

R&D Strategy to Become a Major Global Player

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2 Global R&D strategy

3 Prioritizing Social Innovation Business

4 Strengthening the management platform

5 Open innovation

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Contribute to the creation of sustainable social infrastructures

Accelerate Social Innovation Business Strategies Execution

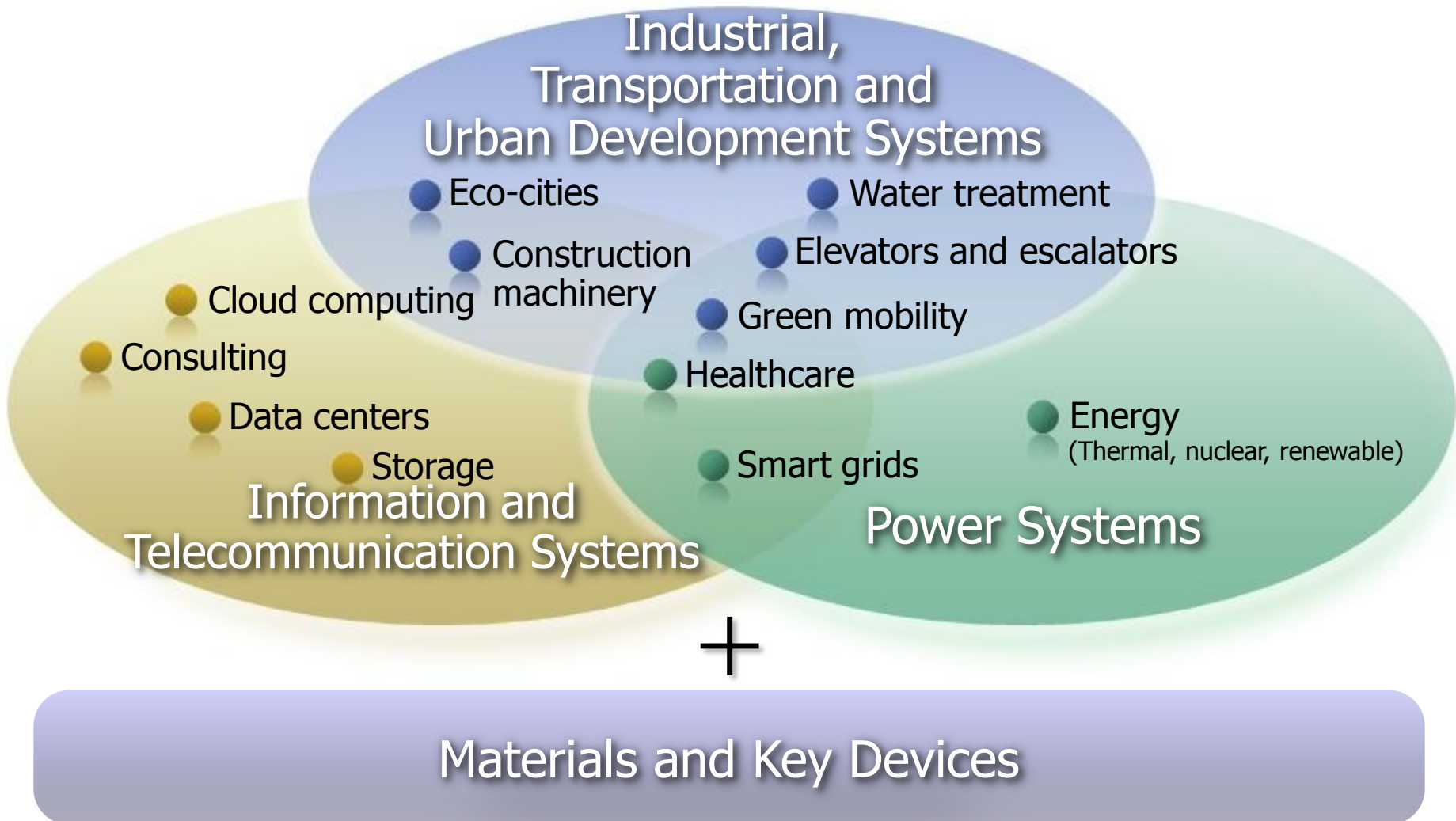
- Leverage Hitachi's strengths to promote a global growth strategy
- Focus business resources on Social Innovation Business
- Strengthen the business structure to stabilize profitability

Transform into a worldwide innovation leading company

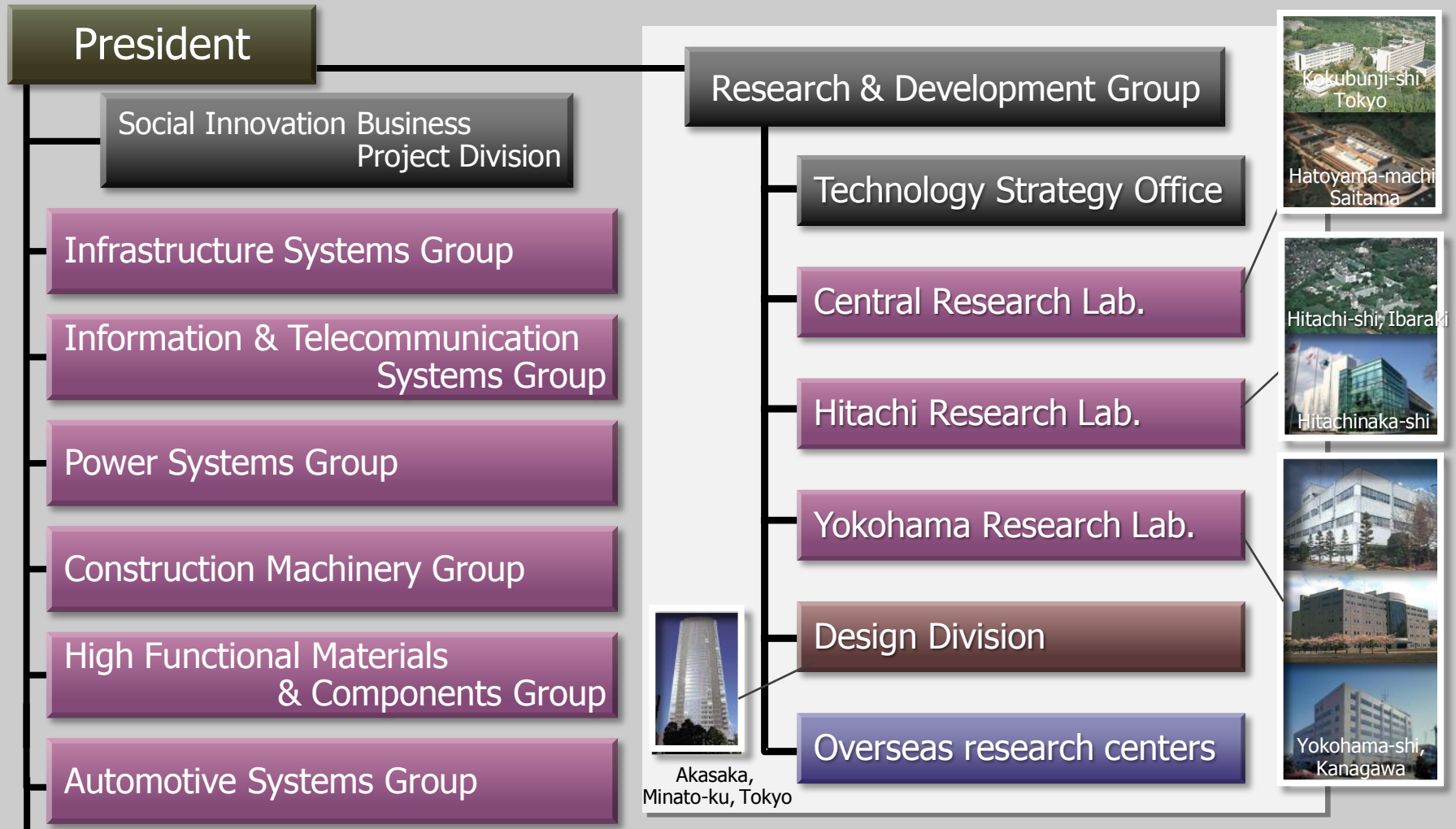
Identify issues with worldwide customers and provide solutions

Become a major global player

Social Innovation Business

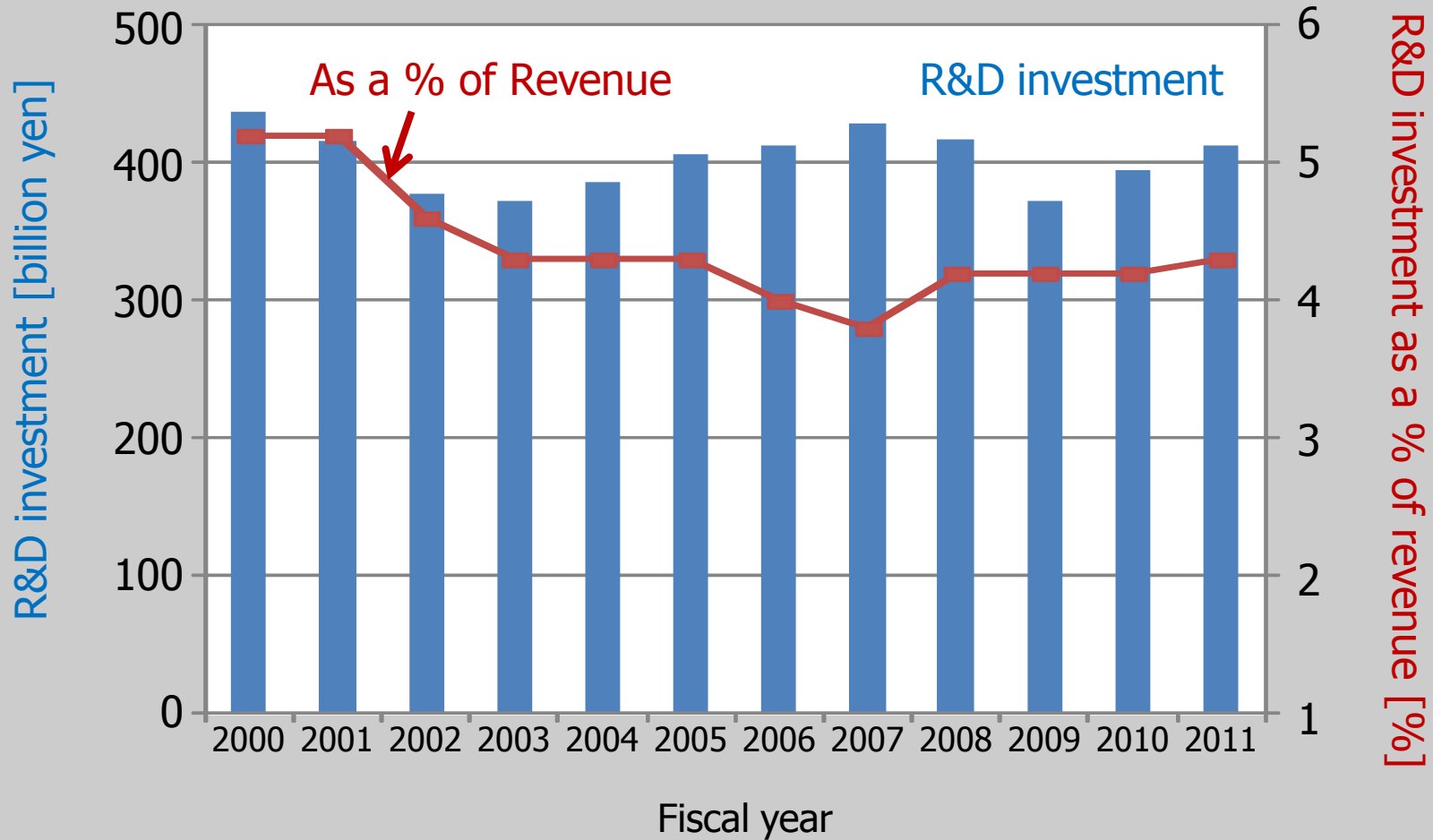


Hitachi's 6 Business Group structure and the R&D Group



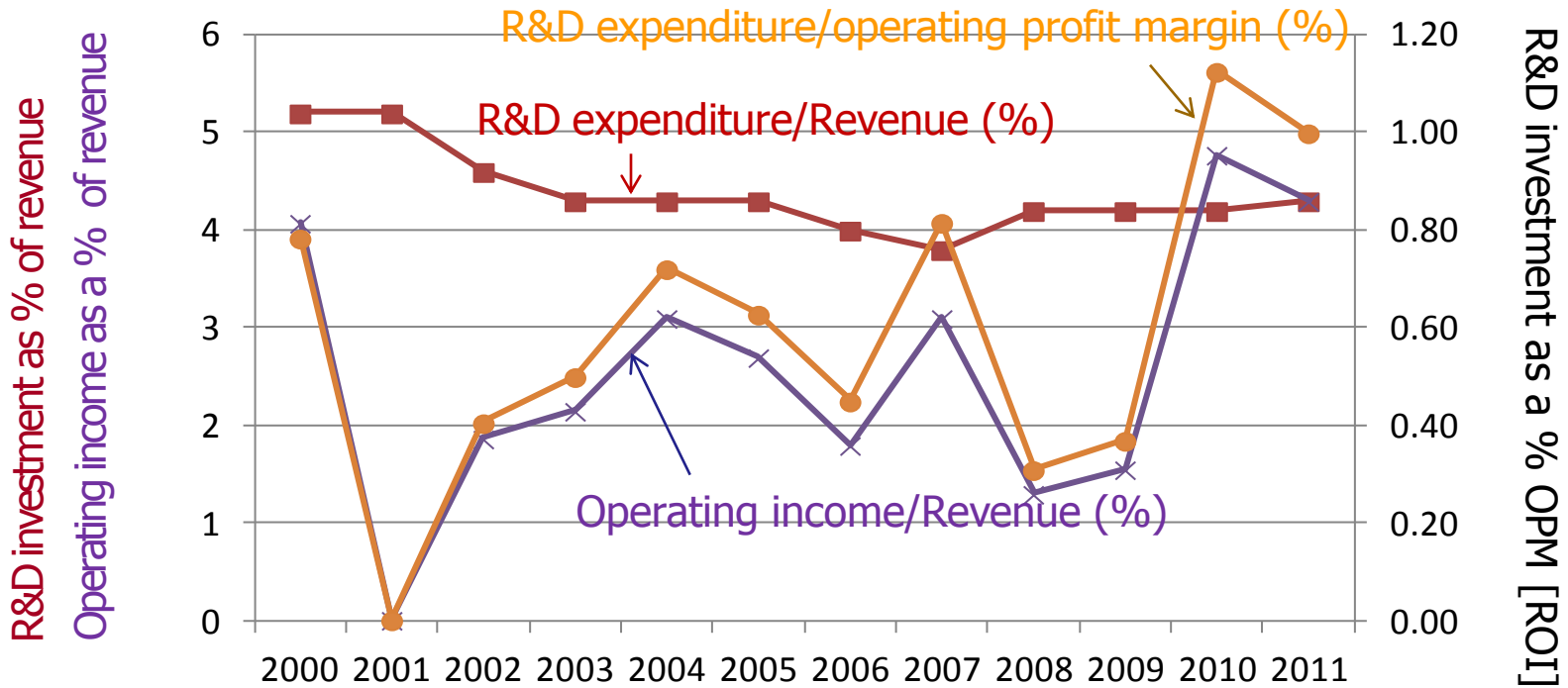
1-4. R&D investment

Approx. 400 billion JPY invested in Hitachi Gr. R&D, approx. 4% of revenue



1-5. R&D investment efficiency & personnel

Annual trend in R&D investment return

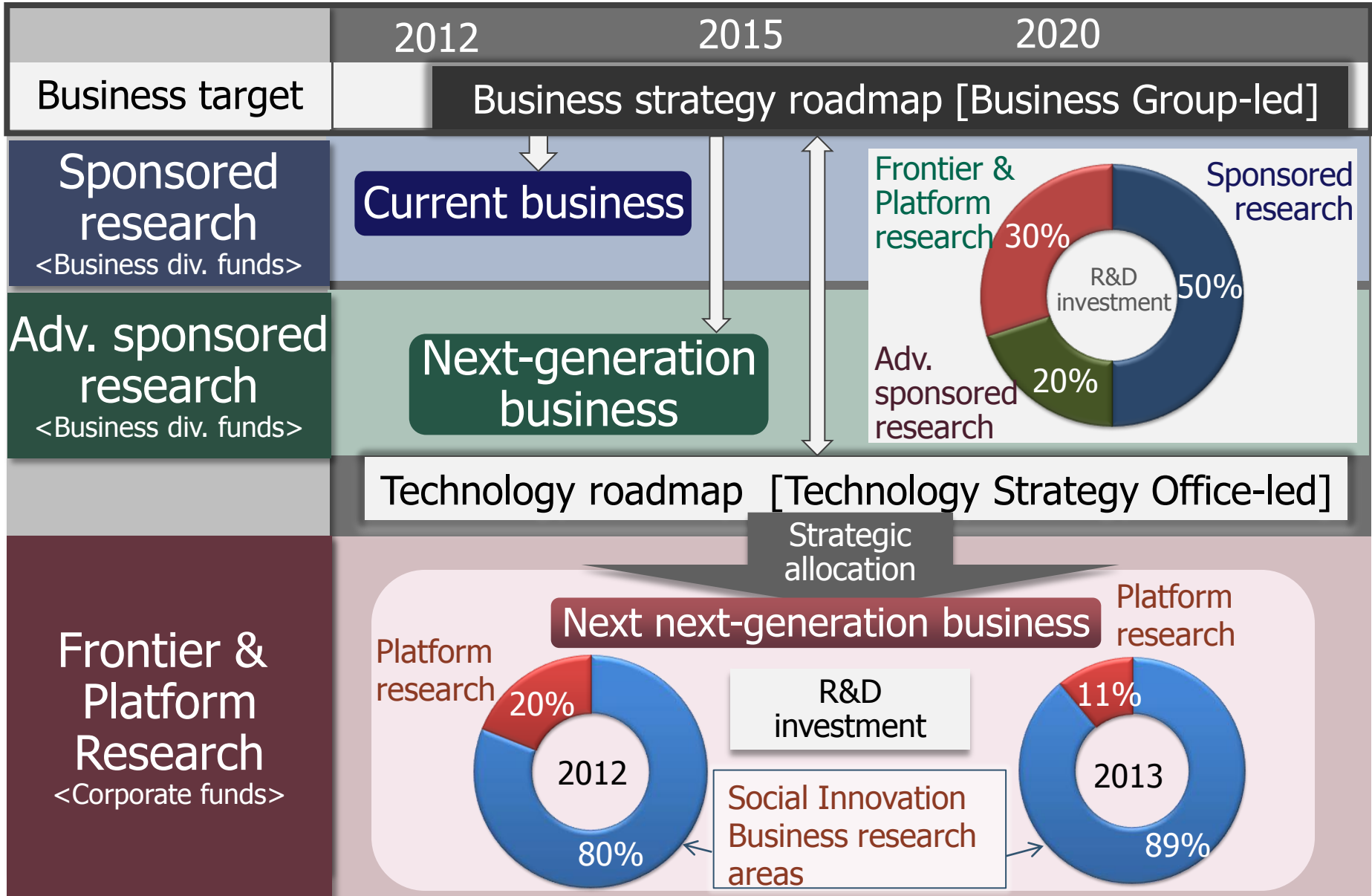


Annual trend in number of R&D personnel

	FY2011	FY2012	FY2013*
Hitachi, Ltd.	3,481	3,410	3,369
Subsidiary	2,046	1,853	1,929
Total	5,527	5,263	5,298

*forecast

1-6. Strategic allocation of investment



1. Global growth strategy

- Enhancing regional research contributing to overseas business expansion

2. Prioritization of Social Innovation Business

- Development of No. 1 technology for prioritized business areas

3. Strengthening the management platform

- Cost structure reform
- Promote Smart Transformation Project

Open innovation

- Strengthen proposals for solutions & new products through collaboration with global partners
- Participation in national projects & pursuit of govt./industry/ academia collaborations in frontier research

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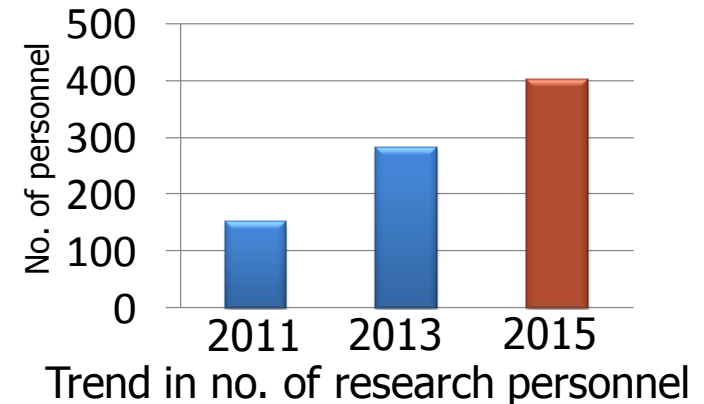
5 Open innovation

Reinforcement of regional research supporting global business expansion

[Measure 1] Expand global research bases

- 1) Increase research personnel in IT, Infrastructure and Materials
(approx. 280@2013 → approx. 400@'15)
- 2) Utilize global human resources: increase % local leadership
(4 in 9 labs* @2012 → approx. 5 in 11 labs @'15)

*No. of research labs & centers



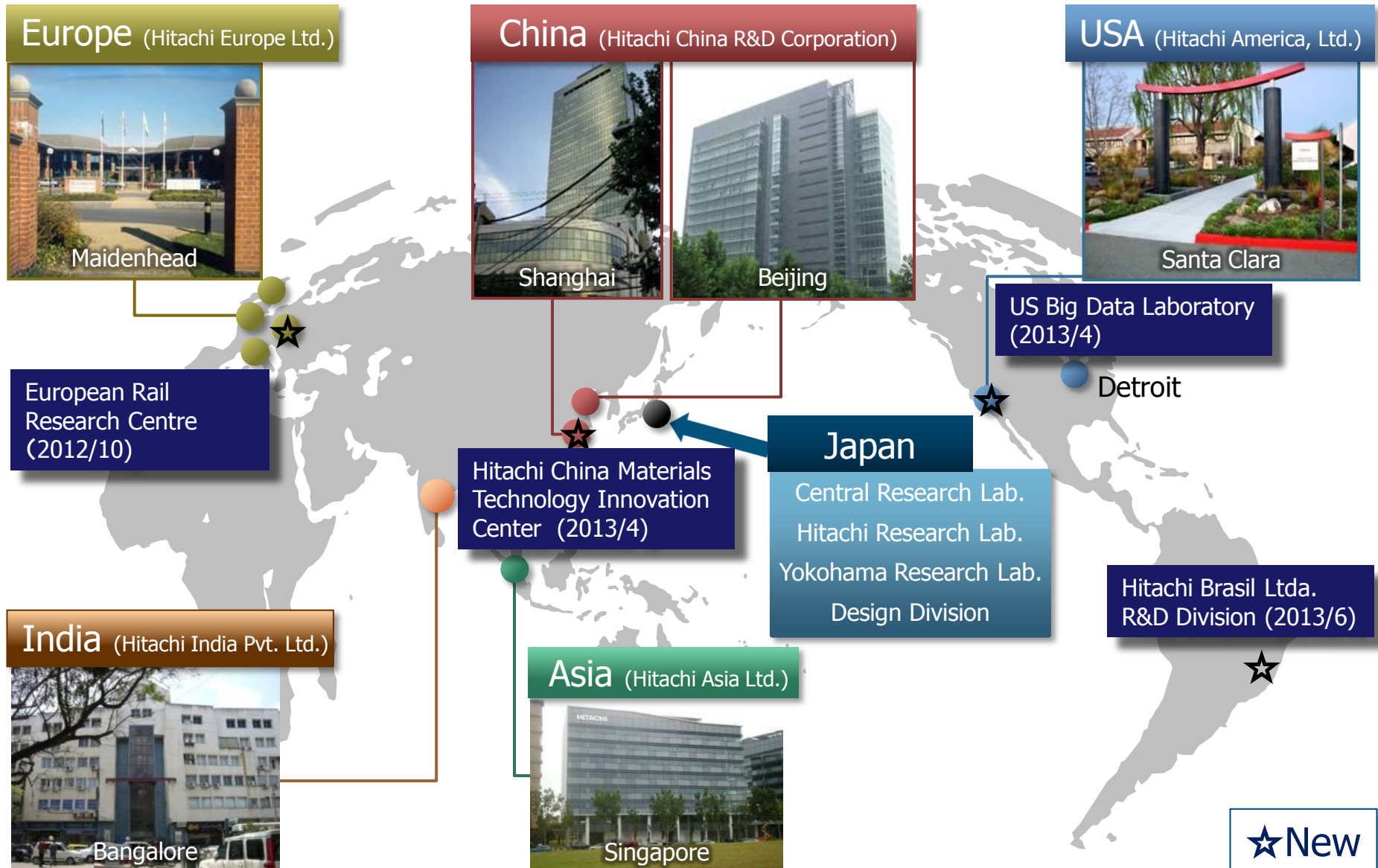
[Measure 2] Deploy R&D to strategic business regions

Set-up Hitachi Brazil Laboratory (2013/6)

[Measure 3] Establish laboratories reinforcing regional business strategy

- 1) Advanced research of local issues for expansion of the European railway business
→ **European Rail Research Center (est. 2012/10)**
- 2) Reduction of material costs in Hitachi Group companies enabling the utilization of inexpensive and high quality local Chinese materials
→ **Hitachi China Materials Technology Innovation Center (est. 2013/4)**
- 3) Promotion of big data research for advanced IT companies in the US
→ **HAL/R&D Big Data Research Laboratory (est. 2013/4)**

2-2. Network of seven regional R&D bases and newly est. labs



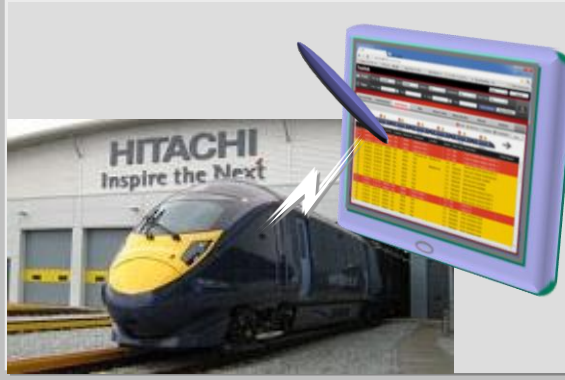
Contributing to European Rail Systems Europe business expansion

Rail car



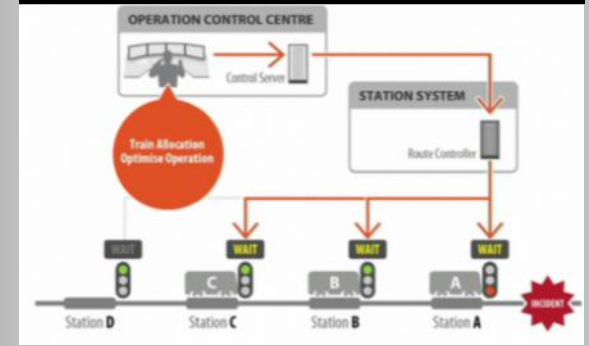
Design support for rail cars for the European market

Maintenance



Sophistication of maintenance systems

Operation & Management



Development of a U.K. traffic management system

Strengthen Hitachi Group cost structure through increased use of Chinese materials

- To be established on the campus of Shanghai Jiao Tong University (SJTU)

Hitachi exclusive laboratory



- Quality and characteristics assessment of local Chinese materials
- Development of manufacturing processes for Chinese material and design support

Joint research

SJTU School of Materials Science and Engineering

Advanced analytical technology for Chinese materials



Selection of high quality inexpensive Chinese materials



Hitachi Group in China

Increase % local procurement

Cost reduction
Shorten lead time
Increase quality

Hitachi Smart Transformation PJ

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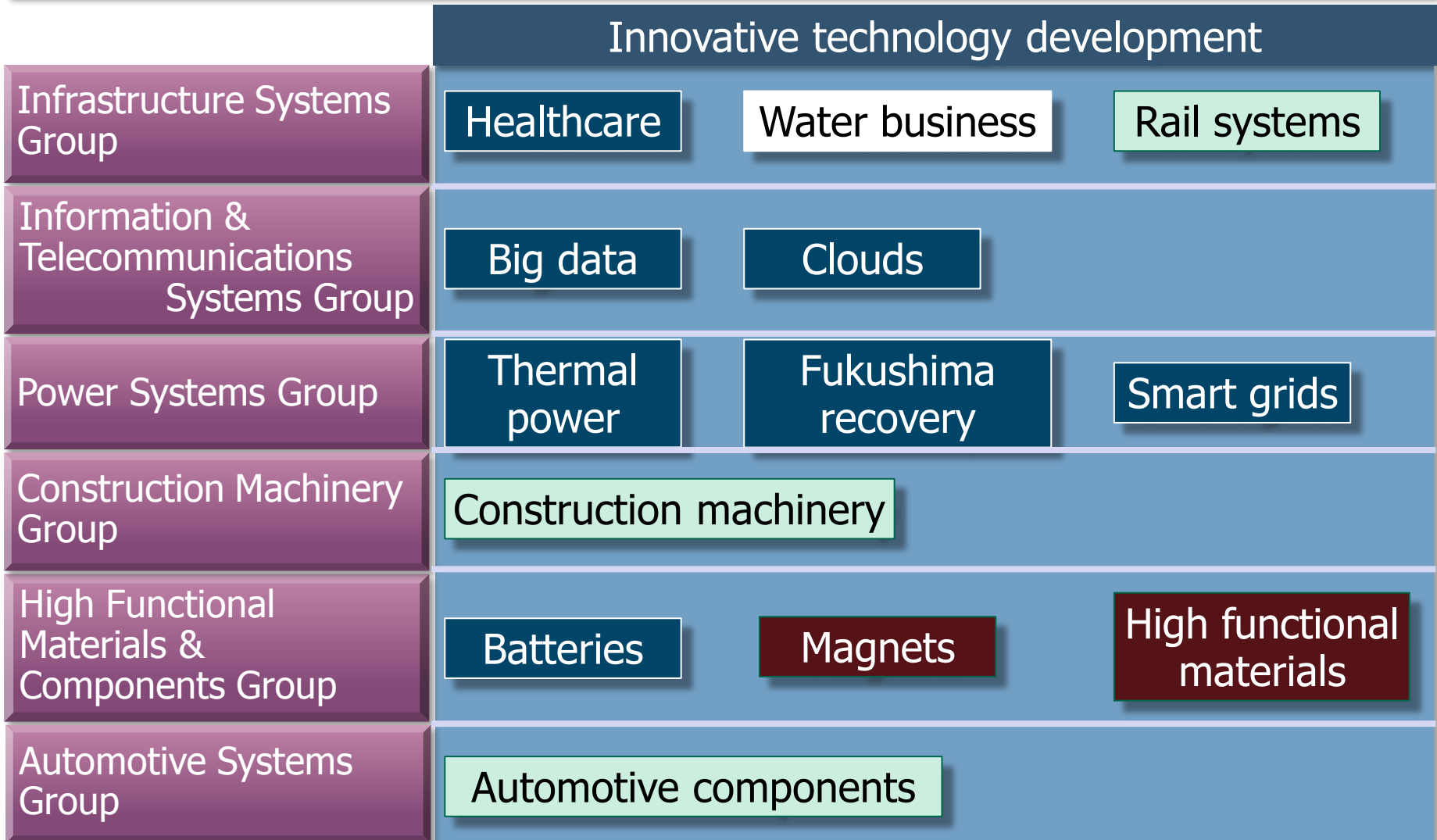
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Devt. of global No. 1 components and pioneering systems & service business



Development of cutting-edge technology for healthcare business expansion

Expand current business

Diagnostic

Diagnostic imaging



Superconductive Imaging System

Analysis

Platform technology for clinical analysis
Gene analysis



Clinical Analyzer

Treatment

Beam control tech.
Radiation control technology



Particle Beam Therapy System

Pioneer new business

Regenerative medicine

Cell processing



Closed automatic culturing equipment

Biopharmaceutical manufacturing

Fluid-metabolism Interaction analysis



Biopharmaceutical manufacturing plant

Realization of an oval bore reducing subject psychological burden

Application of design technology developed for nuclear fusion equipment

Simulation for nuclear fusion equipment

Arbitrary coil pattern calculated from desired magnetic field distribution



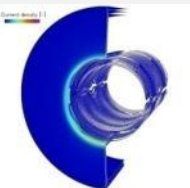
Fusion device



Magnetic field analysis



Plasma control coil



Eddy current analysis

Application

Gradient magnetic field coil



Spacious Superconductive Imaging System

Feature Oval bore with a horizontal dimension of 74cm

1.5 tesla equipment

“ECHELON OVAL”
2012/4 Approval under
Pharmaceutical Affairs
Act of Japan



3 tesla equipment

“TRILLIUM OVAL”
2013/3 Approval
under Pharmaceutical
Affairs Act of Japan

Further improved resolution



High-speed high-accuracy automatic biochemistry analyzer reducing patient burden and testing costs

Sample dispenser probe capable of handling 1 μ L

Sample dispenser probe



Minimum amount of liquid used reduced to 2/3*

High speed reagent dispensing mechanism

25% improvement in test process performance*

- 1,000 tests/hour

25% reduction in reagent necessary*

- Minimum amount of reaction liquid required: 75 μ L



Automatic analyzer "LABOSPECT" series

Medium-sized model released in Nov. 2012, joining line-up of large and compact model

[Hitachi High-Technologies Corporation]

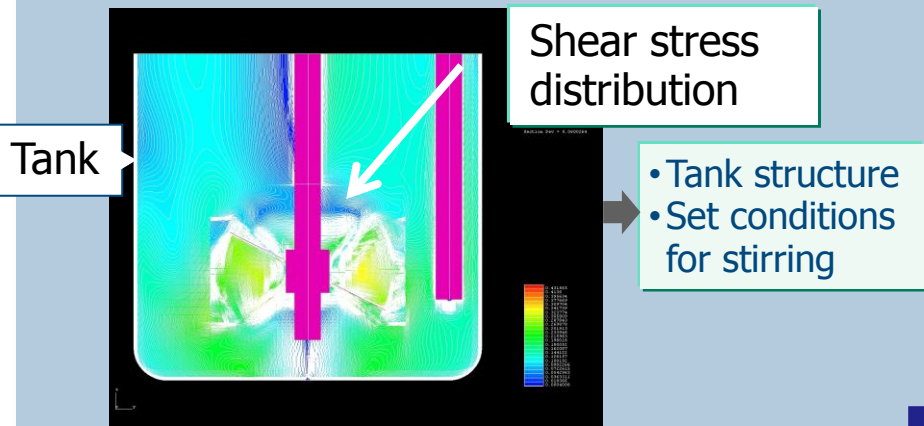


*Compared to previous Hitachi equipment

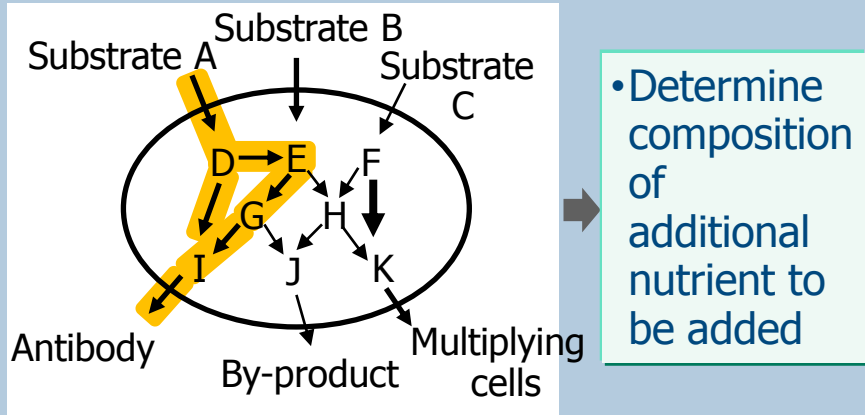
Optimization of bio-manufacturing plant cell culture environment using simulation

Combined fluidics & metabolomics

Stirred flow simulation in tank



Analysis of cell metabolism



Pilot 200L cell culture facility

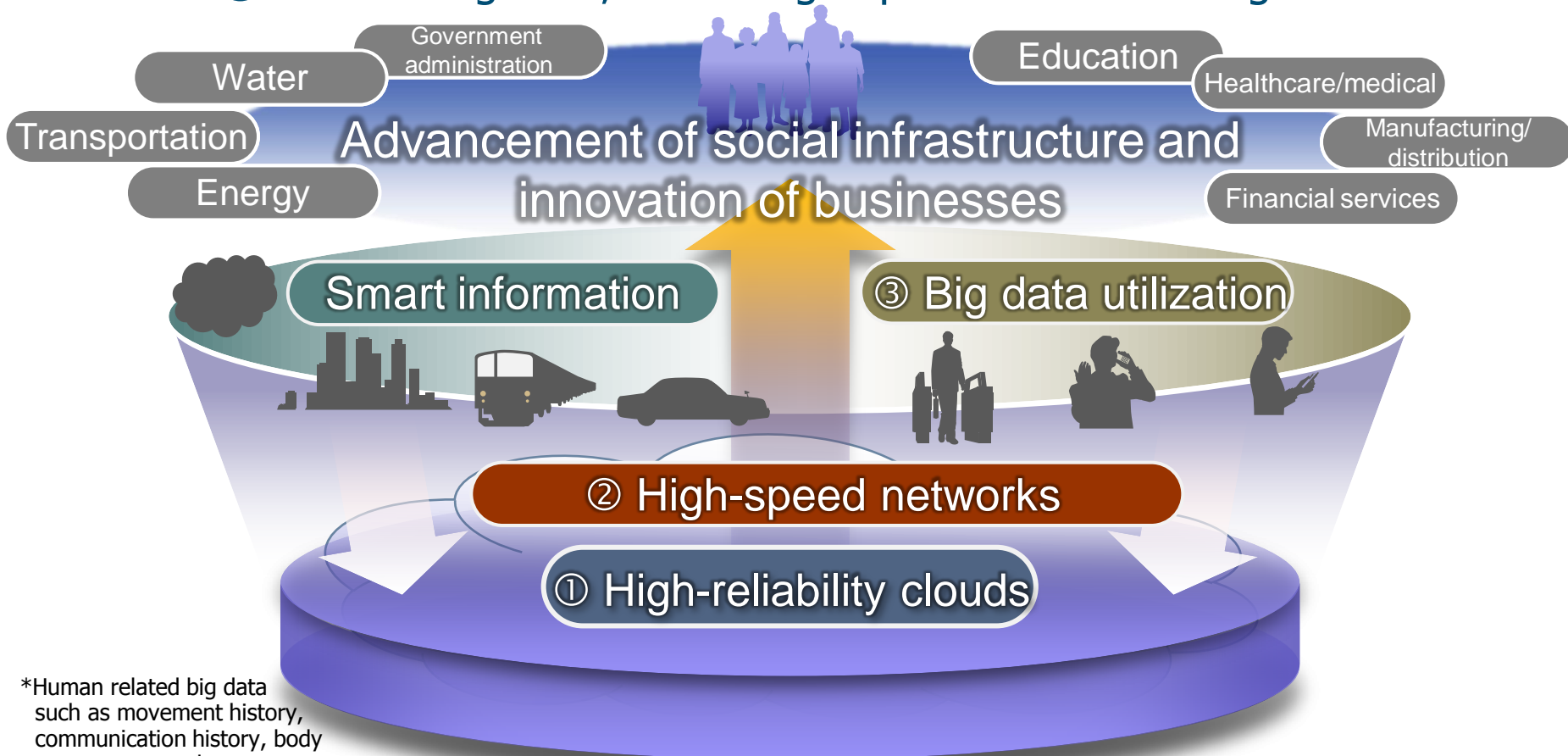
Optimize the environment within a cell culture tank for bio-pharmaceutical production



Increase productivity & quality of bio-pharmaceuticals

Innovative technology for big data/cloud to support Social Innovation Business

- ① High reliability ultra-high speed platforms
- ② High speed networks for the Cloud
- ③ Human big data,* ultra-high speed data base engines



*Human related big data such as movement history, communication history, body temperature, pulse rate, etc.

3-7. Clouds: High reliability ultra-high speed platform

World-class high-speed mid-range storage (1.3x previous model*1)

High-end storage hardware & control software downsized and applied to mid-range storage

Mid-range storage
Hitachi Unified Storage VM
(2012/9 product release)



Flash module realizing large capacity and reduction in introduction costs (approx. 55% reduction*2 in bit cost)

Development of Flash memory high performance control technology

Flash module
Hitachi Accelerated Flash
(2012/11 product release)



Integrated management software for storage/server/network

VM^{*3} deployment time:
15 days → 15 min.^{*4}
(Unified management)

→ Highly reliable private cloud platform

Integrated platform
Hitachi Unified Compute Platform
(2012/10 product release)



*1: Sequential performance comparison

*2: 400GB MLC SSD comparison

*3: Virtual server

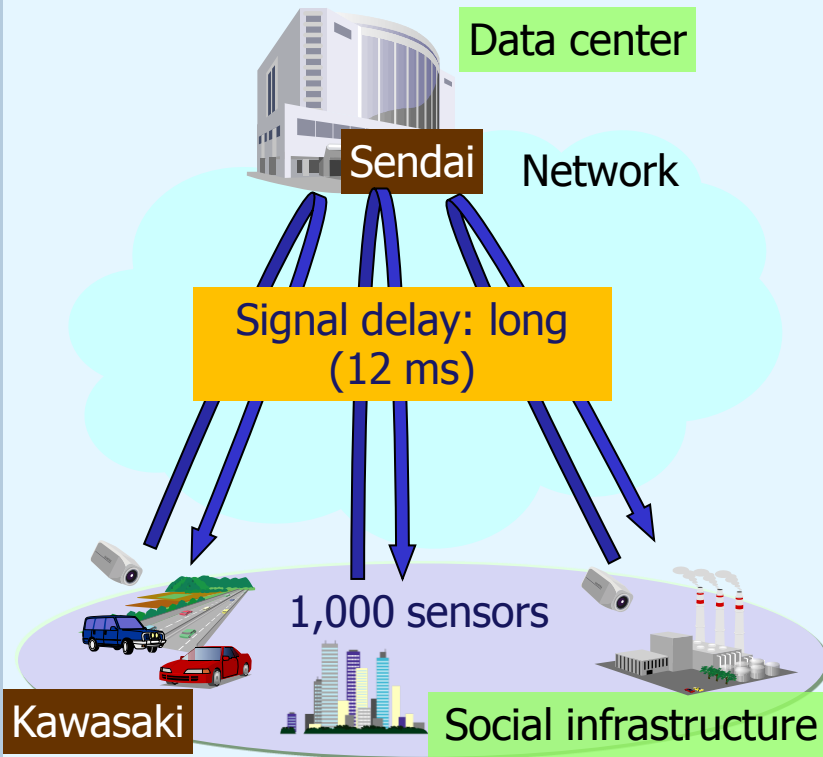
*4: Benefit may vary depending on customer environment

3-8. Network: High speed response networks for the Cloud

High-speed response network technology to achieve M2M*1 societal infrastructure through the Cloud

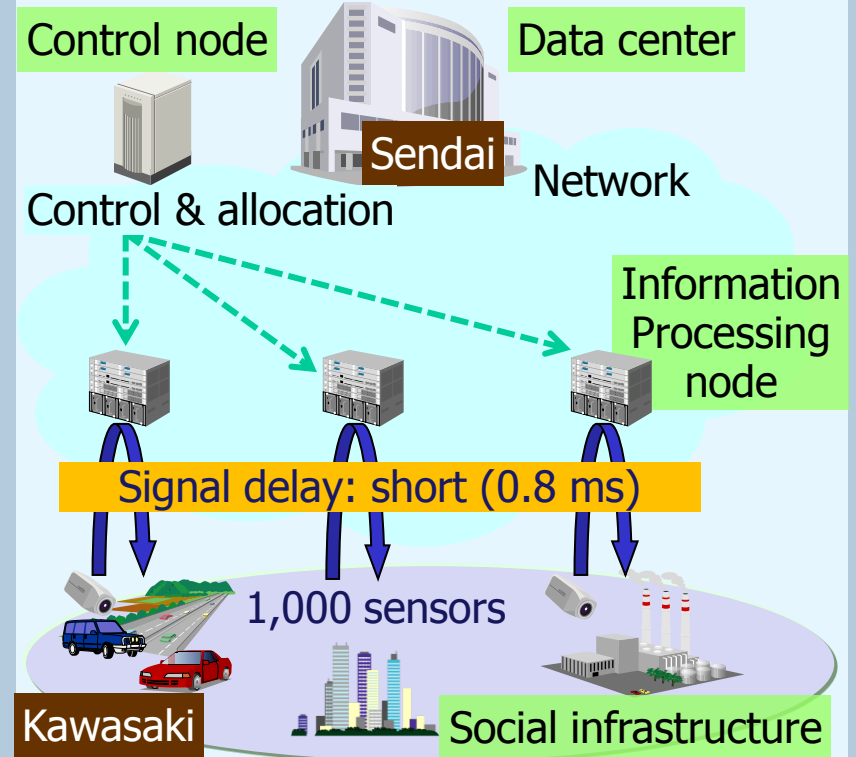
Conventional technology

Signal delay is long due to distance between data center and equipments



Technology developed: Delay approx. 1/15*2

Signal delay is reduced by using distributed information processing nodes



*1 M2M: Machine to Machine

*2 Utilized the test bed "JGN-X" supporting next generation network R&D recommended by NICT, Japan

- This research was supported in part by the Ministry of Internal Affairs and Communications, Japan

- 2013/2/20 News release

Solving management issues utilizing large body of human behavioral data

Name tag sensor node

2005~ joint research with MIT
2009~ Hitachi High-Technologies Corp. business



- Communication log
- Behavioral log etc.



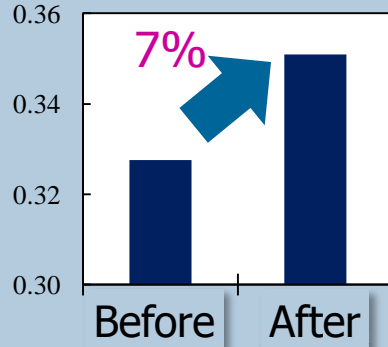
13% increase in call center orders received*1

Optimization of scheduling and teaming resulting in increased activity

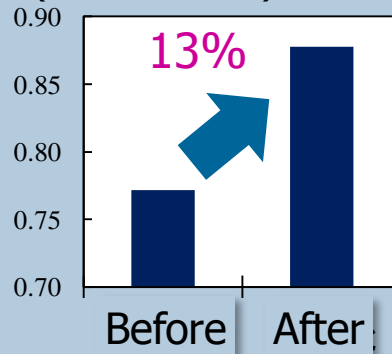
Activity during breaks

Orders/clerk

(Activity level)



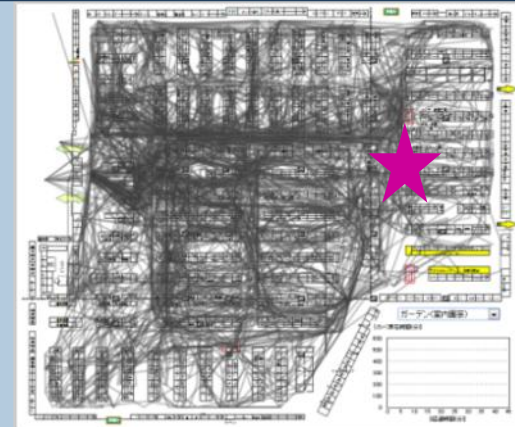
(No. of orders)



15% increase in avg. sales/customer*2

Identification of sales assistant locations increasing average sales/customer

Visualization of customer movement



Hot spot

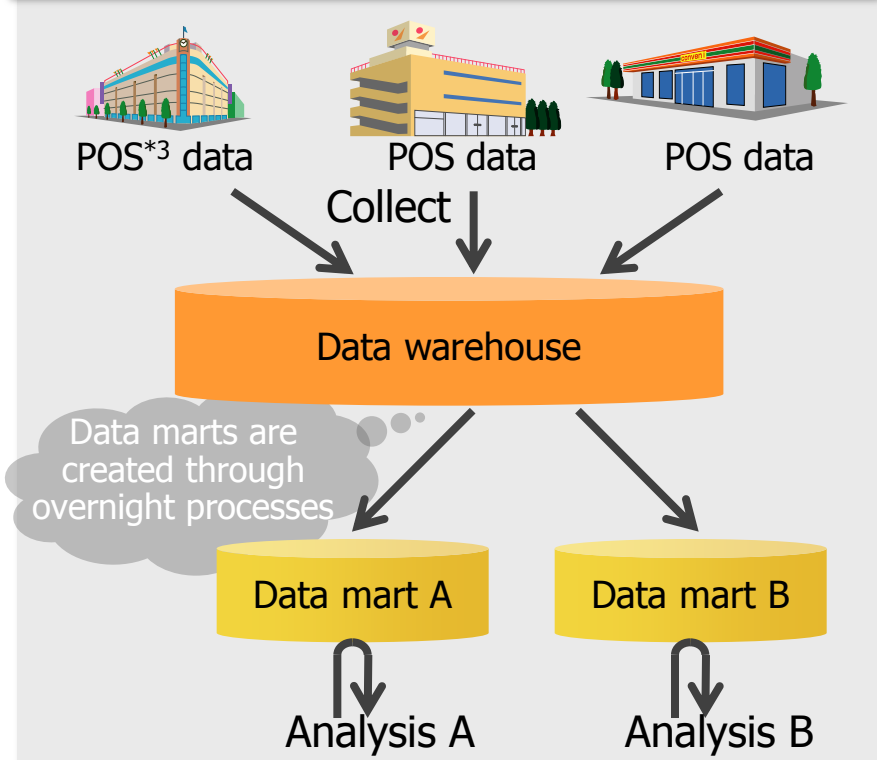
*1 2012/7/17 Joint press release with MOSHI MOSHI HOTLINE, Inc.

*2 Home center verification test results (2012/10/19 News release)

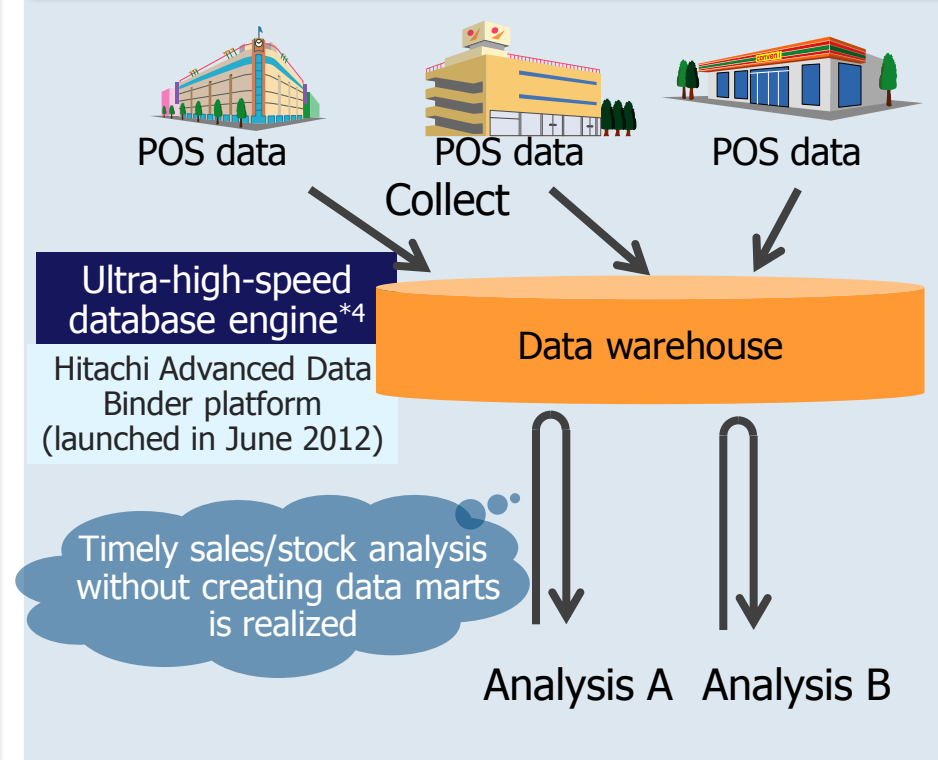
3-10. Big data (2): Ultra-high speed data base engine

The "Out-of-Order Database Engine"*¹ technology proposed by Prof. Kitsuregawa (Univ. of Tokyo and also Director-General, National Institute of Informatics) accelerates big data analysis by a hundred times*²

Conventional technology



Ultra-high-speed database engine



- *¹ A principle proposed by Prof. Kitsuregawa (Univ. of Tokyo and also Director-General, National Institute of Informatics) and Project Associate Prof. Goda (Univ. of Tokyo)
- *² Compared with Hitachi conventional technology. The performance was measured based on standard analytical benchmarks. The speeding-up effect on various queries are different. We compared the performance of searching a fixed amount of data which met a certain condition in the database.
- *³ Point of sales
- *⁴ The outcome of "Development of the fastest database engine for the era of very large database, and Experiment and evaluation of strategic social services enabled by the database engine" project (Principle Investigator: Prof. Masaru Kitsuregawa, University of Tokyo and also Director-General, National Institute of Informatics), supported by the Japanese Cabinet Office's FIRST Program (Funding Program for World-Leading Innovative R&D on Science and Technology).

Development of creative energy technology for a clean & prosperous future

Gas turbine

- Highly efficient, lower-environmental impact new gas turbine technology*1



(40MW-class test facility)

Coal-fired thermal power generation

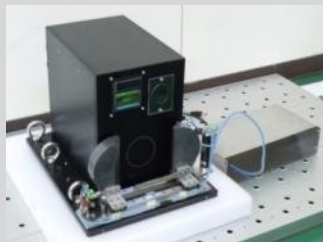
- Next-generation coal-fired thermal power generation technology drastically reducing CO₂ emission*2



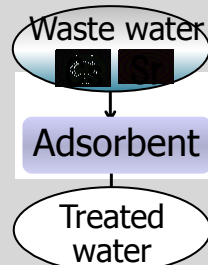
(Pilot plant)

Recovery-support technology

- Gamma-ray intensity distribution measurement
- Radionuclide removal technology



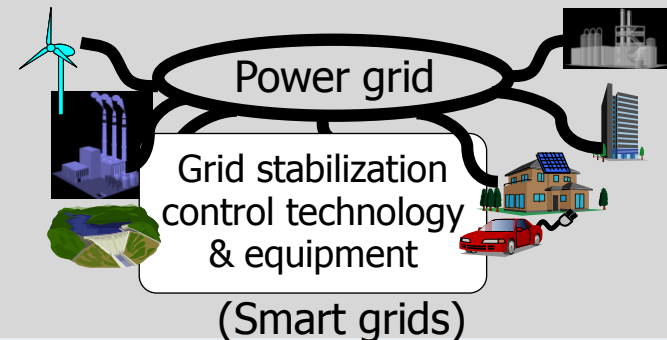
(Gamma camera)*2



(Radionuclide removal)

Smart Grids

- Voltage regulation technology to support renewable energy sources



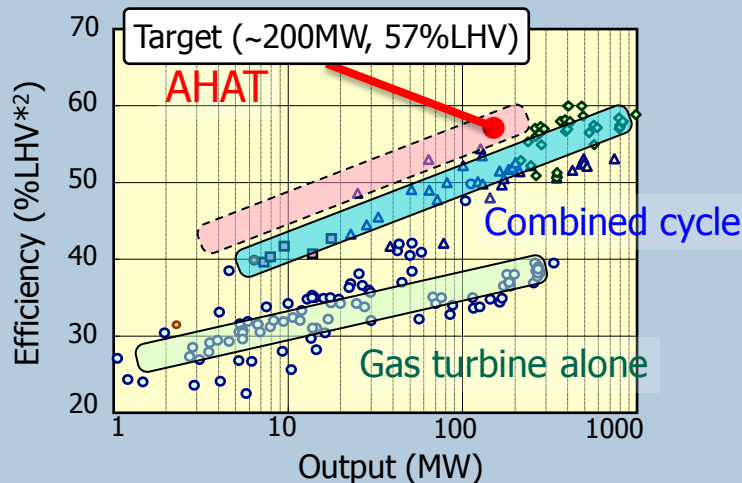
*1 Project supported by the Ministry of Economy, Trade and Industry (METI), Japan.

*2 Project support by the New Energy Development Organization (NEDO), Japan.

40MW-rated output achieved with AHAT*1 system equipped facility

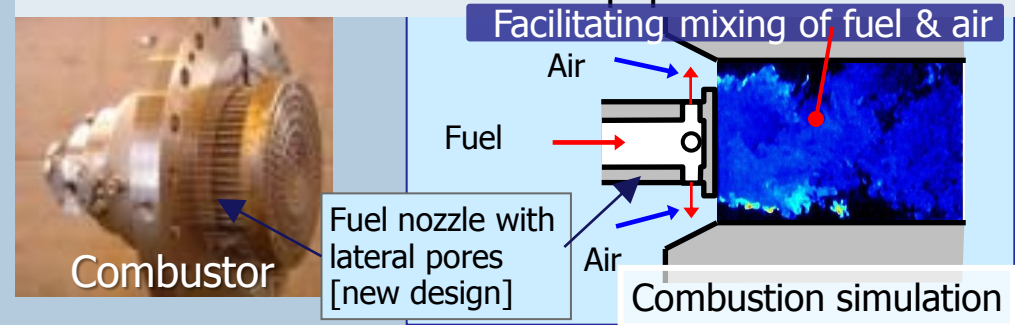
AHAT: Gas turbine cycle using highly humid air

Highest efficiency in medium-class gas turbine



Features of the 40MW pilot facility

- ① Start-up time: 60 min. from ignition to 40MW rated power → 1/3 previous equip.
- ② Lower environmental impact: Equivalent to NOx concentration of < 10ppm in commercial equipment



Development schedule

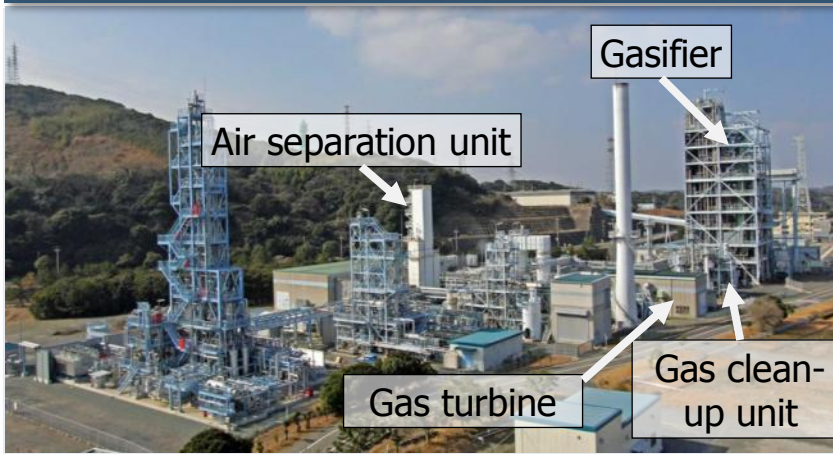
Phase I	Phase II	Phase III
Verify elemental technologies (3,000kW)	Application technologies (40MW)*3	Technical demo. (up to 200MW)
2010/6/16 News release	AHAT general test facility	Apply to next-gen. highly efficient power generation technology
	2013/2/14 News release	

*1 AHAT: Advanced Humid Air Turbine *2 LHV: Lower Heating Value

*3 Project supported by the METI, Japan.

Achieved dry, single digit NOx at the coal gasification pilot power plant

Pilot plant (EAGLE*1)

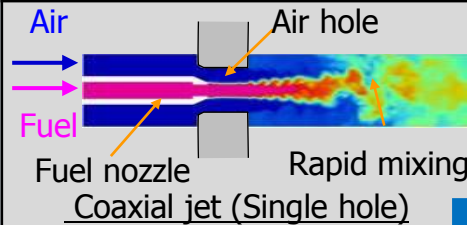


*1 EAGLE: coal Energy Application for Gas, Liquid and Electricity

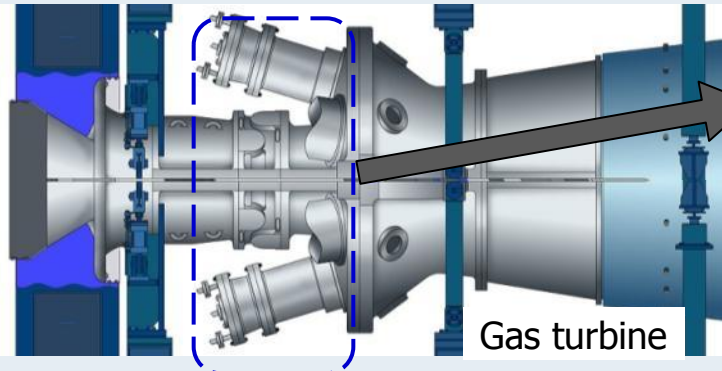
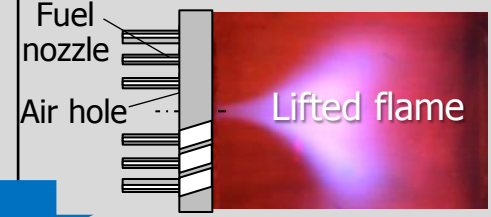
NOx reduction technology

Dry, low NOx combustion using "Multi-hole co-axial jet burner"

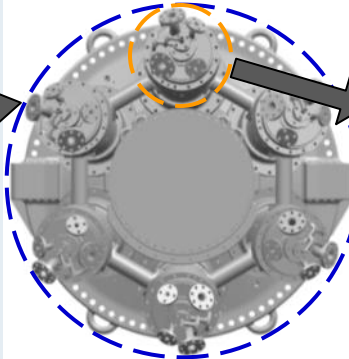
Rapid mixing technology (Low NOx combustion)



Flame lifting technology (Flashback prevention)



Actual gas turbine with multi-can-type combustor



Front view of a multi-can type combustor



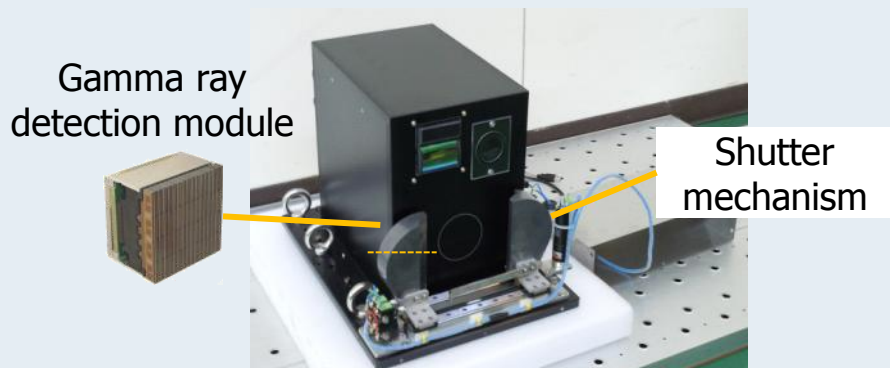
Front view of a single-can combustor burner

- Diluent-free (dry)
- NOx < 10ppm (single digit NOx) achieved

- This technology was developed as the NEDO project on "Innovative Zero-emission Coal Gasification Power Generation Project: Development of low NOx combustion technology for high-hydrogen syngas in IGCC." The EAGLE pilot test was conducted as part of the project with the support of Wakamatsu Research Institute of J-POWER.

Innovative technology for radiation monitoring & decontamination

High dose rate environment gamma camera



Measurement under high dose rate environment of 300mSv/h enabled

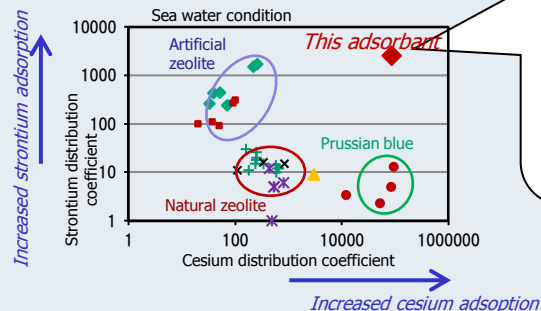


Measurement within reactor building

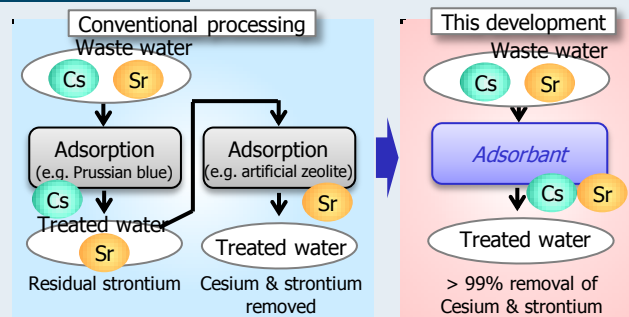
-The gamma camera was developed as part of a NEDO project.

Simultaneous removal of 2 radionuclides

Adsorption effect



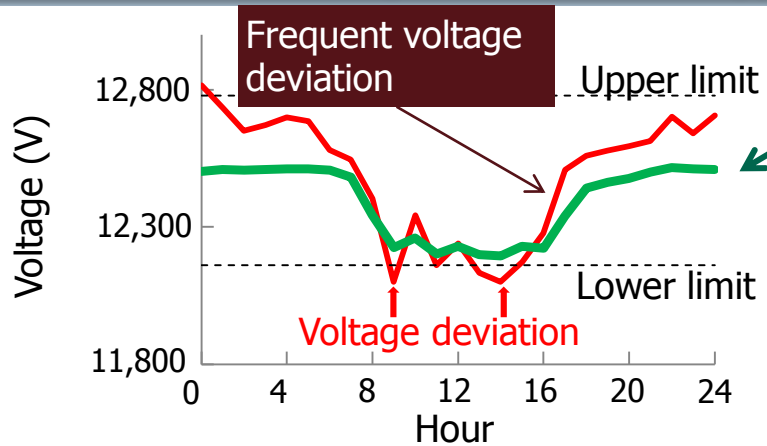
Eliminated process



Achieves simultaneous removal of Cs and Sr

Voltage regulation technology for the mass introduction of renewable energy

Issue in introducing renewable energy



Voltage fluctuation as a result of unstable renewable energy generation

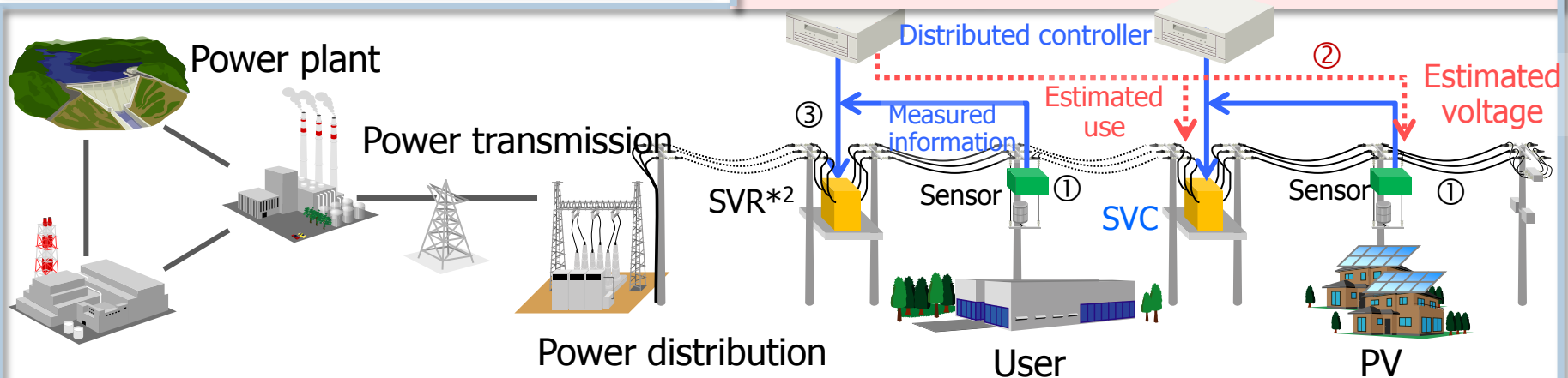
Voltage regulation technology

Voltage deviation reduced from **10% to 3%**

(1,000 homes with 40% solar power, 2 SVC*¹)

- Feature**
- Inexpensive:** Voltage stabilizing central control system unnecessary
 - Scalable:** Region-by-region sequential investment is possible

- ① Use of existing communication networks
- ② Estimate line voltage from sensor data collected by distributed controllers
- ③ Adjust voltage controller so that the line voltage meets the target voltage



*1 SVC : Static Var Compensator

*2 SVR: Step Voltage Regulator

Development of energy storage systems for power plants using renewable energy sources

Large capacity secondary batteries

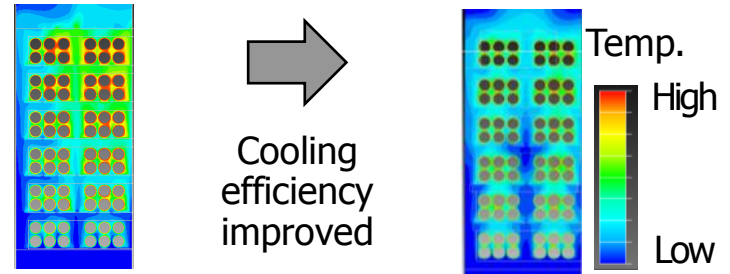
Large capacity Li-ion battery (CH75-6)



- 75Ah capacity
- Large discharge current capacity of max. 300A

Large capacity energy storage systems

Thermo-fluidic analysis to improve cooling efficiency



Cooling efficiency improved

Suppresses temperature increase of batteries

Lead battery (LL1500-W-8)



- 1,500Ah single batter (4 units mounted)
- Battery life (17 years)

Equivalent to life expectancy of wind-powered plant (17 years +)



Installed in 2 divisions of Shin-Kobe Electric Machinery Co., Ltd.

- Hikone Works (400KW)
- Saitama Works (100KW)

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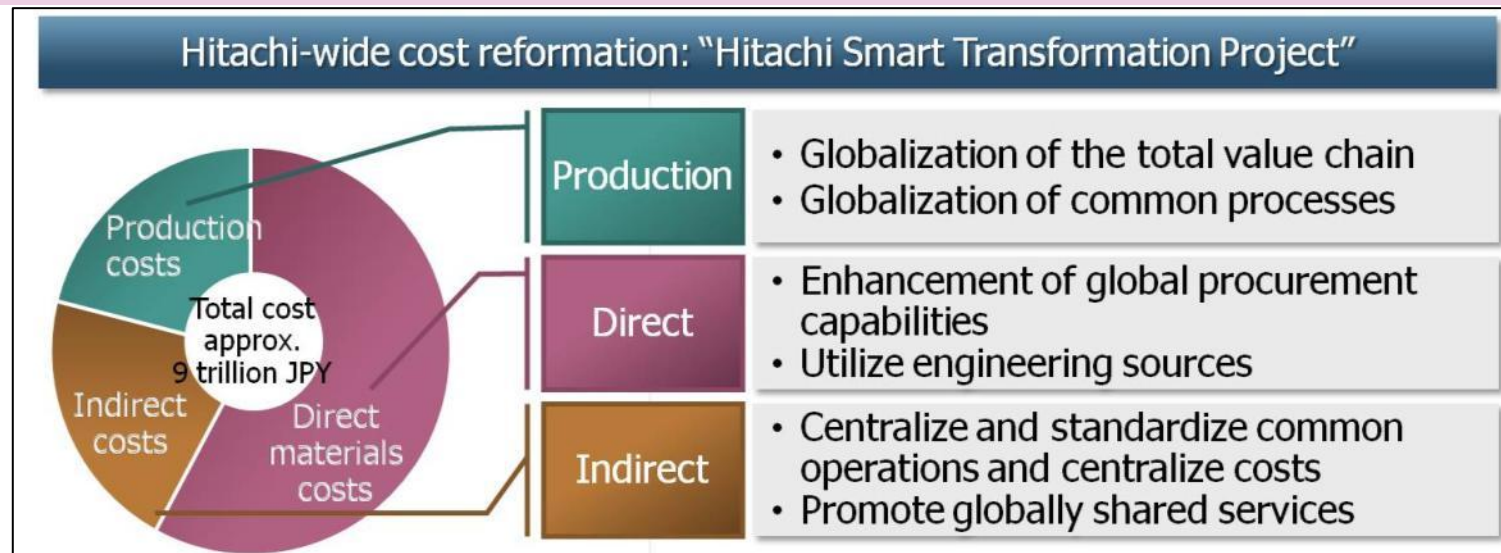
Contribute to the “Hitachi Smart Transformation” project through production engineering, computational analysis & materials research

Production cost transform

- Design technology to minimize costs in global supply chains
- Analysis-led design to reduce number of prototypes

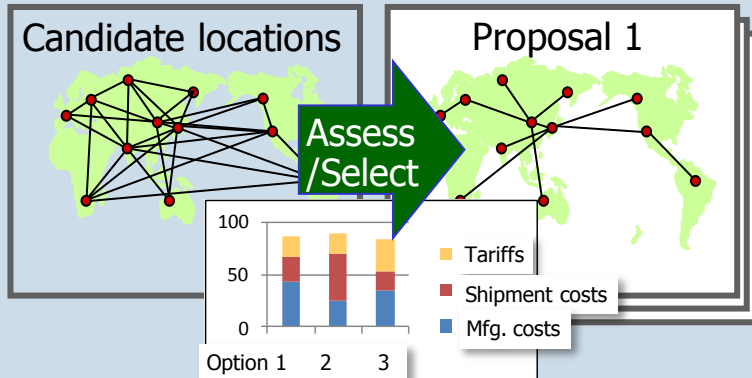
Direct materials cost transform

- Reduce material costs through “rare-metal-less” technology
- Establish Hitachi China Materials Technology Innovation Center
⇒ Promote the use of materials made in China



Optimizing locations of facilities by considering parameters such as tariffs, etc. to minimize costs

Global supply chain

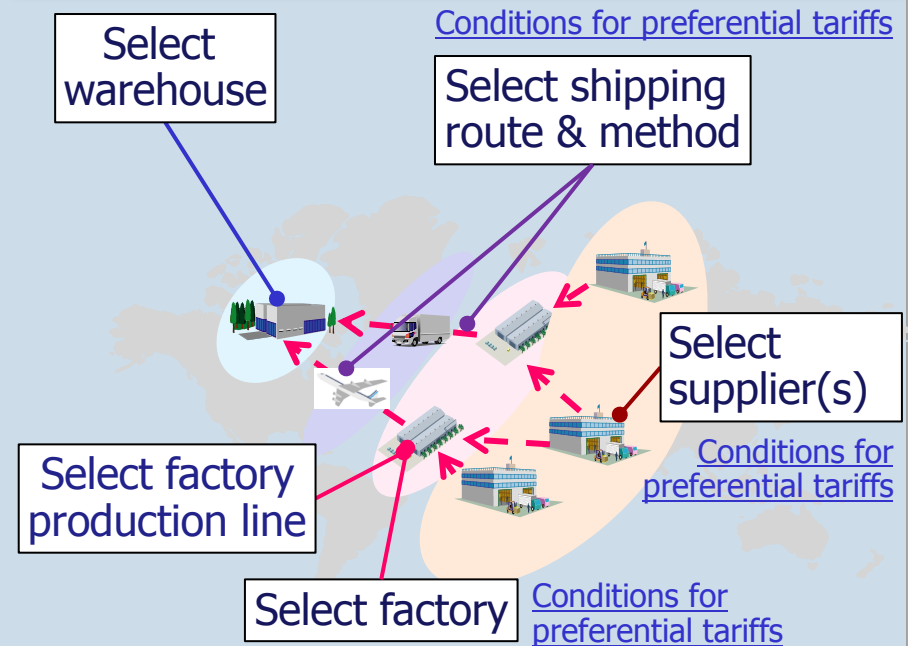


- ① Select from among numerous candidate locations
- ② Differing regional costs
- ③ Differing regional shipping lead time
- ④ Differing production line for products
- ⑤ Conditions for preferential tariffs*

Hundred of millions of possible location combinations
⇒ Manual comparison difficult

New design technology

Taking into consideration the configuration of production line & preferential tariffs



Automatically determines the optimal location of facilities for minimal costs based on a mathematical engineering approach

* Preferential tariff rate: Determined under the Economic Partnership Agreement (EPA), the preferential tariff rate applies to designated countries or regions, and is set lower than that those for non-designated regions
- 2012/11/27 News release

Reduction of raw materials costs through "rare-metal-less"

Rare-metal-less motor

- Feature**
- ① Rare-metal-less structure *1 (News release 2012/4/11)
 - ② Position-sensor-less motor (control) (Announced 2013/4)

Benefit Material & motor control cost reductions



11kW permanent magnet synchronous motor



① Control

Motor revolutions measured using stator electrical signals

Rotation angle sensor unnecessary

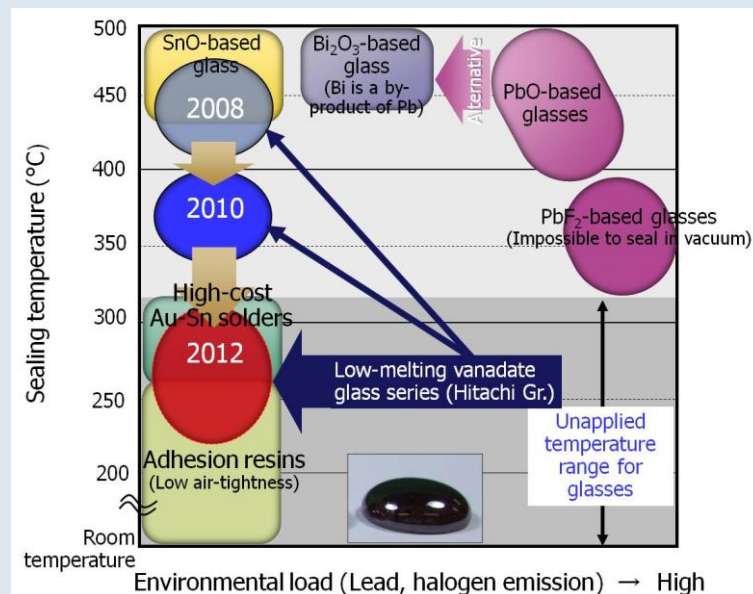


Motor control circuit achieving "sensor-less"

Au-Sn alternative low melting glasses

Feature Sealing temperature equivalent to Au-Sn solder (220~300°C)

Benefit Low cost: Approx. 1/5 *2 Au-Sn
Application: crystal oscillator, IC packages



Hitachi Research Lab., Hitachi Chemical Co., Ltd. (2012/11 News release)

*1 A part of this technology was developed under a NEDO project

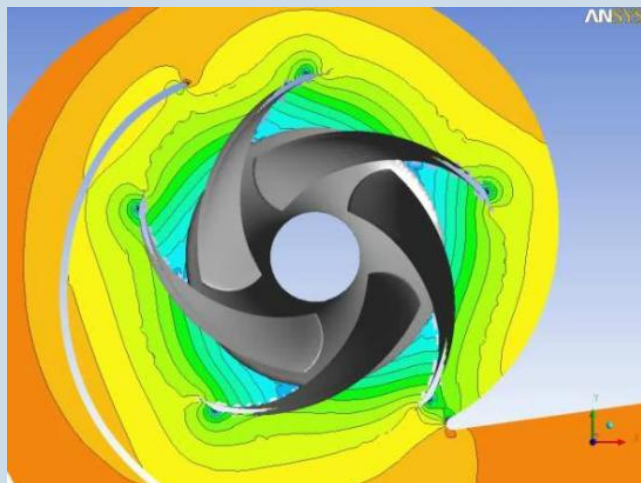
*2 Sample price

Reducing number of prototypes through analysis-led design

Double suction volute pump

Feature Optimization design tool
+
Fluid simulation

- Benefit**
- ① Number of prototypes reduced from previously 5-10
⇒ 1 model
 - ② Improved efficiency: 2% ↑



Air conditioner (Scroll compressor, Fan)

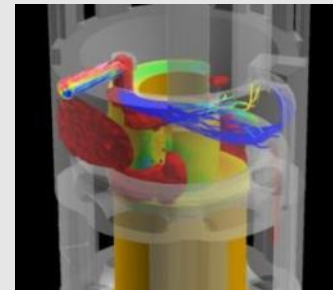
Feature

- ① Multi-physics simulator able to handle control / inverter / motor / compressor mechanism as one
- ② Large scale simulation of 100 million grid

- Benefit**
- ① Low noise structure
 - ② Increased efficiency
⇒ 20% increase under part load condition

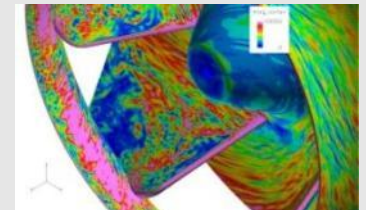


Compressor performance analysis



Predictive analysis of lubricating oil behavior

Noise analysis of air-conditioning fan



Visualization of the vertical vortex structure formed on the wall side as a result of turbulence noise

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5-1. Open innovation

■ R&D collaborations with customers & partners

Organization	Details
King Abdulaziz University	Joint experiment in Saudi Arabian water quality monitoring
13 organizations incl. European automobile manufacturers	Advanced ICT integrated platform for EV
Mitsui & Co., Ltd. Brazilian crop producer	Verification tests for the analysis of crop growth conditions based on satellite imaging
Honda R&D Co., Ltd.	Commercialization of WAN*1 accelerator



WAN Accelerator



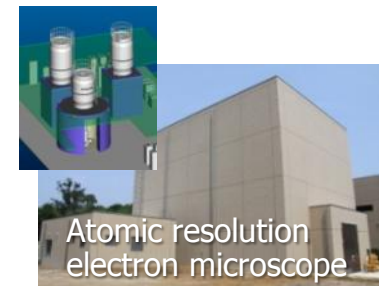
Particle Beam Therapy System

■ Strategic steps for future business using industry-academia collaboration

Hokkaido Univ. (FIRST, CoE)	Particle Beam Therapy System
Univ. of Tsukuba, City of Tsukuba Mobility Robot Experiment Special District	Single-passenger mobility-support robot "ROPITS"
Univ. of Cambridge	Quantum computing
RIKEN (FIRST)	Atomic resolution holography electron microscopy
Tokyo Women's Medical University (FIRST, CoE)	Automatic culturing equipment for regenerative medicine
Kyoto University	Fused silica storage



ROPITS



Atomic resolution electron microscope

*1 WAN: Wide Area Network

*2 FIRST: Funding Program for World-Leading Innovative R&D on Science and Technology, Cabinet Office of Japan

*3 COE: Formation of centers for the creation of innovative mergers of leading edge technologies, MEXT, Japan (-2015)

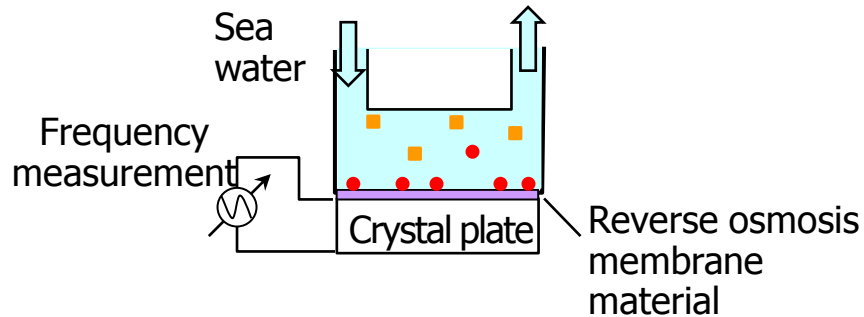
*4 ROPITS – Robot for Personal Intelligent Transportation System

Pursuing O&M*1 business through development of rapid water quality measurement technology for desalination plants

Rapid water quality measurement technology

Measurement time: Previously 1 day ⇨ 1 hour

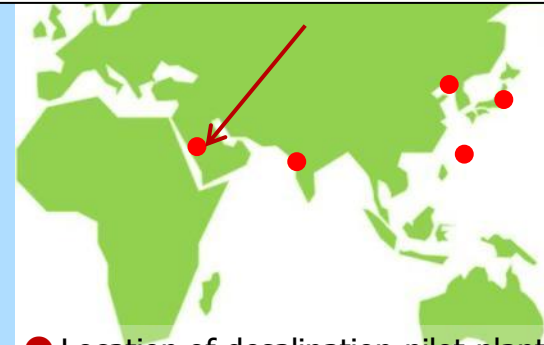
- ① QCM*2 + Reverse osmosis membrane sensor
- ② Direct thin film formation on crystal plate
- ③ Risk index of reverse osmosis membrane contamination



Operation control for stable running of facility

Verification tests in Saudi Arabian waters

Joint Research with King Abdulaziz University, Saudi Arabia (2012/11)



● Location of desalination pilot-plant sites



Desalination facility

Contribute to EPC*3 and O&M business expansion

*1 O&M: Operation & Maintenance *2 QCM: Quartz Crystal Microbalance

*3 EPC: Engineering, Procurement and Construction

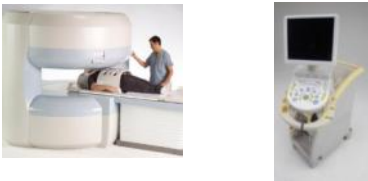
5-3. Activities for regenerative medicine business

Promoting research for future business through industry/academia collaboration

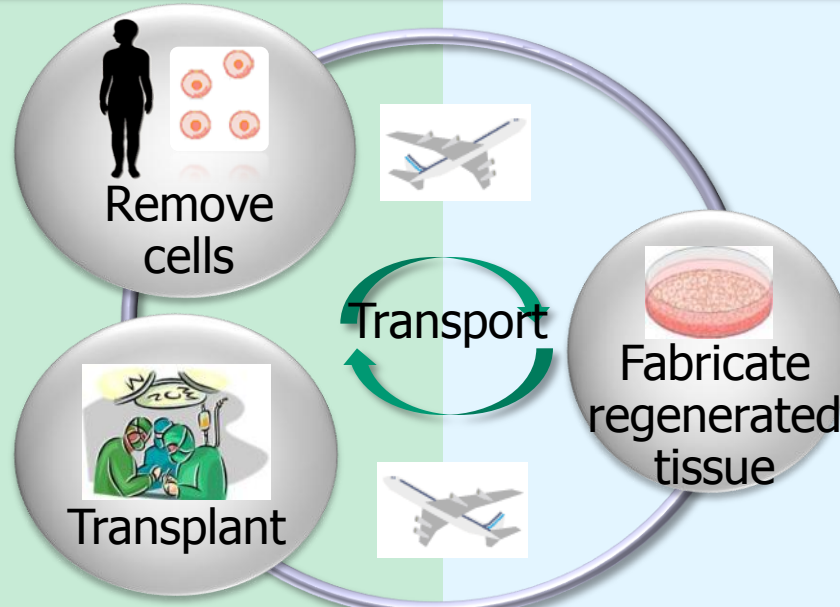
Hospital



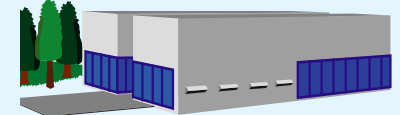
Pre/post surgical
diagnostic imaging



Hitachi Medical Corporation
Hitachi Aloka Medical, Ltd.



Cell processing facility



Clinical testing
equipment



Hitachi High-Technologies
Corporation

Cell transport
technology

Automatic culturing
technology

Low temp./Sealed/Sterile



Hitachi Transport System, Ltd.

Promoting research through university alliance



Bio cleanroom

Culture information
processing system

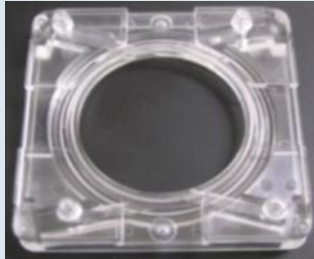
Bacteria/Microbial
Testing Equipment

Infrastructure
Systems Company

5-4. Cell sheet automatic culturing technology

Establishment of automatic culturing technology for stable quality and cost reduction

Small automatic culturing equipment

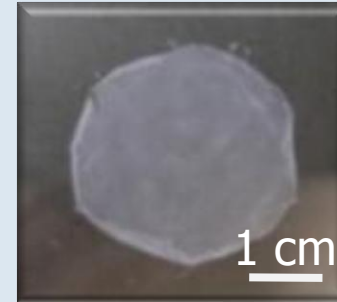


Cell culturing cartridge

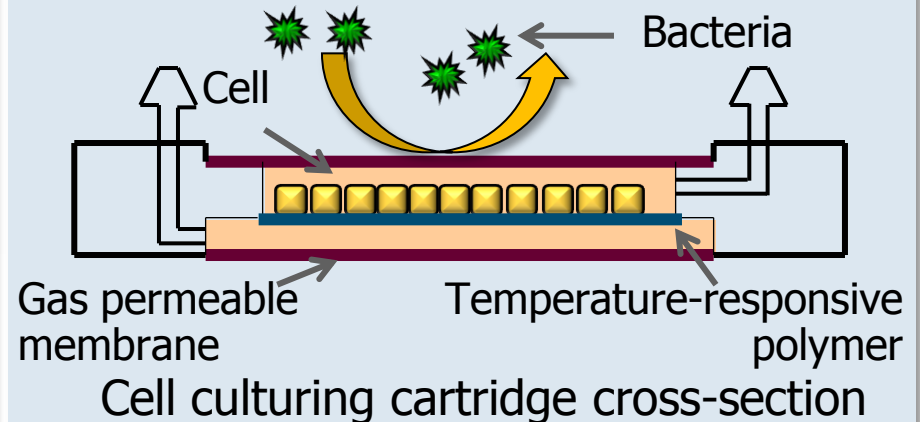


Completely closed automatic cell culturing equipment to prevent contamination from the outside

Human corneal & esophageal tissue culturing



Cell handling technology to detach tissue without damaging cells
(Tokyo Women's Medical University)



- Result of joint research with TWMU in the Ministry of Education, Culture, Sports, Science and Technology project on the "Creation of Innovation Centers for Advanced Interdisciplinary Research Areas Program: CSTE (Cell Sheet Tissue Engineering Center)", and the basic technologies research promotion project of the New Energy and Industrial Technology Development Organization, for the "Development of nano-bio interface technologies for tissue regeneration implant.

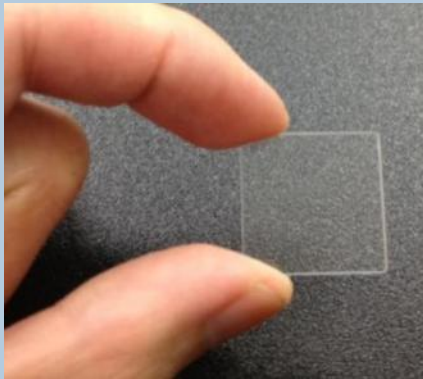
- 2012/8/29 News release

Establishment of semi-perpetual digital archiving technology for historically valuable data

CD-equivalent density achieved

Kyoto University
Microfabrication using

Femtosecond-pulse laser technology



- Multi-layer recording using high power laser to record 4 layers within the fused silica [40MB/inch²]
- Accelerated temperature resistance test of 1,000°C for 2 hours with no degradation [equivalent to fire-resistant safe]

Simple access to data using commercially available optical microscope



- Optical microscope image



Image processing
[Contrast, outline
enhancing signal
processing technology]



- Image after image processing
- Zero read error achieved for all four layers [S/N ratio: 15 dB]

Major awards & recognitions (1)

Recognition

Technology/Product [Joint recipient]

The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology
(April 2013)

Development of Particle Beam Therapy System



The New Technology Development Foundation
44th Ichimura Prizes in Industry
- Meritorious Achievement Prize (April 2012)

For the development and practical application of the spot-scanning proton beam therapy system

The Nikkan Kogyo Shimbun, Ltd.
Japan Industrial Techniques Grand Prix -
Minister Award of Education, Culture, Sports,
Science and Technology (April 2012)

Development of the new E5-series *Shinkansen*
[East Japan Railway Company & 10 others]

The Nikkan Kogyo Shimbun, Ltd.
55th (FY2012) Best Ten New Products Awards
- Best Ten New Products Prize
- Nippon Brand Prize (January 2012)

Hitachi
WAN Accelerator



2012 IEEE Reynold B. Johnson Information Storage Systems Award
(November 2012)

For leadership in the development of innovative storage systems



Recognition

Technology/Product [Joint recipient]

universal design GmbH

- universal design award 2013
- universal design consumer favorite 2013
(February 2013)

- X-ray equipment "Radnext PLUS"
[Hitachi Medical Corporation]
- Washer/dryer "Heat recycle *Kaze-iron* Big Drum Slim BD-S7500"
[Hitachi Appliance, Inc.]

iF International Forum Design GmbH
iF Product design award 2013

(Dec. 2012)



- Cyclonic vacuum cleaner "CV-SU" series
[Hitachi Appliance, Inc.]



- LCD projector "8000 series"
[Hitachi Consumer Electronics Co., Ltd.]



The Nikkan Kogyo Shimbun, Ltd.
42nd Machine Design Awards
- Nippon Brand Prize

(July 2012)

- X-ray equipment "Radnext PLUS"
[Hitachi Medical Corporation]



Promotion of R&D for a major global player

Enhancement of global R&D

Increase global R&D personnel to 400 by 2015

Newly establish 1 lab, 3 research centers to lead regional business

Prioritizing Social Innovation Business

Generate competitive component products as well as lead infrastructure systems services for global business

Strengthening the management platform

Promote cost structure reform through research and development in materials, analysis and *MONOZUKURI* technology

Open innovation

Pioneer solution business and promote leading-edge research for future business through collaborations with global customers or industry-academia alliances.

END

R&D strategy to become a major global player

April 16, 2013

Shigeru Azuhata

Executive Vice President & Executive Officer,
General Manager, R&D Group,
Hitachi, Ltd.

HITACHI
Inspire the Next 