

R&D Activities for Social Value Innovation

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- 1. NEC and Social Value Innovation
- 2. NEC R&D Contributes to Solutions for Society
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 - 3-1. Reinforce Technology to Create New Business
 - 3-2. Initiatives for Innovative Technologies
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Japan's population is expected to decrease from 120 million people today to 80 million people in 2050

The Earth

Requires effective infrastructure with capability to handle twice as much as current demand



Japan

Requires effective infrastructure that can be supported by 60% of current population



Challenging the issues in society

Identified seven themes for social value innovation by observing megatrends and technology trends

6 Megatrends



Chain of resource & environmental issues



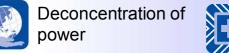
Emerging countries growth & challenges



Search for mature society models



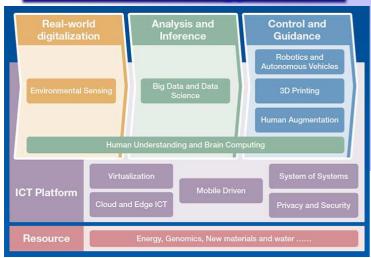
Power and influence of individuals





Diversified threats, need for safety and security

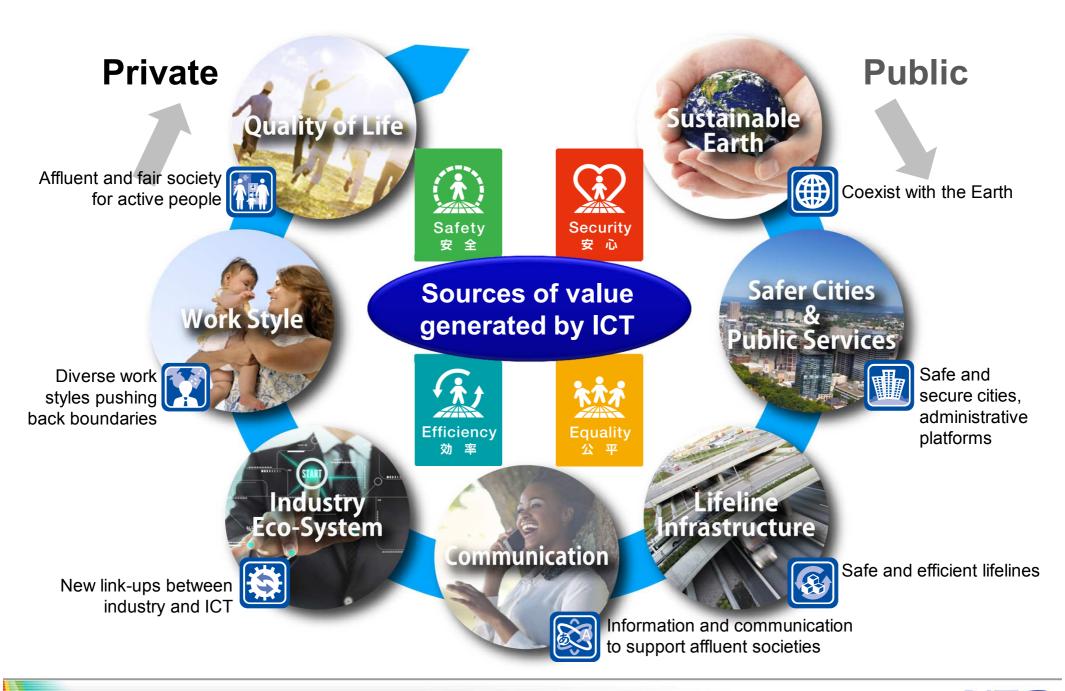
Future Technology Trends



Seven Themes for Social Value Innovation



Seven Themes for Social Value Innovation



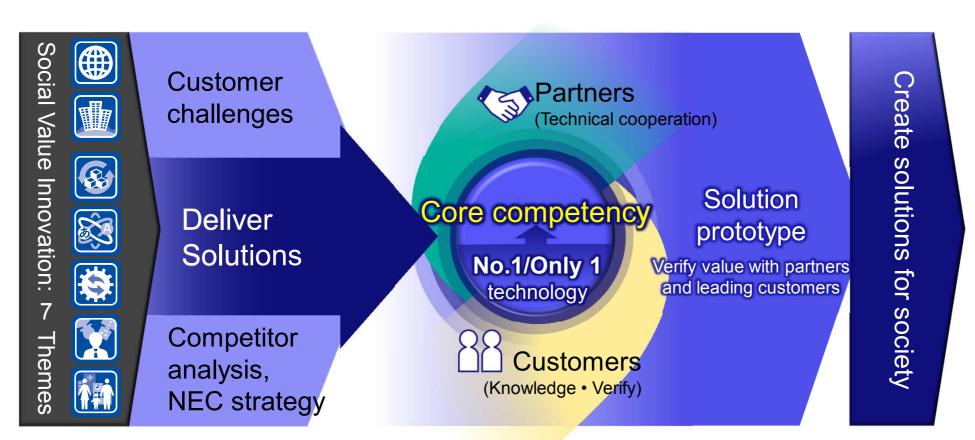
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2-1-1. R&D Strategies

- (1) Concentrate and deliver high value in our strong areas
- (2) Deliver core conpetency with strong technologies
- (3) Co-create strong solutions with our partners and customers







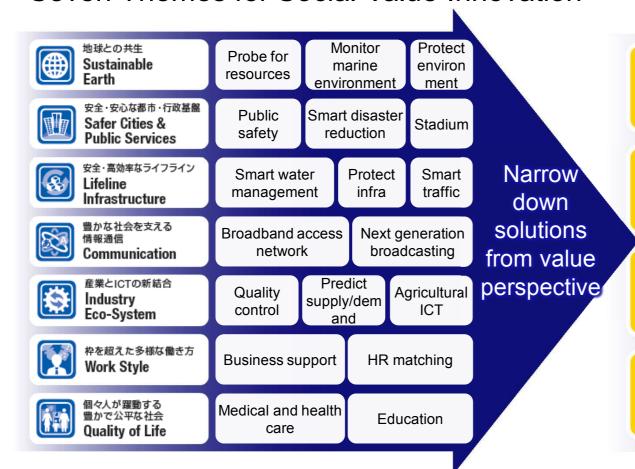




2-1-2. Narrow Down Solutions

Focus on solutions for society that deliver high value

Seven Themes for Social Value Innovation



Potential solution

No.1/Only 1 Technology

Stable infrastructure operation at power companies

Invariant analysis

Integrated city monitoring for emerging nations

Face recognition

Manage business information risk in large corporations

Recognizing textual entailment

Efficient energy management at large-scale facilities

Heterogeneo us mixture learning

.

2-1-3. Main Business Outcomes

(2013-2014)

Continued to deliver competitive solutions for society. Worked to refine our propriety technologies.









2-2-1. Case Study: Integrated City Monitoring

Integrated analysis of data from surveillance cameras and SNS using the world's best engines. Verify efficient monitoring systems for government interagency use

Inefficient security maintenance to government silos

Deteriorating safety due to rapid urbanization

Barriers between ministries

For governments:
Comprehensive
city surveillance
by Interagency
Collaboration

Develop technologies for image processing, sentence analysis



Consortium for technical

cooperation

- Smell analysis (iOmniscient)
- · GIS Platform (ESRI) and other 7 companies

Integrated analysis of information between organizations

Facial recognition technology No. 1 for accuracy and speed*

Recognizing Textual Entailment
No. 1 for target accuracy*

Accumulate knowledge by verifying with Singapore government agencies

ntegrated city monitoring

88

Singapore government agencies

- Provide data from street surveillance cameras
- Provide venues for demonstration experiments

*Evaluated by the U.S. National Institute of Standards and Technology (NIST)

2-2-2. No.1/Only 1 Technologies: Business Contributions

(2013-2014)

Seven Themes for Social Value Innovation

Contributions to the Business

No.1/Only 1 Technologies



地球との共生 Sustainable Earth



安全・安心な都市・行政基盤 Safer Cities & Public Services



安全・高効率なライフライン Lifeline Infrastructure



豊かな社会を支える 情報通信 Communication



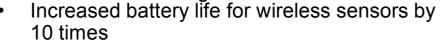
産業とICTの新結合 Industry Eco-System



枠を超えた多様な働き方 Work Style



個々人が躍動する 豊かで公平な社会 Quality of Life Reduced power consumed by air conditioning by 30% at NEC Kanagawa Data Center





Introduced system at Lemon Tree Hotels in India

 Participated as a leading enterprise in the Singapore Safe City Project

 Predictive monitoring for nuclear plant failures at The Chugoku Electric Power Co., Inc.

Set up cyber security solution systems

Provided TMS applications

 Delivered over 200 SDN^{*2} solutions to corporations and organizations worldwide

Verified product demand prediction at major retailers

 Provided to major advertising agencies a service that link print medium ads with smartphones

Provided HR matching solutions

Built 4K broadcasting system/ test broadcasting

Phase change cooling

Spintronics circuit

Facial recognition

Crowd behavior analysis

Invariant analysis

Lightweight encryption

Bandwidth prediction

SDN

Heterogeneous mixture learning

Image recognition

RAPID machine learning

Real-time processing

*1: Traffic Management Solution

*2: Software-Defined Networking

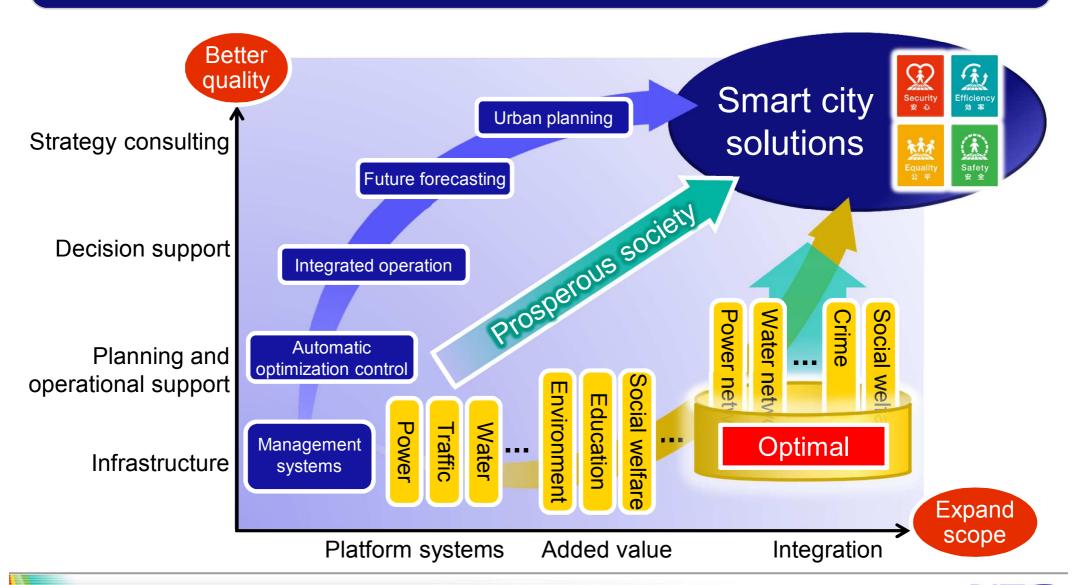


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3-1-1. Changes in Solutions for Society

Provide high value-added solutions for society by upgrading services and optimizing entire systems



3-1-2. Provide Integrated Solutions for Society

Provide for customers with efficient and secure businesses by integrating our strong competencies



Smart water management

Efficient and equality water supplies



Diagnose deterioration

Predict deterioration

Preventive infrastructure maintenance

Efficient maintenance of road infrastructure



Predictive monitoring

System security

Secure Operation of social infrastructure

Stable operation of all important infrastructure



Traffic prediction

Fleet management

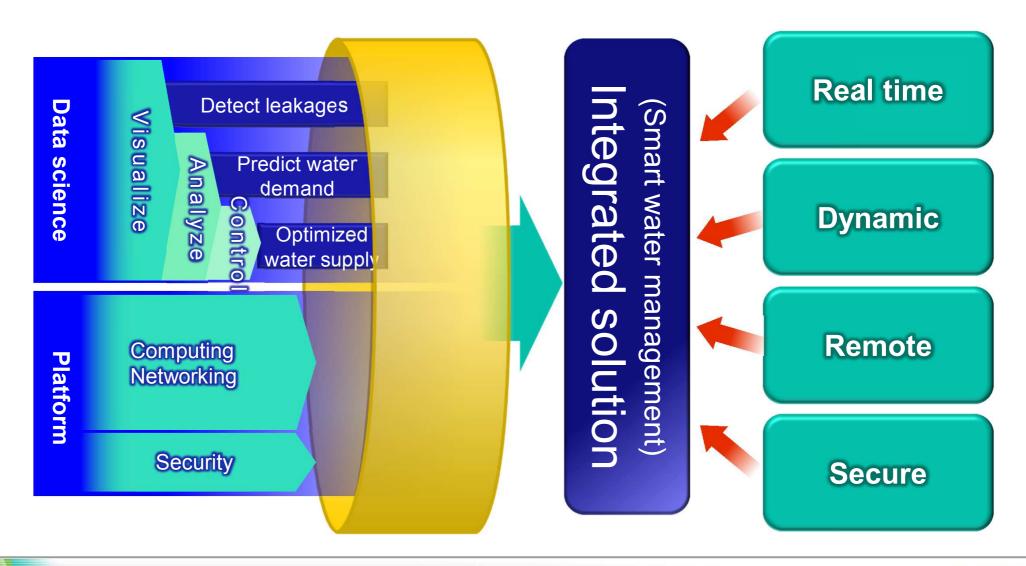
Smart traffic

Safe and efficient public transport



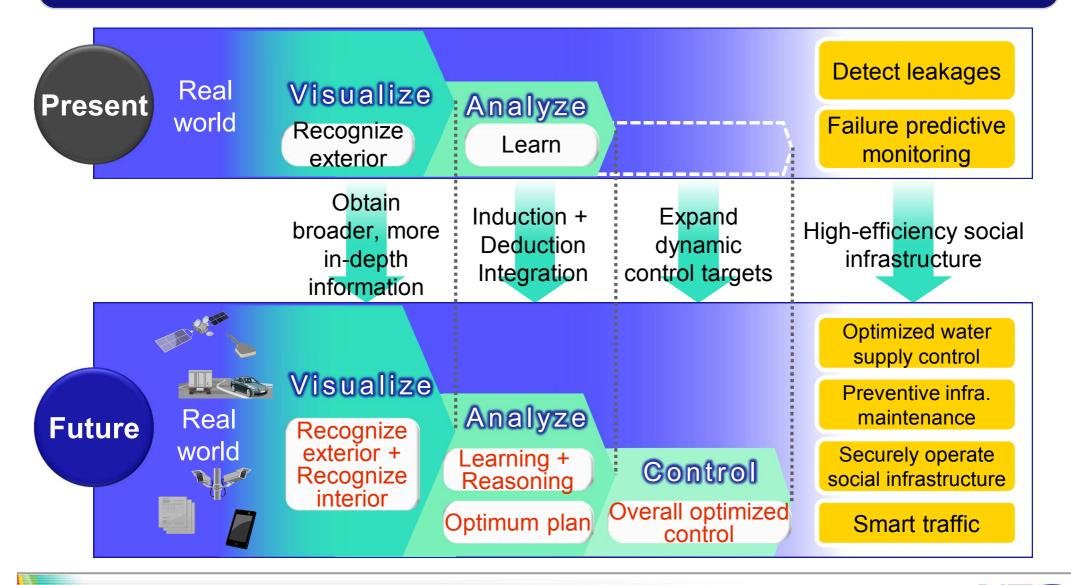
3-1-3. Added Value and Integrated Solutions for Society

Focus on core technologies to add value to solutions and refine No. 1/Only 1 competency



3-2-1. Changes in Data Science Technologies

By leveraging our strength in visualization and analysis, enhance accuracy of prediction and broaden subjects of surveillance



3-2-2. Reinforcement of Data Science (1) Visualization

Provide unique solutions by obtaining broader, more in-depth information

No. 1 technologies (Accumulated strengths)

Visualization technologies (Reinforce strengths)



Recognize exterior



btain in-dep

information

information

btain broac

Recognize interior



Identify unique patterns only



Identify general objects

Preventive maintenance of infrastructure



Differentiate with new social values

Diagnose extent of structural deterioration

Smart cities, smart infrastructure

Secure distribution



Tagless tracing

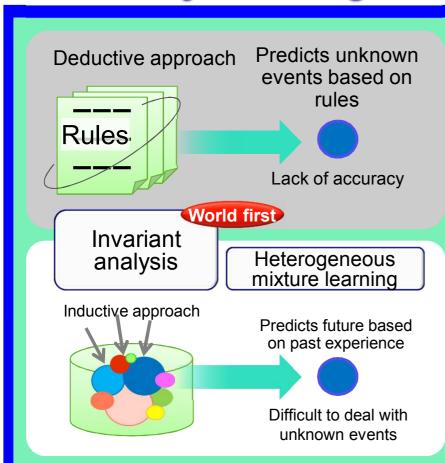
2014

2018

3-2-3. Reinforcement of Data Science (2) Analysis

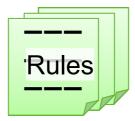
Optimize future prediction for more complex and uncertain social systems by joining inductive prediction (experience) with deductive prediction (rules)

No.1/Only 1 Technologies



Analytical Technologies

Reasoning based on organically combining induction and deduction



rules for the unforeseen



Smart Traffic



Optimum deployment for public transport incidents Supports incidents

Supports more complex and uncertain systems

Optimum water infrastructure



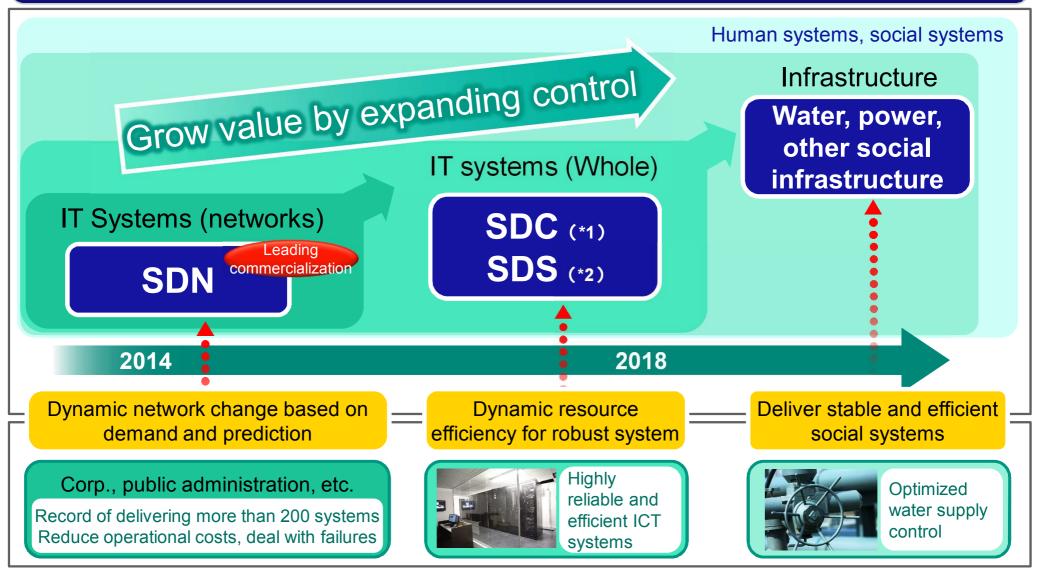
Supports a city-wide incidents

2014

2018

3-2-4. Reinforcement of Data Science (3) Control

Expand objects of control to deliver dynamic and optimized controls for the entire social system



*1: Software-Defined Computing

*2: Software-Defined Storage

Empowered by Innovation

3-2-5. Aims of Platform Technologies

Respond to large-scale, complex issues in the real world by developing the sources of ICT value: Real-time, Dynamic, Remote, Secure

Real time

Understand and respond to current situations in real time



Predict next likely situation, optimize controls in real-time

Dynamic

Build the response based on information



Respond efficiently and in real time to complex changes in situations

Remote

Freely exchange information between remote locations



Overcome distances,

deliver functionality
without stress

Secure

Secure stability for each system, venue



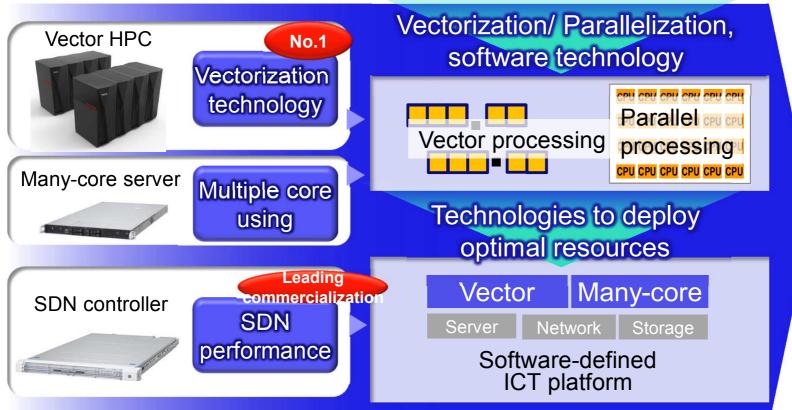
Secure stability of overall social systems

Respond **ISSUES** large-scale, complex the real world

3-2-6. Strong Platform (1) Computing

Deliver real-time operation and cost-efficient manner by dynamic combination of vector/parallel processing technologies





Real time

Process large-scale, complex visualization, analysis in real time

Dynamic

Dynamically change configurations, allocations in line

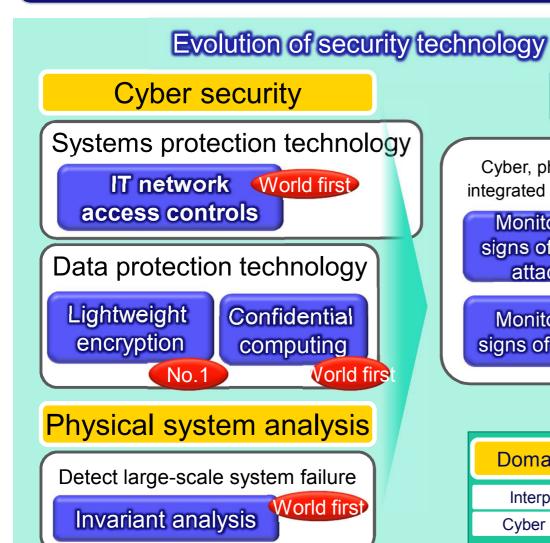
3-2-7. Strong Platform (2) Networking

Deliver non-discriminative and high-quality communications platform by elevating optics and wireless connectivity

Mobile broadband evolution **Network evolution** 100G Capacity (Bit/s) / Fiber Pair Regener Super Channel Multi-Core 5G Multi-Mode **Throughput** 10G **CLTE-Advanced** 10T (Digital Coherent 1G 3rd Generation (Multi-level formats 100M IEEE 802.16m 2nd Generation 1x EV-DO Rev.A 10M (Bit/s) HSPA+ 1x EV-DO Rev.0 1M **Transmission** W-CDMA 2.5G x 8 **EDGE** Generation capacity of optical (WDM) H cdma2000 1x 100k **GPRS** submarine cable HSCSD 2010 2010 2000 2005 2015 2020 1994 2000 2020 1995 Remote Large-capacity optical Compact wireless station submarine cable High-Half size Fair 400G efficiency Optical signal commumodulation Transmission nication technology platform **World first** Easy to put in crowded places Across the South Atlantic

3-2-8. Strong Platform (3) Security

Securely operate large-scale, complex social infrastructure with integrated physical and cyber security defenses



Cyber, physical integrated defense

Monitor for signs of cyber attacks

Domain knowledge

Interpol collaboration

Cyber Security Factory

Information systems

Failure

Control systems

Cyber attacks

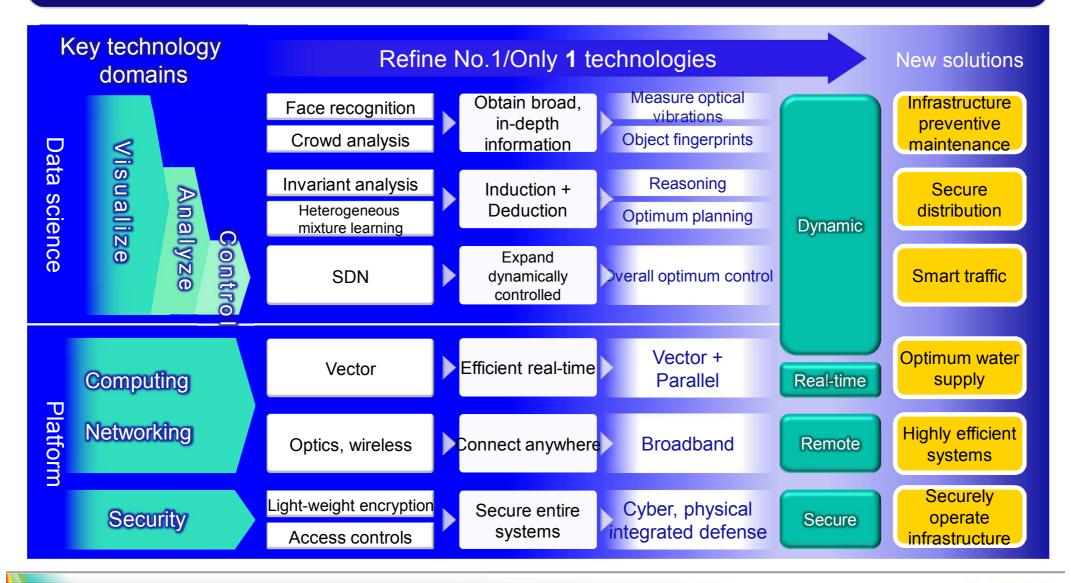
Physical systems

Peterioration

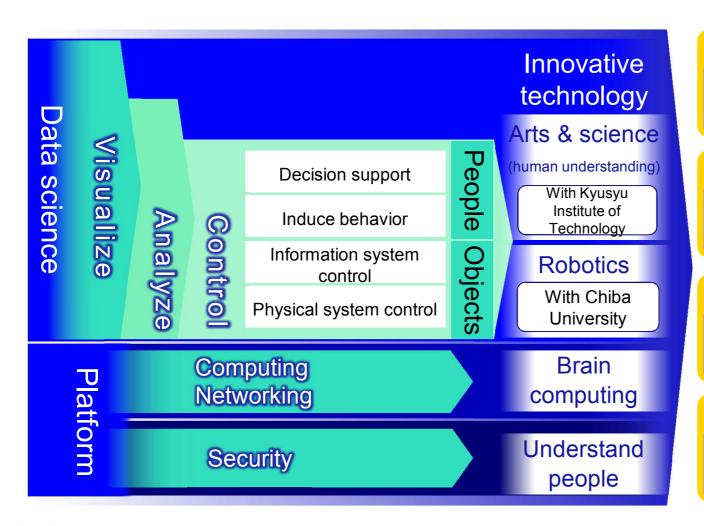
Failure

Secure operation of large-scale, complex social infrastructure

Focus on strengthening visualization, prediction and optimal control for large-scale complex systems and platforms



Innovative technologies that comprehend and influence human behavior operate efficient systems across society



The New Society

Control with Humanlike Thinking

- Induce user behavior
- Marketing based on understanding people

Advanced Security

- Measures to counter inside jobs
- Measures to counter linked cyber, physical attacks

Human-Robot Cooperation

- Automatic operation, driverless transport
- Improve production efficiency, product quality

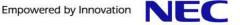
Expand Human Ability

- Reinforce functional capacity, cognitive ability of people
- Expand memory and capacity for judgment

NEC

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4-1-1. Strengthen Global R&D Activities

- (1) Leverage local advantages at five labs to create No.1/Only 1 technologies, create new business through collaboration between labs
- (2) Reinforce global open innovation to build solutions

NEC Labs. Europe •R&D marketing and core technology development through standardization and • Develop new solutions for a sizable market

NEC Labs. America, Inc

EU projects

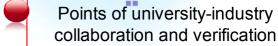
 Develop core technologies by leveraging presence in the country of cutting-edge technology and business Established in 2013

NEC Labs. Singapore

 Use core technologies from other labs for collaboration and demo experiments with local government and customers

Central Research Laboratories (Japan)

- The control tower for research
- Develop new solutions in collaboration with customers/divisions

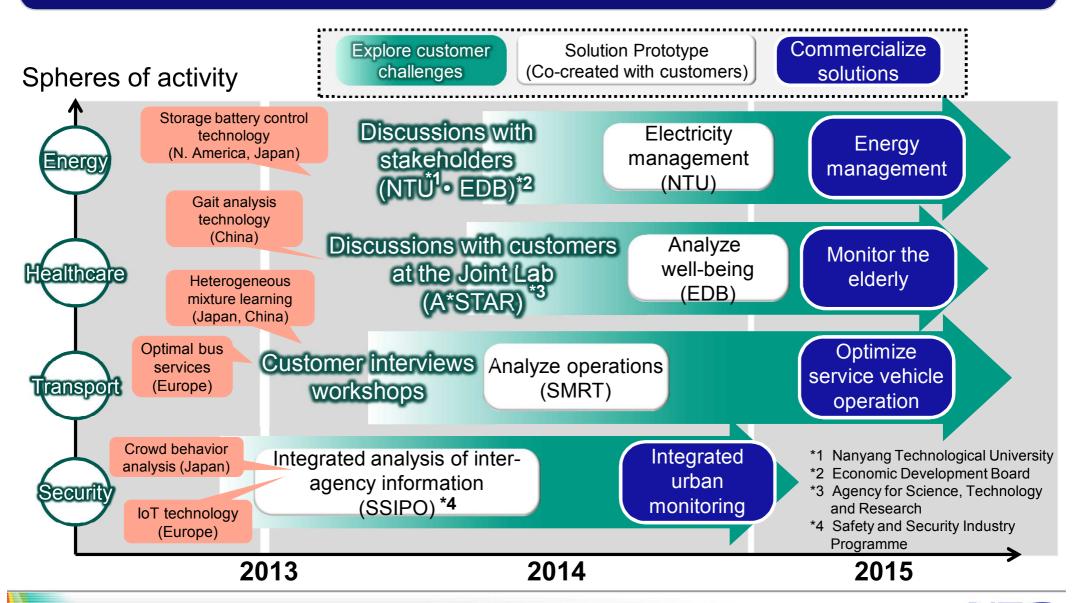




4-1-2. Verify Solutions at NEC Laboratories Singapore

Expand activities to other domain following the success in the safety domain.

Introduce competent technologies and promote open innovation



4-2-1. Build Solutions Based on Open Innovation

In collaboration with Imperial College and Water Utilities in UK, delivered smart water solutions by leveraging leakage detection and technologies to forecast demand



Imperial College London, UK

Water quality monitoring, water pressure sensors, water pressure remote control, monitoring and other water network control technologies

Vibration sensing technology

Detect water pipe leakage

NEC

World's first
Heterogeneous mixture learning

Predict water demand

Customer

Water utilities, UK

All data, fields for water pipe network



Smart water solution

Prevent leaking pipes

Plan, control optimum water supply



4-2-2. Other Open Innovation Cases

Leverage No.1/Only 1 technologies to collaborate with strong partners and knowledgeable customers

Aim	Main activities (main business partners)	Supporting No.1/Only 1 technology
Explore new ideas (Expert staff to explore external tech.)	 Human systems (Future University Hakodate, Kyushu Institute of Technology) Prevent human error (Keio Univ.) Healthcare Joint Lab (Singapore, A*STAR) 	 Understand human mind through approaches based on cognitive science, physiology Explore security of human systems Heterogeneous mixture learning
Reinforce core tech. (Strengthen portfolio by teaming up with world's No.1 organizations)	 Obtain security technologies (ETH Zurich) Develop SDN related tech in USA (ON.Lab *1) 	Encryption technologyDistributed controller
Promote commercialization (Verify value together with customers)	 Water management (Imperial College, UK) Public safety (Singapore, SSIPO) Micro grids (Singapore, NTU) Wireless networks to support education (SRM Univ., India) 	 Leakage detection/ Heterogeneous mixture learning Real server integrated monitoring Storage battery integrated monitoring Communication without infrastructure

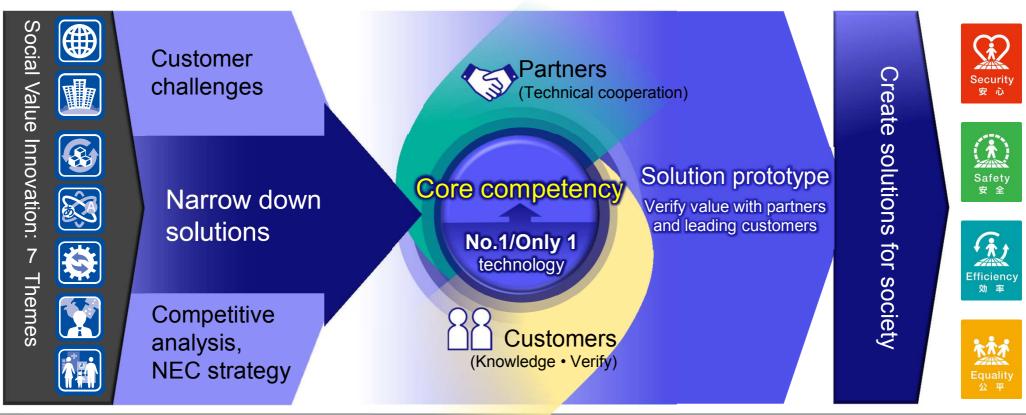
*1 The Open Networking Lab.



5.Summary

Create new solutions for society through co-creation with partners and customers; differentiate through strong technologies and by narrowing down domains

- (1) Actively search for technologies and next growth market
- (2) Refine our competencies by focusing on No.1/Only 1 technologies
- (3) Create new solutions with global open innovation



Orchestrating a brighter world

NEC brings together and integrates technology and expertise to create the ICT-enabled society of tomorrow.

We collaborate closely with partners and customers around the world, orchestrating each project to ensure all its parts are fine-tuned to local needs.

Every day, our innovative solutions for society contribute to greater safety, security, efficiency and equality, and enable people to live brighter lives.