”
2. Focus globally on growth areas & societal issue

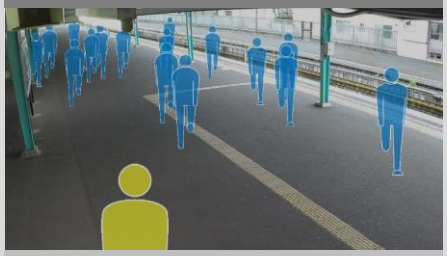
FY2017 results and next steps

■FY2017 results

Video analytics solution

Daikin, Daicel, et al

People flow visualization



Tokyu, et al

Fleet management

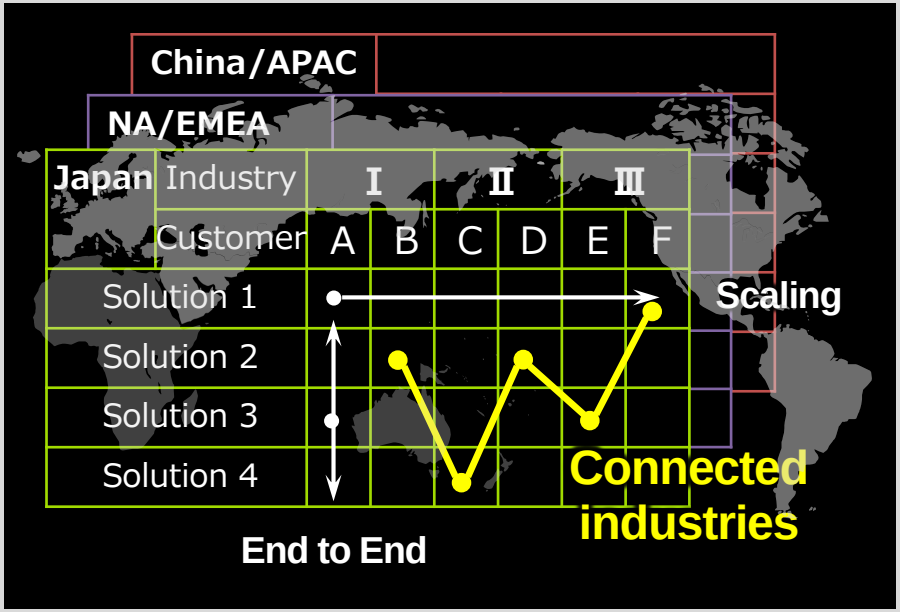
Penske

Logistics solution

MonotaRO, et al

■Global CSI’s next initiative

Lead business model development for “Connected industries” solutions



Daikin Industries, Ltd., Daicel Corporation, Tokyu Corporation, Penske Corporation, MonotaRO Co., Ltd., NA: North America

2.2 “Connected Industries” solution examples

HITACHI
Inspire the Next

Finance × Healthcare
(Dai-ichi Life Insurance)

Accurately estimate risk of hospitalization from lifestyle-disease assessment models to expand insurance subscription

Establish appropriate insurance underwriting standards

↓

Increase in new subscribers
300+ subscribers/ month

Dai-ichi Life

10 million people

- Contract/payment data
- Know-how in insurance services

Hitachi

AI

- Analytics for medical cost estimation
- Know-how in diabetes prevention services

Medical big data AI

Assessment model

Industry × Finance
(Mizuho Financial Group)

Manage & share global supply chain data, to agilely respond to financing needs

SMEs

Mgmt. efficiency, Financial services

Order/Purchase information

Mizuho×Hitachi

Supply chain Finance

Hitachi

Reflect order/ purchase info. in operations

Weekly/Monthly

↓

Real-time

Past record, know-how

Operation

Blockchain PF

Design & mfg. site A

Design & mfg. site B

- Improve efficiency in procurement and inventory management
- Rapid decision-making in ordering /purchasing

2.3 Focus on growth area & regions (1)

HITACHI
Inspire the Next

NA

Industry: Industrial equip., Mnfg./Mobility solutions
Finance: Financial system integration

- Expand from maintenance to mobility services
- Blockchain validation & business deployment

Blockchain

Verification by customer using advanced analytics technology

Financial Innovation Lab.

Case example: Public notary service

Workflow mgmt. | Agreement record mgmt. | Credit analysis | …

Advanced analytics tech

Collaboration with Stanford Univ.

Academia

Auditable blockchain (on Cloud)

HYPERLEDGER

OSS community

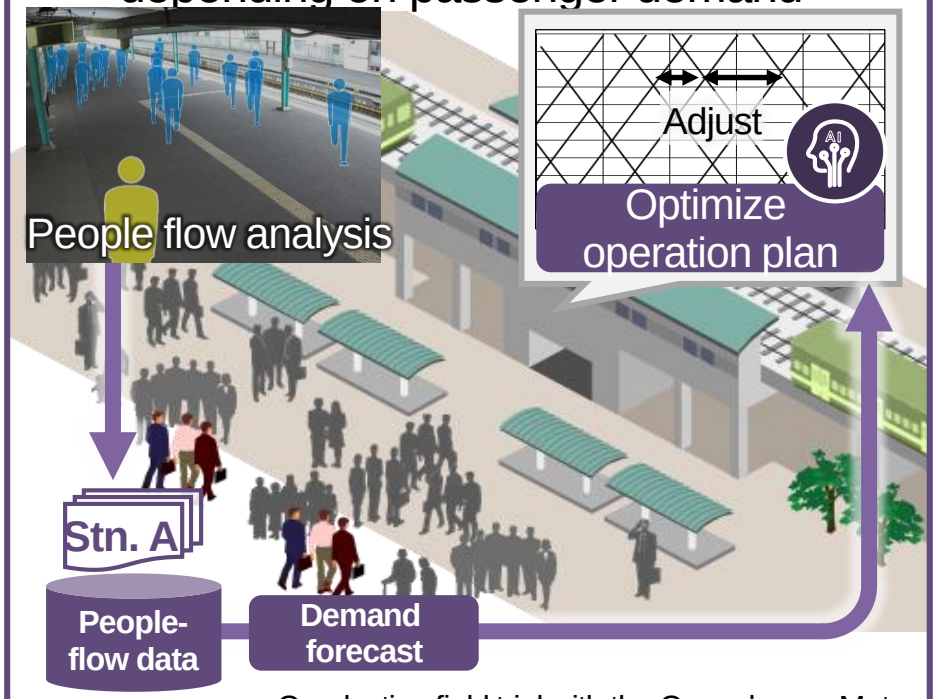
EMEA

Urban: Railway systems, Railway digital solutions

- Expand from railway carriages & signals to service business

Dynamic Headway Solution

Optimization of train operations depending on passenger demand



Conducting field trial with the Copenhagen Metro

SI: System integration, OSS: Open source software

2.4 Focus on growth area & regions (2)

HITACHI
Inspire the Next

China

Healthcare: Elderly nursing
Urban: Digital solution for buildings

- Expand digital business for Healthy China 2030
- New elevator/escalators, maintenance and digital solutions

Digital care management

Increase sophistication by monitoring brain/bodily functions, and future prediction

Hospital
- Improved medical checks

Medical data

Nursing care
- Improved service
- Prevent accidents

Nursing data

Home
- Quality care

Life data

Hitachi

Predict risk or change in condition

Analysis of brain/bodily functions

Optical Topography

Image analysis of walking

Know-how through PoC with Sino-Fortune Senior Industry Development (Tianjin) Co., Ltd.

APAC

Industry: Manufacturing solution
Financial/Social: Digital infrastructure

- Digital infrastructure business w/ govts.
- Digital business focusing on Thai mnfg.

Digital India

Digitalization of govt. services through co-creation with MGRM

Municipal government/School

Hitachi MGRM Net

e-Governance

2.5 Global deployment of Social Innovation Business

HITACHI
Inspire the Next

Power • Energy

Industry • Distribution • Water

Urban

Finance • Social • Healthcare

LUMADA

EUR

- Railway systems/ Railway digital solutions

CHN

- Elevators & Escalators /Building-related digital solutions
- Healthcare solutions

Asia

- Financial & Societal solutions
- Industrial equipment & Mnfg. Solutions
- Elevator & Escalators /Building-related digital solutions

NA

- Financial SI
- Industrial equip. & Mnfg. solutions
- Mobility solutions

Accelerate global deployment with Hitachi Global Digital Holdings

HITACHI
Inspire the Next

Contents

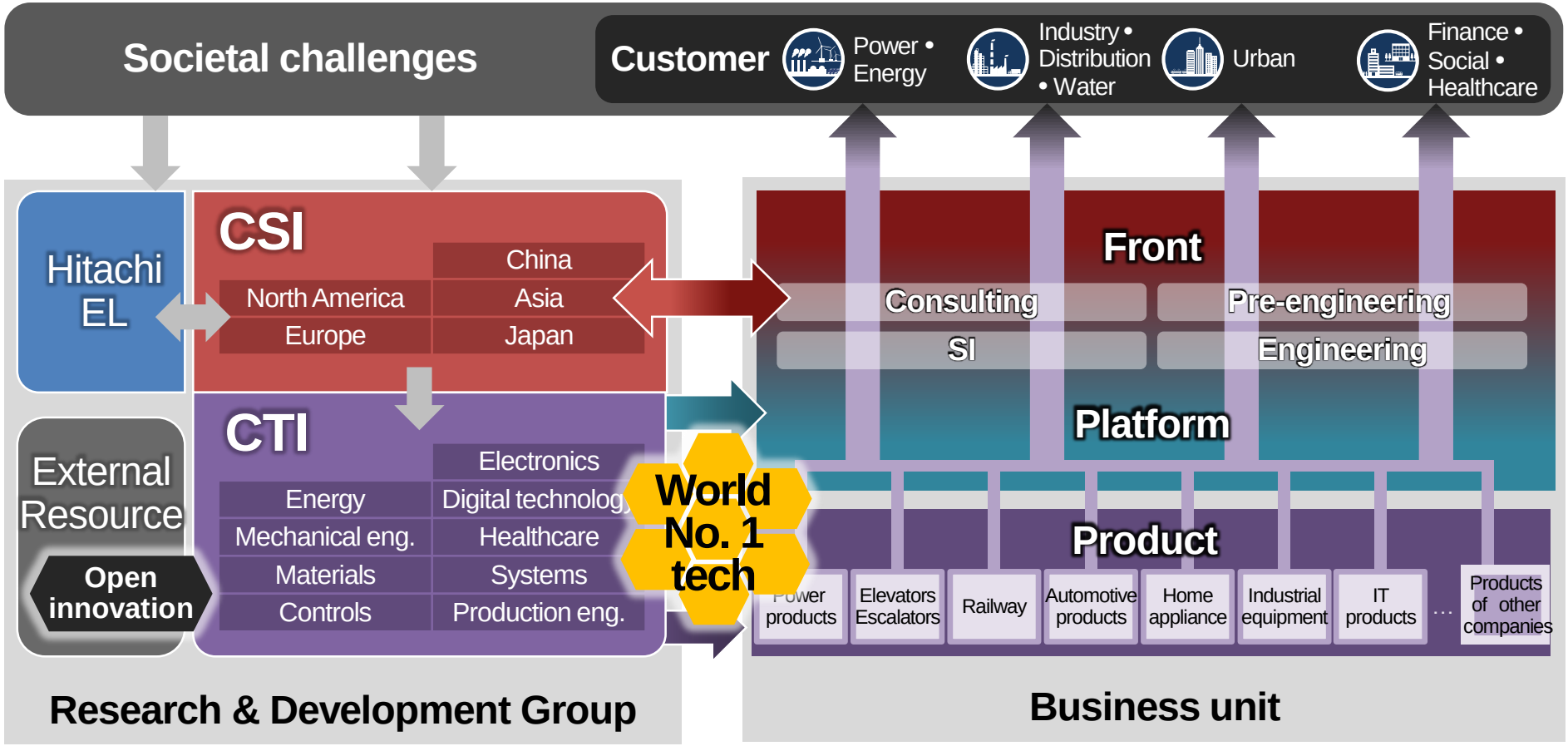
3.1 Technology for world No. 1 Products & Services

HITACHI
Inspire the Next

Create world No.1 technology platforms based on societal challenges faced by customers

Policy

1. Create world No.1 technology to lead Social Innovation Business
2. Further accelerate open innovation



EL: Embedded laboratory, BU: Business Unit

HITACHI
Inspire the Next

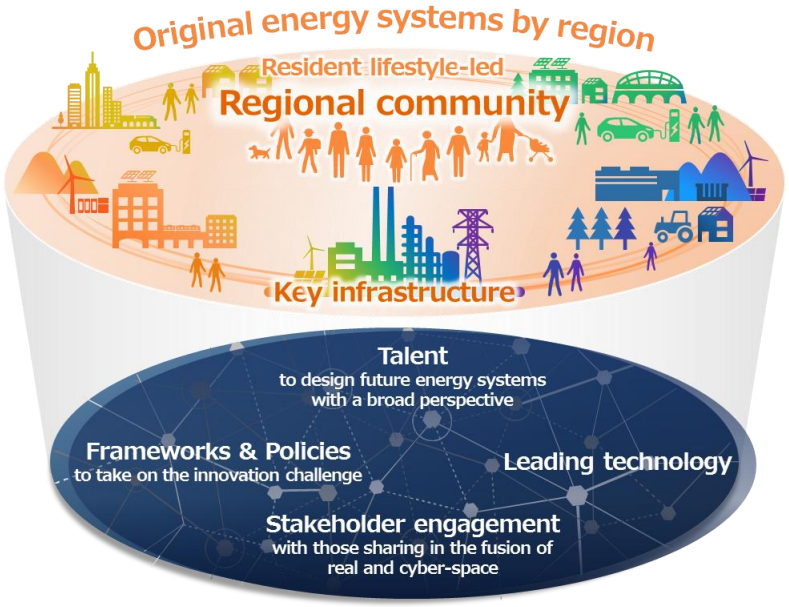
Proposing an energy system to support Society 5.0

Future energy system

Cooperative mechanisms integrating diverse distributed resources with the core systems in regional communities

Hitachi U.Tokyo Lab. Energy Forum*

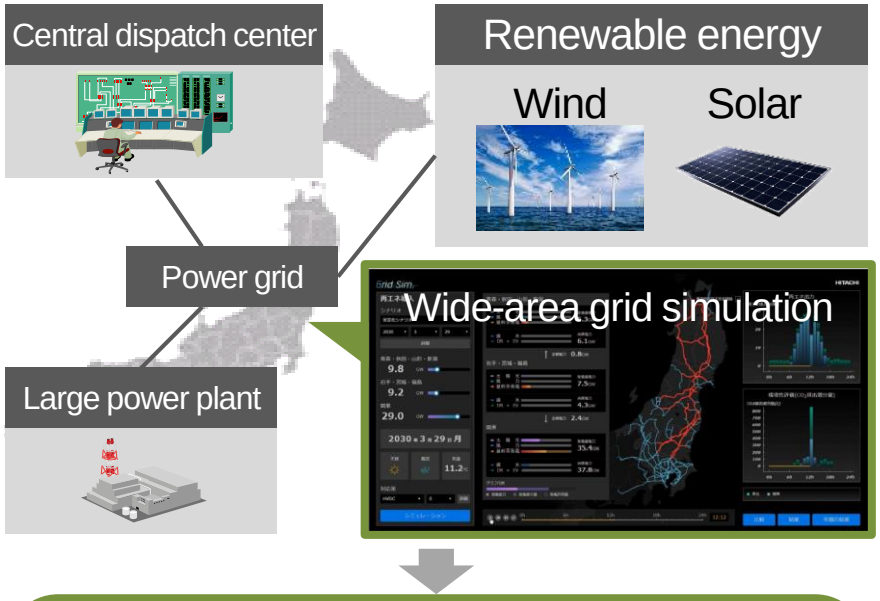
"Towards the realization of a energy system supporting Society 5.0"



No. 1 Tech: Power grid control

An analytical tool assessing grid stability taking into account supply-demand balance and grid failure

Wide-area energy grid simulator



Asses renewable energy power output necessary to maintain stable power grid

*Held on 18 April 2018

HITACHI
Inspire the Next

Optimize the total value chain from production to logistics sites

Smart production / distribution

- Accumulate successful in-house smart manufacturing solutions & deploy externally
- Visualization & increased efficiency of the total supply chain

Examples of external deployment

No.1 Tech: Robot autonomous cooperation

Realize both flexibility and increased productivity by cooperation between operators and different types of robots

Autonomous cooperation between robots

Group control based on autonomous cooperation

Free layout + Improve productivity

Deployed in manufacturing & logistics sites

Autonomous cooperation between AGV & picking robot

Free routing + 38% ↑ processing speed

Collaboration with Hitachi Transport and U.Edinburgh

Okuma Corporation, Amada Co., Ltd., MonotaRO Co., Ltd.
AGV: Automated Guided Vehicle

Hitachi Transport System, Ltd.

HITACHI
Inspire the Next

Design and control technology for mobility systems and solutions

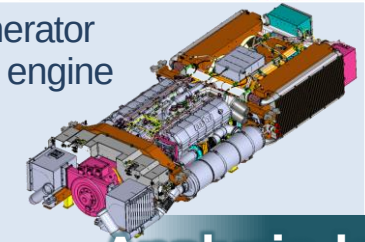
Railway carriage

Delivery of bi-modal (electric/diesel) high-speed railway carriages for GWR (UK); operation commenced

No.1 Tech: Analysis-led design

Elemental development → Carriage development → Experiment & certification → Operation

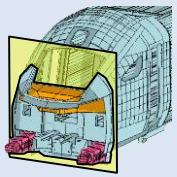
Generator with engine



Running test

Analysis-led design

Shock absorbing structure



Train bogie

Operations commence for high-speed IEP ['17/10]

Autonomous driving

V2X cooperative control for autonomous driving tested in Europe, USA and Japan

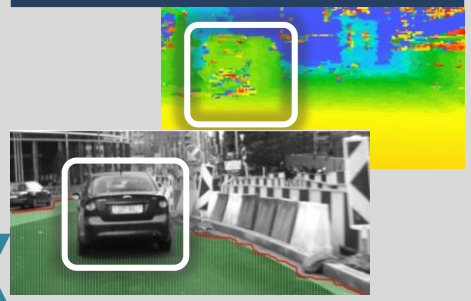
No.1 Tech. : Cooperative control

Demonstrate autonomous driving through OI

Europe: AutoNet 2030

USA: U. Michigan MTC

Stereo camera



Surround view camera

GWR: Great Western Railway, IEP: Intercity Express Programme, V2X: Vehicle to X, MTC: Metropolitan Transportation Center

HITACHI
Inspire the Next

New services utilizing digital technology to improve safety and convenience

Cyber-security

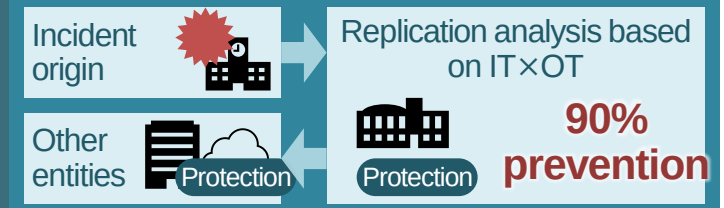
Collaborate with Keio U. et al to promote cybersecurity for social infrastructure

No.1 Tech: Distributed security operations

Realizing prompt response by sharing data necessary to cope with incidents, and task allocation in case of attack

Attack simulation to increase protection

Hitachi core tech



Ultrasound diagnostic equipment

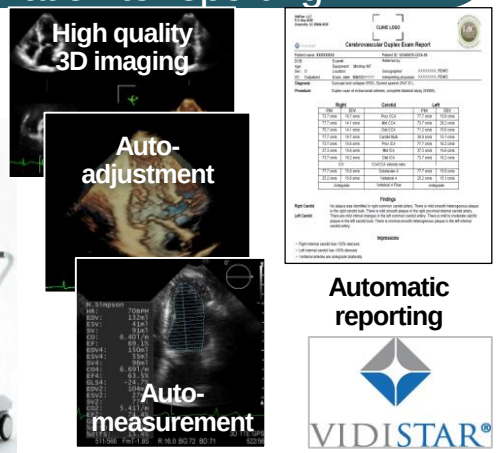
Reduce physical burden on patient and improve hospital examination throughput

No.1 Tech: High definition imaging probe

Skill-independent operation based on imaging probe, auto image adjuster and auto measurement technology

Dramatically shortened time from examination to reporting

High quality 3-D imaging probe



SOC: Security operation center

3.6 IoT platform

HITACHI
Inspire the Next

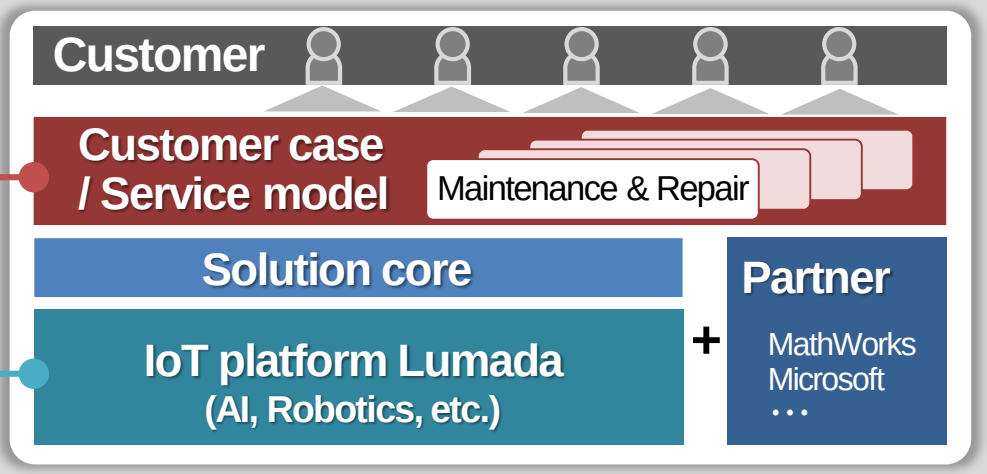
Accelerate global scaling by increasing customer cases & solution cores

Enhancing Lumada through open innovation

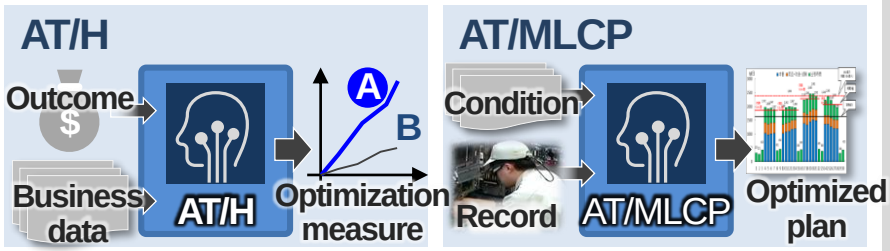
Apply Hitachi OT know-how, AI & robotics technology for global collaboration

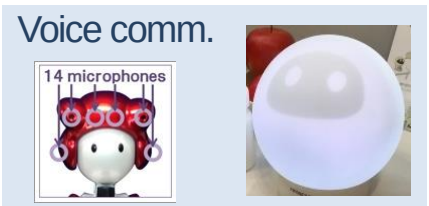
Partnering & HR training

- Collab. w/ MATLAB and Microsoft Dynamics
- 3,000 data scientists initiative [FY'21]



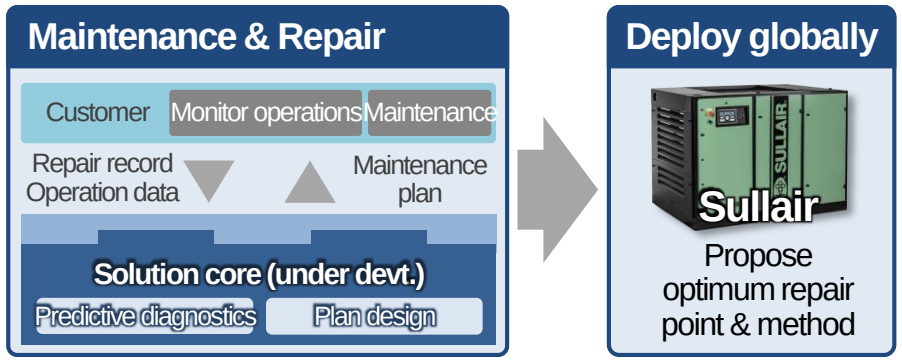
AI, Robotics, No. 1 technology





Case example: Maintenance & Repair

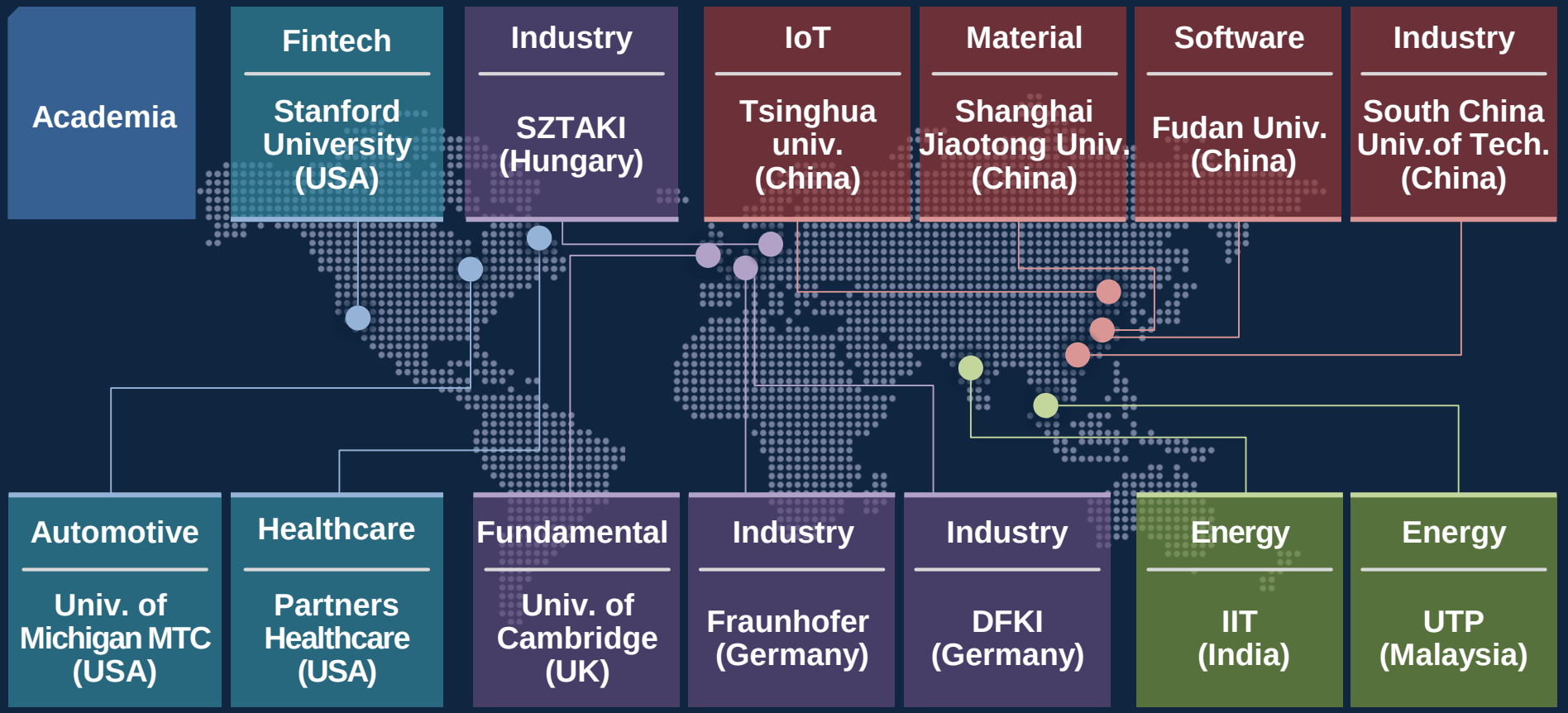
Capture signs of defect for early maintenance using AI founded on OT



HR: Human resource
AT/MLCP: Hitachi AI Technology/MLCP (Machine Learning Constraint Programming)

3.7 Collaboration with academia & startups to enhance disruptive technology development

HITACHI
Inspire the Next



Open community

Blockchain
Hyperledger
Edge computing
Edgecross Consortium

Startup investment

Venture capital

Geodesic Capital
(Silicon Valley)

Focusing themes

Blockchain | **Autonomous driving** | **Smart manufacturing**
AI | **Robotics**

DFKI: Das Deutsche Forschungszentrum für Künstliche Intelligenz, IIT: Indian Institutes of Technology;
MTC: Metropolitan Transportation Center, SZTAKI: Számítástechnikai és Automatizálási Kutatóintézete ,
UTP: Universiti Teknologi PETRONAS

HITACHI
Inspire the Next

Contents

4.1 Strategy to resolve societal issues

HITACHI
Inspire the Next

Create disruptive technology & future vision to solve social issues

Policy

1) Create disruptive technology through open innovation
2) Create visions to lead Society 5.0

SDGs
Sustainable Development Goals

Society 5.0
Human-centric Super Smart Society

CER's research fields

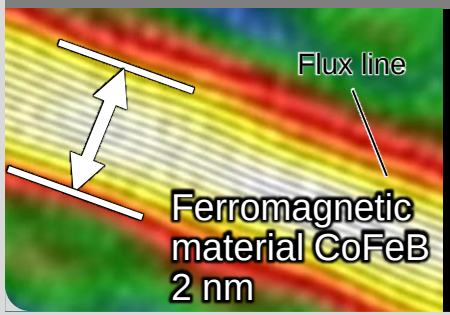
- Information science
- Life science
- Materials science
- Frontier

Joint research center

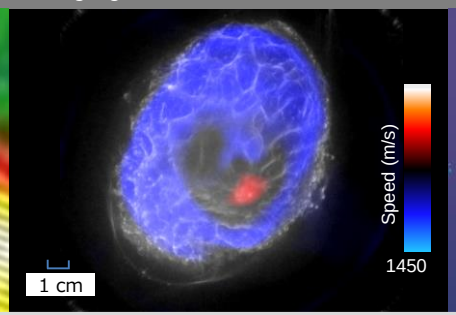
- Hitachi Cambridge Lab.
- Hitachi U. Tokyo Lab.
- Hitachi Hokkaido U. Lab.
- Hitachi Kyoto U. Lab.
- Hitachi Kobe U. Lab.

FY2017 achievements

Ultra-electron microscope[*1]
Top resolution of 0.67nm



Ultrasound CT
Imaging of human breast cancer[*2]



Happiness Planet
Announce happiness vision

Society 5.0 vision
Energy Forum

*1 A part of this research was supported by the FIRST Program initiated by CSTP of the Cabinet Office of Japan, and the CREST Program (Start of Core Research for Evolutional Science and Technology) of the Japan Science and Technology Agency (JST).
*2 Joint research with Hokkaido University CT: Computed tomography

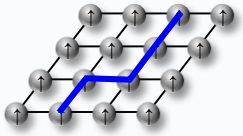
HITACHI
Inspire the Next

Accelerating efforts to realize quantum computing, simple cancer screening

CMOS annealing machine

- Scalable based on size of societal challenge to be solved
- 100K bit processing achieved with FPGA

Convert to Ising model

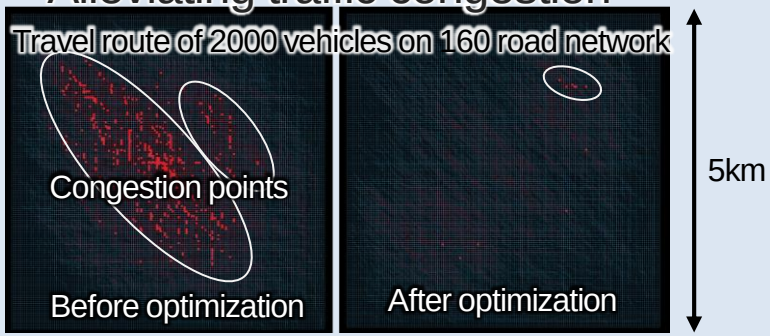


Explore shortest route in real-time

Implement in hardware

Cloud service (Aug 2018)

Alleviating traffic congestion



Partner: Hokkaido U., NEDO

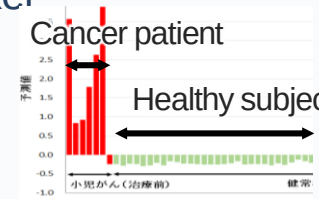
Simple cancer screening

- Verified low-burden cancer screening
- Successful detection in adult & pediatric cancer

Cancer-screening using urine-based tumor-marker

Urine sample

Component analysis (LC/MS))

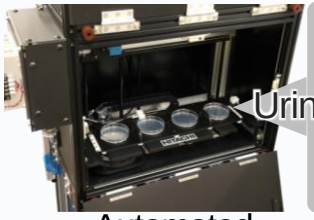


Data analysis
e.g. Pediatric cancer

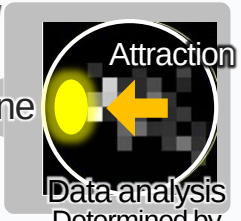
Nematode-based cancer screening

Attracted to elements in cancer patient urine

Nematode



Automated analysis system



Data analysis
Determined by attraction/avoidance response

Partner: Nagoya U., Aflac, HIROTSU Bio Science

FPGA: Field-programmable gate array

HITACHI
Inspire the Next

Create visions through industry-academia-govt. collaboration to resolve societal challenges, and share with the world

Society 5.0 Vision to resolve societal challenges

Hitachi U.Tokyo Lab

[Energy systems]
Energy Forum

[City planning]
Habitat Innovation Project

Hitachi Kyoto U. Lab

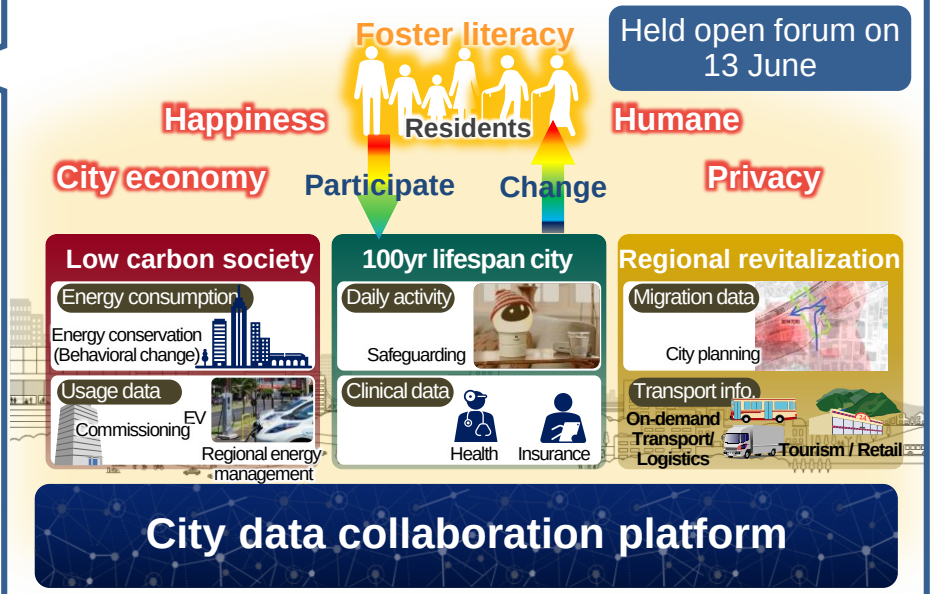
[AI policy proposal]
Scenarios for the future

Hitachi Hokkaido U. Lab

[Food & Health]
Hokkaido U. COI Symposium

[City planning] Habitat Innovation

1. Vision of future city with goal of "Human Security & Well-being"
2. Challenge-resolving model to actualize "Society 5.0"
3. Business model based on synergy of strengths between Hitachi and U.Tokyo



COI: Center of innovation

HITACHI
Inspire the Next

Contents

5.1 Summary

1	Enhancing co-creation of global solutions
2	Creating and focusing on world-leading technology
3	Promoting basic research to resolve societal issues

NGO: Non-Governmental Organization

New challenges for the next 100 years at “Collaboration Forest”

To be completed in March 2019

HITACHI

Inspire the Next