B2B2X Value Creation by NTT R&D

September 28, 2017

Hiromichi Shinohara

Senior Executive Vice President, Representative Member of the Board
CTO, CISO, Head of Research and Development Planning

NIPPON TELEGRAPH AND TELEPHONE CORPORATION

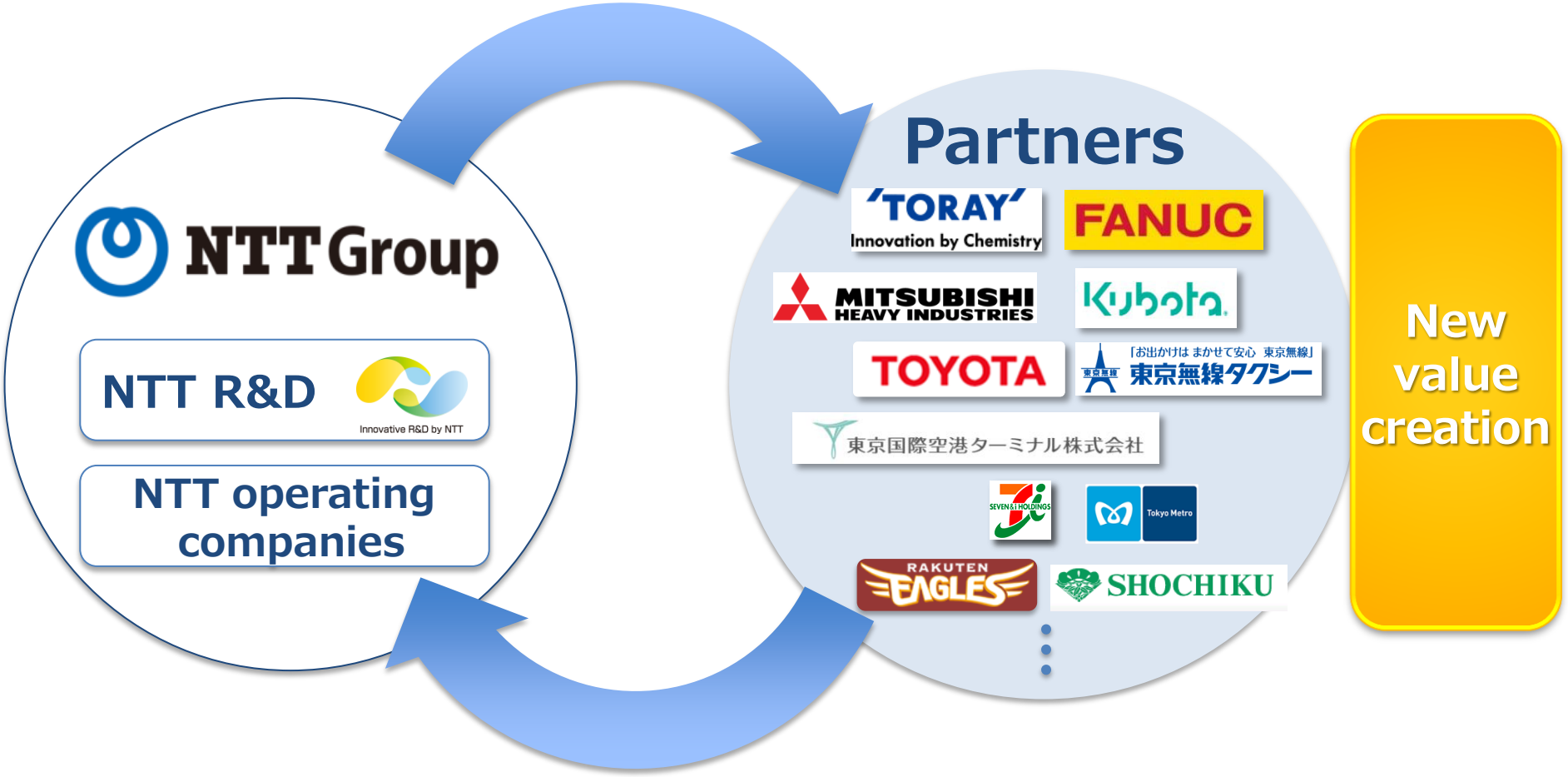
Progress of B2B2X Business

Innovative R&D by NTT

New Values Created by R&D

R&D Toward a Better Future

B2B2X and R&D



Innovative R&D by NTT

FANUC to Offer New IoT Platform for Manufacturers

NTT Group

NTT DATA

NTT Communications

NTT

Preferred Networks

FANUC

Manufacturers

Application Software developers

NTT DATA

Network integration partners

NTT Communications

FIELD system is an IoT system for manufacturing industry developed jointly with Cisco systems, Rockwell Automation, Preferred Networks and NTT group under FANUC's initiative.

Safe and Secure Operation of Important Infrastructures

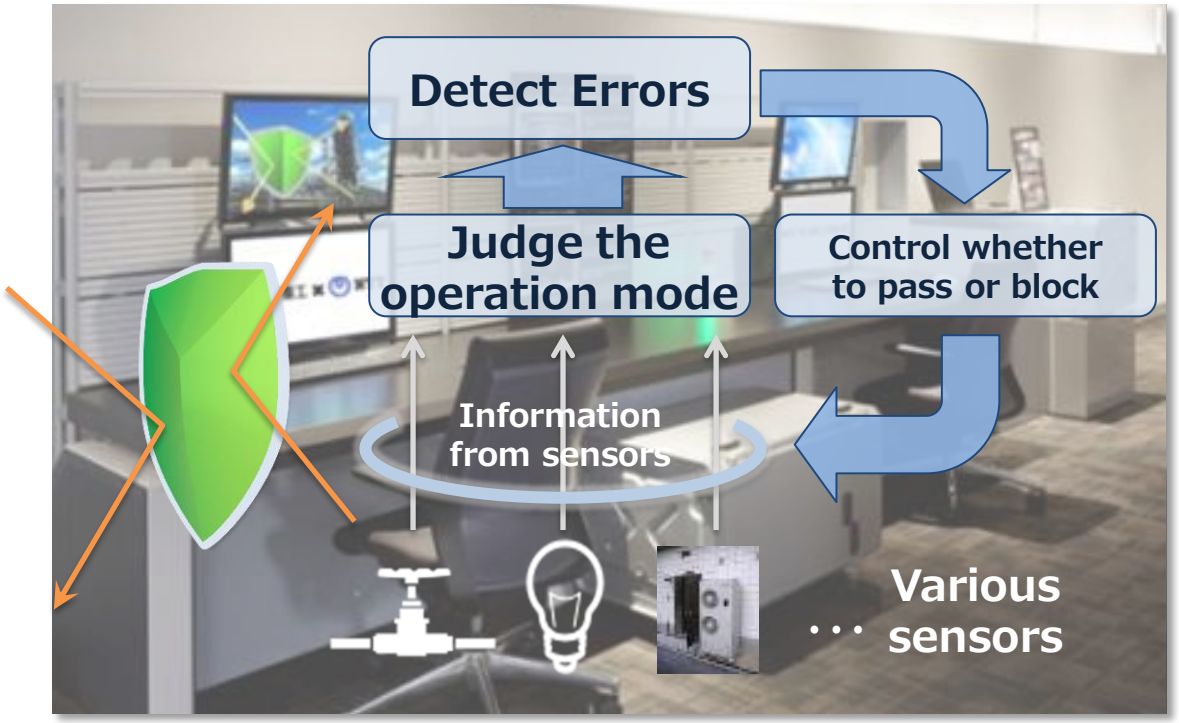
Highly reliable control technology obtained in defense/space fields

MITSUBISHI HEAVY INDUSTRIES & NTT NTT Communications

Cutting-edge security technologies

InteRSePT®

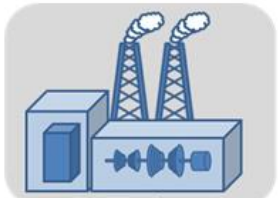
A cyber security technology for critical infrastructure control systems



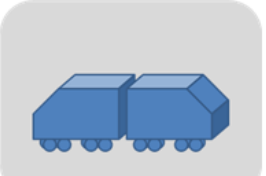
Important Infrastructures

Safe and Secure Operation

Market Expansion



Power generation plants



New Automated transit systems

Chemical Plants

Launch Virtual Reality Baseball Coaching System

RAKUTEN EAGLES & NTT NTT DATA

Athlete First-Person Vision Synthesis

Rakuten Baseball, Inc. will pioneer use of the system from 2017 season

allows players to experience a sense of full realism

Utilized by professional players for training before a match

Real video image + CG

Innovative R&D by NTT

Progress of B2B2X business
New Experience by Integration of Traditional Entertainment and ICT

NTT

SHOCHIKU & NTT

2017

2016

April 2016
Cho-Kabuki
Supported by NTT

May 2016
KABUKI LION
In Las Vegas

March 2017
Virtual Kabuki Theater in Kumamoto

Kumamoto Prefecture

NTT WEST

April 2017
Cho-Kabuki
Supported by NTT

dwango

ニコニコ超会議2017

Progress of B2B2X Business

Innovative R&D by NTT

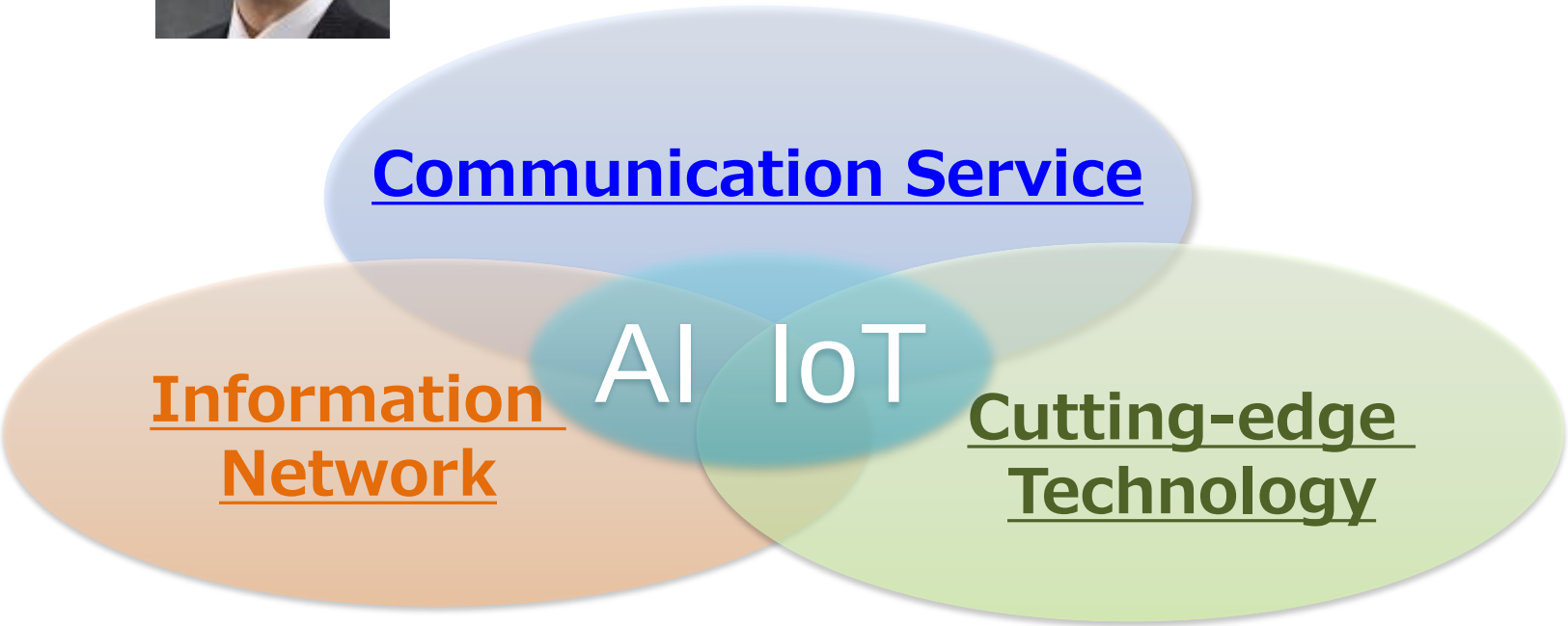
New Values Created by R&D

R&D Toward a Better Future

Three Laboratory Groups of NTT R&D

Senior VP of Service Innovation Laboratory Group

Katsuhiko Kawazoe



Senior VP of
Information Network
Laboratory Group

Tadashi Ito

Senior VP of
Science and Core Technology
Laboratory Group

Yoshiaki Sato

New Values Created by R&D

Innovative R&D by NTT

Realization of Connected Car

safe

comfortable

secure

appropriate

Realization of connected car

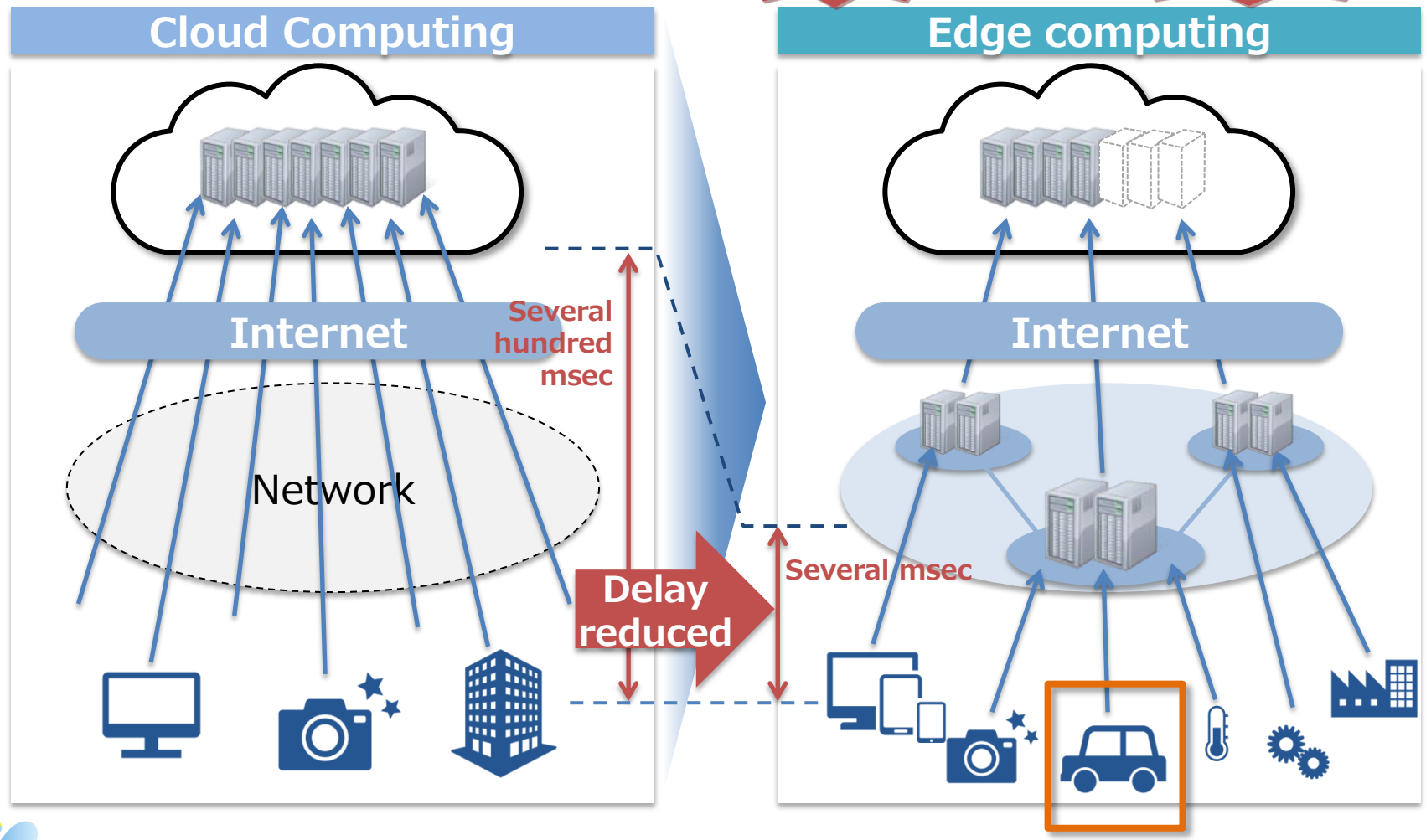
Innovative R&D by NTT

Technologies Supporting Connected Car

Edge Computing

Real-Time operation

optimal application placement



Innovative R&D by NTT

Technologies Supporting Connected Car

Car Security R&D

Service provider

Auto manufacturer/ supplier

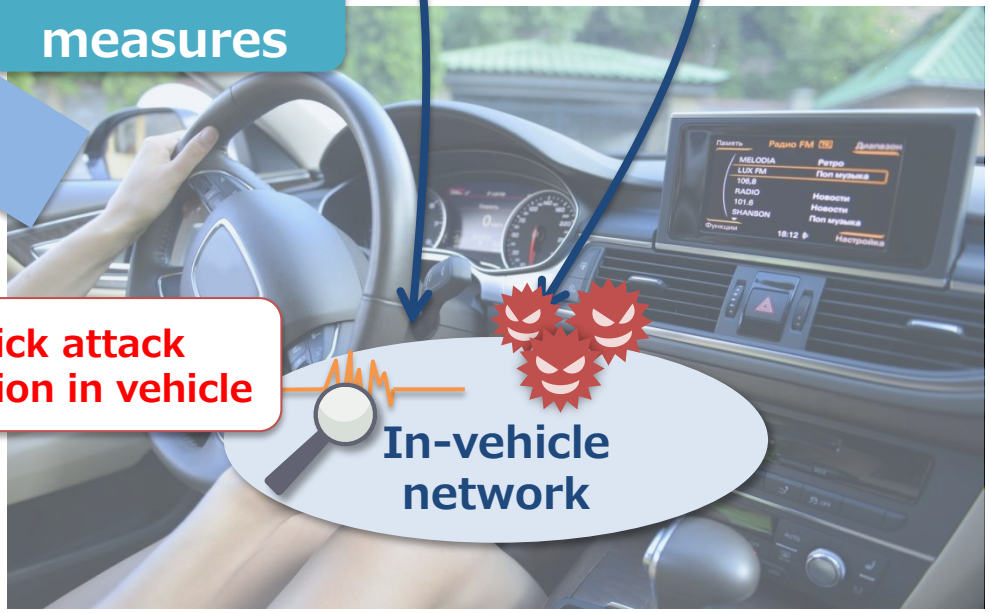
Cloud measures

Advanced attack detection

Network traffic

In-vehicle measures

Vehicle data/Log



Quick attack detection in vehicle

In-vehicle network

Cyber Attack Countermeasures specialized in “in-vehicle”

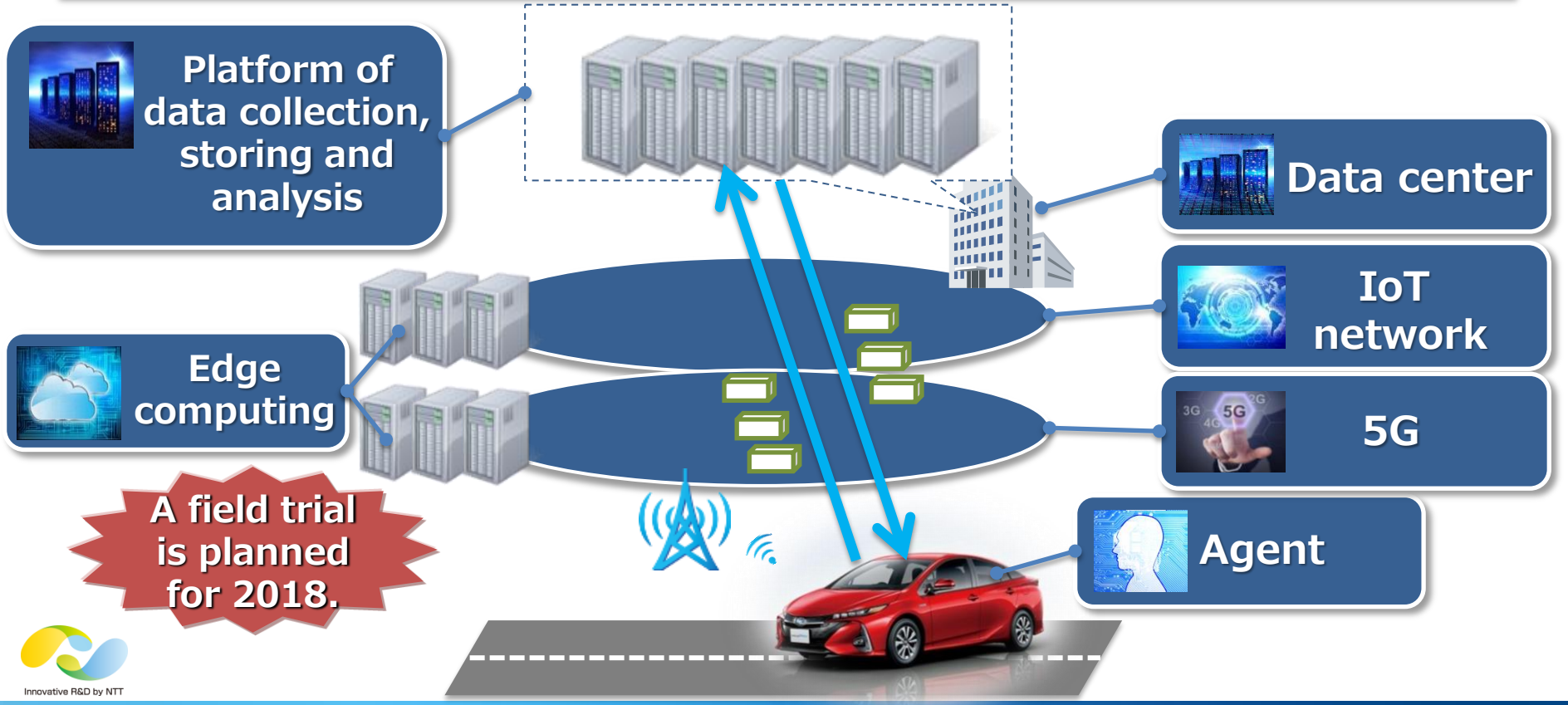
Innovative R&D by NTT

Collaboration in Connected Car Field

TOYOTA & **NTT Group**

Technologies related to vehicle **Technologies related to ICT**

Toyota and NTT collaborate with the aim of developing, validating, and standardizing technologies in the connected car field.



Innovative R&D by NTT

Establishment of Consortium in Auto Industry

3GPP
3rd Generation Partnership Project

ETSI
European Telecommunications Standards Institute

Open Edge Computing

Propose to international standards organizations

- Car manufacturers
- Carriers
- Auto parts manufacturers
- NW device vendors
- Semiconductor vendors

Promote to related industries

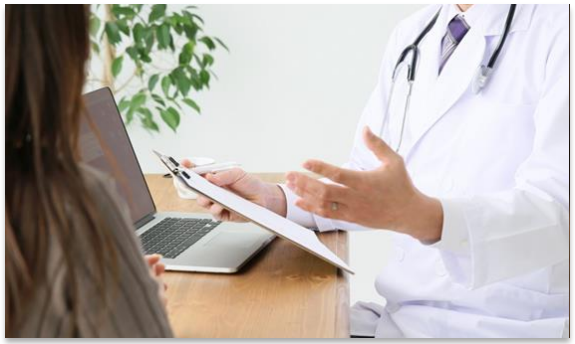
Automotive Edge Computing Consortium

Promoters

DENSO
Ericsson
Intel
NTT
NTT DOCOMO
TOYOTA Info Technology Center
TOYOTA

Innovative R&D by NTT

Realization of Healthy Longevity Society



Extension of healthy longevity

Optimization of healthcare cost

Dealing with super aging society

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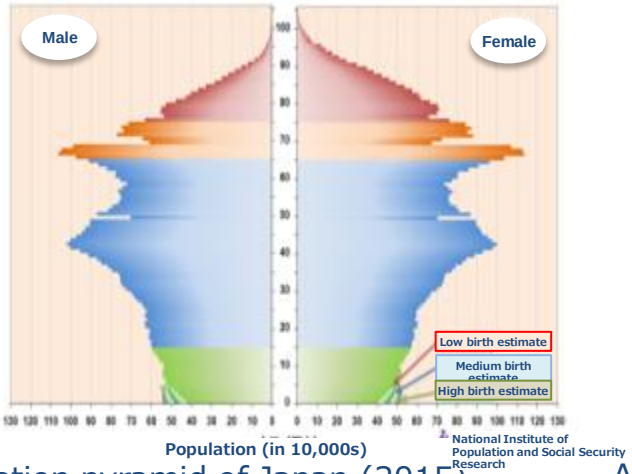
Improvement of disease detection rate

Promoting early discharge

Care prevention

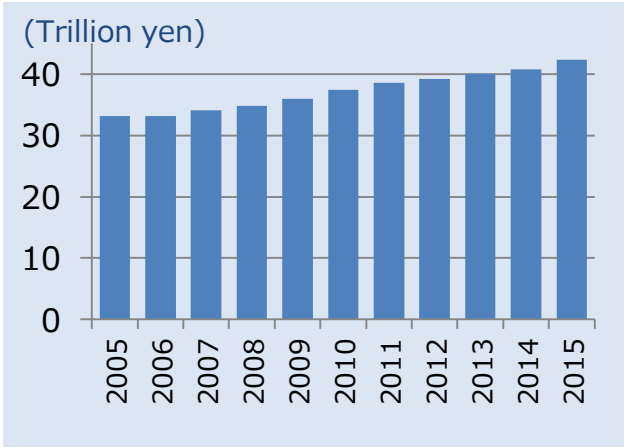
Monitoring system for elderly people

.....



Population pyramid of Japan (2015)

Source: Web site of National Institute of Population and Social Security Research (http://www.ipss.go.jp/site-ad/TopPageData/pyra.html)



Annual change in national medical care expenditure

Source: Created by NTT based on "Estimates of National Medical Care Expenditure 2015" (MHLW) (http://www.mhlw.go.jp/toukei/saikin/hw/k-iryohi/15/index.html

Innovative R&D by NTT

Functional Material Sensing Fabric “hitoe®”

TORAY Innovation by Chemistry & NTT

Nanofiber Fabric　　Conductive fiber technology

Unlikely to cause skin rash

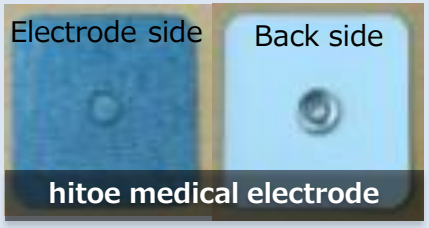
hitoe®

Continuous Long-term monitoring

New Functional Fabric

PMDL
Pharmaceuticals and Medical Devices Law

Registered as General Medical Equipment (Aug. 2016)



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Innovative R&D by NTT

Services Supporting People's Health

NTT

Health Promotion

Optimization of medical cost

Fujita Health University Hospital

'TORAY' Innovation by Chemistry

NTT docomo

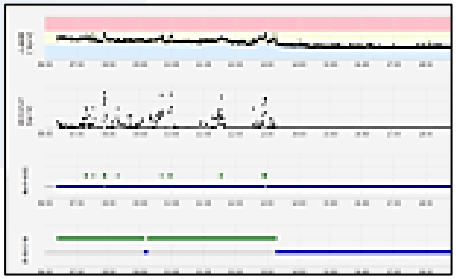
Joint experiment underway

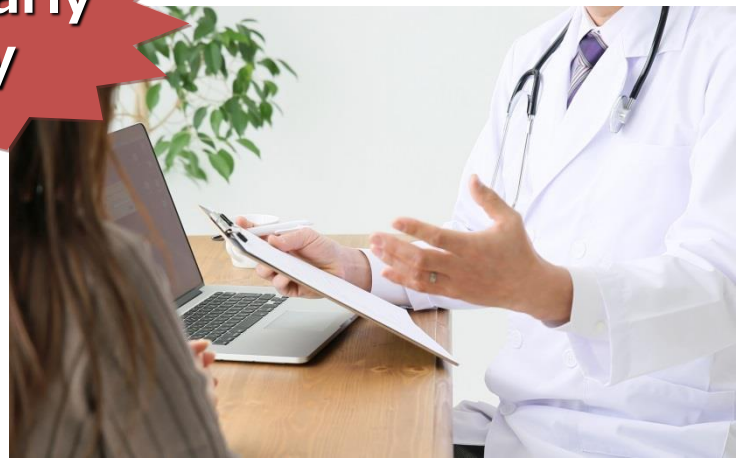
Promote early recovery

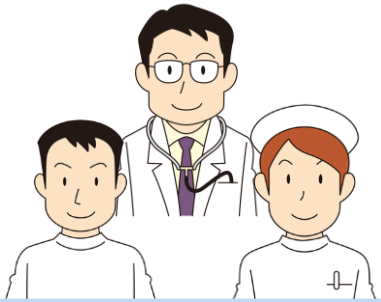
Monitoring of rehabilitation patients

Heart rate

Rest/Walking







Make effective rehab programs

Innovative R&D by NTT

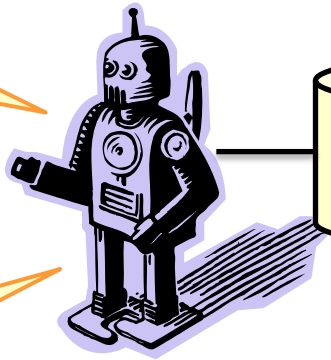
Communication robots

Task oriented dialogue

May I help you?

I want to eat ramen.

...



Dialogue rule

Free dialogue

It's cold today.

I want to eat ramen.

I like 'Tonkotsu' ramen.

Natural conversation with users

Dialogue history

User DB

Dialogue knowledge DB

Interaction between Robot and Various Devices

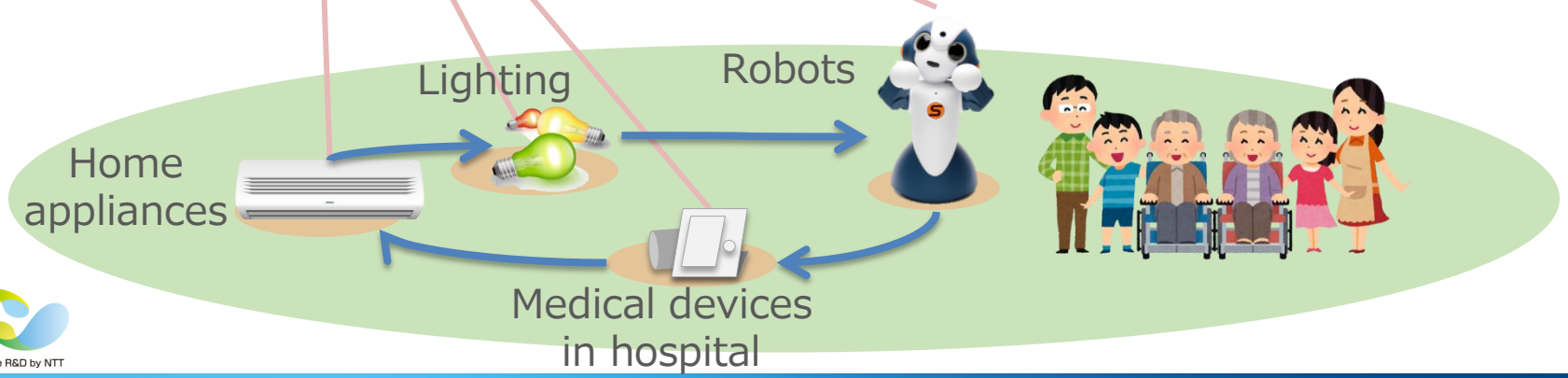
Cloud-based human-machine interaction control technology (R-env)

Easy development without any special knowledge

Simple and efficient creation of service using devices

Combining various devices and corevo

Collaboration of various devices



Innovative R&D by NTT

Field Testing of Robot For Elderly at Home

Increase of willingness to act

Improvement of quality of life of elderly

Effectiveness on improvement of quality of life of elderly is verified.

EnviroLife Research Institute

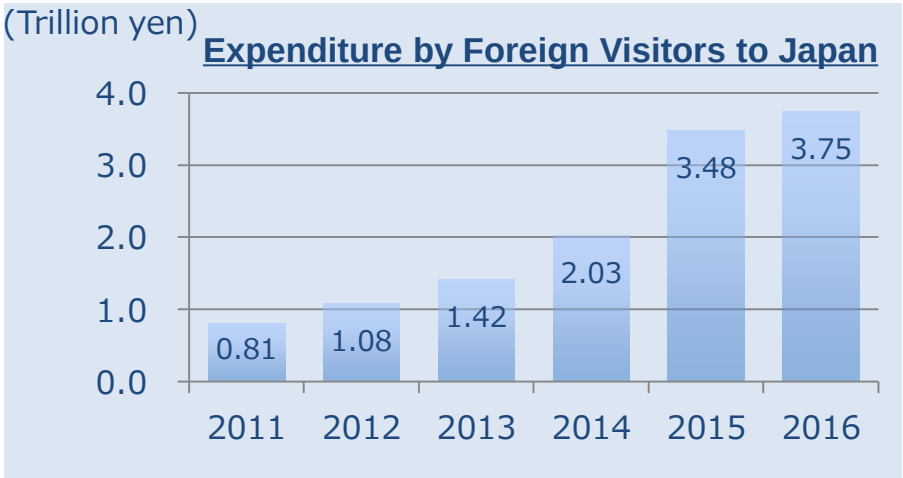
Field testing is underway at service-added homes for the elderly, etc.

Promote conversation of elderly people

Attracting More Customers with High-quality Hospitality

Attracting More customers | **Sales Promotion** | **Hospitality** .....

- Easy-to-understand premises map
- Easy-to-understand product description
- Overcome the language barrier
- Barrier-free .....



Source: Created by NTT based on white paper on tourism by MLIT.

Innovative R&D by NTT

Field Testing of Visual Explorer Navigation Service

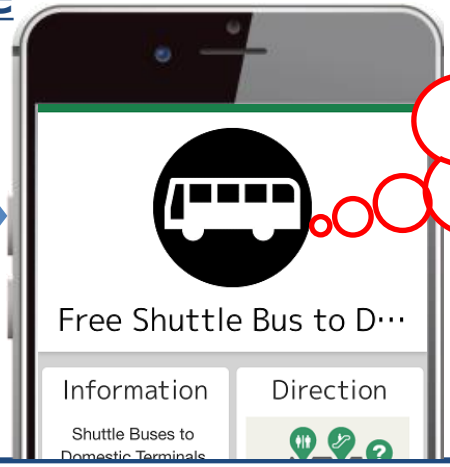
Hospitality **Intuitive**

NTT NTT DATA

field testing at Haneda Airport

Visual explorer navigation service

By simply pointing



Navigation information
- Multilingual information of signage boards
- Map to destination
- ⋮

Angle-free object search technology

Front shot	Cross shot	Close shot	Blocked by human figure
			

Even similar objects, such as panels and signage boards, **can be recognized correctly.**

only need to prepare **2～3** images

Innovative R&D by NTT

Field Testing of Visual Explorer Navigation Service

Hospitality **Intuitive**

field testing at Haneda Airport

Visual explorer navigation service

By simply pointing

Menu
- Multi-lingual menu
- Details

⋮

Angle-free object search technology

Front shot	Cross shot	Close shot	Blocked by human figure
			

Even similar objects, such as panels and signage boards, **can be recognized correctly.**

only need to prepare **2～3** images

Innovative R&D by NTT

Various Visual Explorer Services

Hospitality **Relief**

Information service at convenience stores

By simply pointing

Convenient for foreign visitors

Product information
- Description, ingredients
- information of food allergy

Support 10 to 15 languages

Easy-to-Understand Navigation at Airport

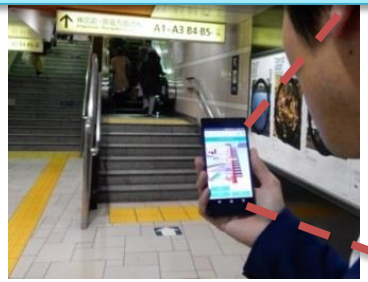
NTT

Intuitive

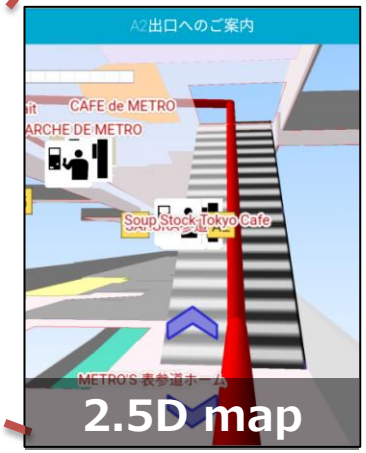
Tokyo Metro NTT DATA

Easy-to-understand navigation system

Field testing started in Feb. 2017



Tokyo Metro Omotesando Sta.



2.5D map

Barrier-Free

MLIT NTT DATA

Barrier-free navigation at airport

Field testing started in Nov. 2016

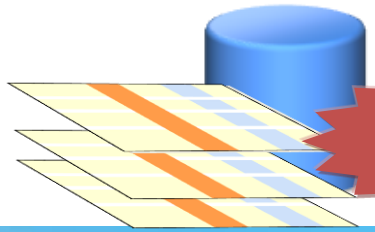
Narita Airport

Barrier-free info & 2.5D map

2.5D map representation technology

Visualization of invisible objects beyond walls or ceilings by controlling object transparency

2D + height



Intuitive

Smart

Technology for generation accessibility information

Collecting information of steps and stairs, etc.

MaPiece

Barrier-free information can be collected without special knowledge

Service for Commercial Facilities

Collaboration of Toyota's "HSR"* and NTT's "corevo®"

Aiming to provide support by anticipating human behavior

TOYOTA

- Providing HSR
- Providing experiment fields

NTT

corevo

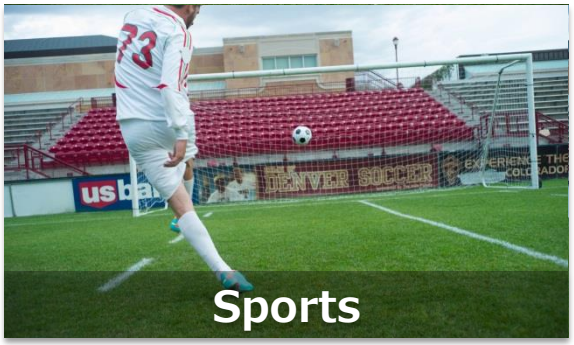
- Providing corevo technology
- Developing service protocols

To be exhibited at CEATEC JAPAN 2017 (Oct. 3 - Oct. 6, 2017)

*HSR: Human Support Robot

Innovative R&D by NTT

Inspiring People by Creating More Attractive Contents



New excitement

Attracting more customers

Cultivating new customers

.....

Surprising experience

Sharing sense of unity

Introducing traditional culture to the world

The world without distance

.....

Contents service that breaks the limit of space & time

Innovative R&D by NTT

Kirari! Technology which breaks the limit of space & time

NTT

The world which you can experience the excitement as if you are really in the sporting venue

Make the spectator's eye shine
("Kirari" means shine)

Technology to Convey Live Experience

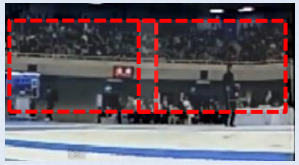
Kirari!

Immersive telepresence technology Kirari!

Reconstructing the visual and audio experience as if the audience were present at the venue

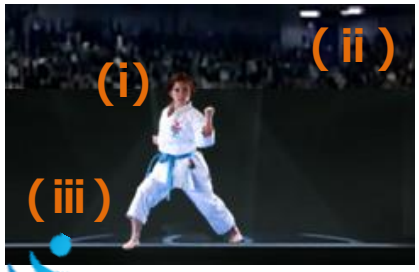
Main subject (i)

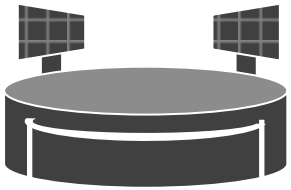
Background Scene (ii)



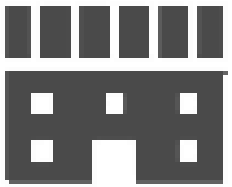
Acoustic space (iii)

Media streaming and synchronization





Event Venue



Broadcasting Venue

Innovative R&D by NTT

Practical Examples “Music Live”

NTT docomo × NTTぷらら × TOWER RECORDS

Sept. 12, 2017
Live music event offering new sensations

3D stereoscopic live relay

Kirari!

"ANGERME VS Up Up Girls (Tentative)
~ THANK YOU! DEAR MY FRIENDS ~ "

Super realistic sensation
as if you were really in the concert hall
Super-realistic live experience!

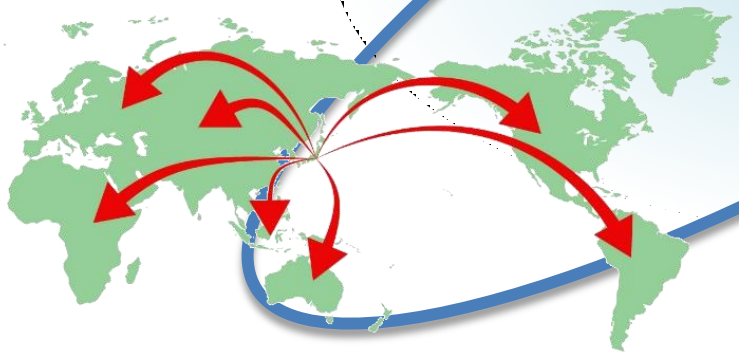
As business tool

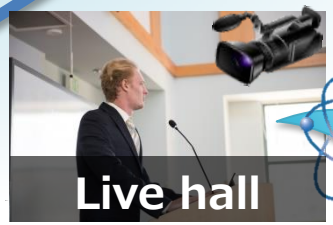
For inquiry counter in futuristic shops

As if staff really exist on the other side of desk

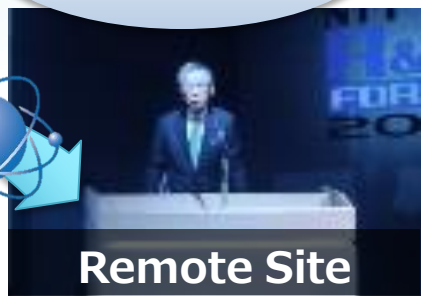
Virtual agent which works with pseudo 3D display and AI

Kirari!





As if speaker facing all audiences



For live streaming such as keynote

Innovative R&D by NTT

Practical Examples “Advertisement”

Understanding how the brain process sensorial information

Optical illusion

Perception of color and movement

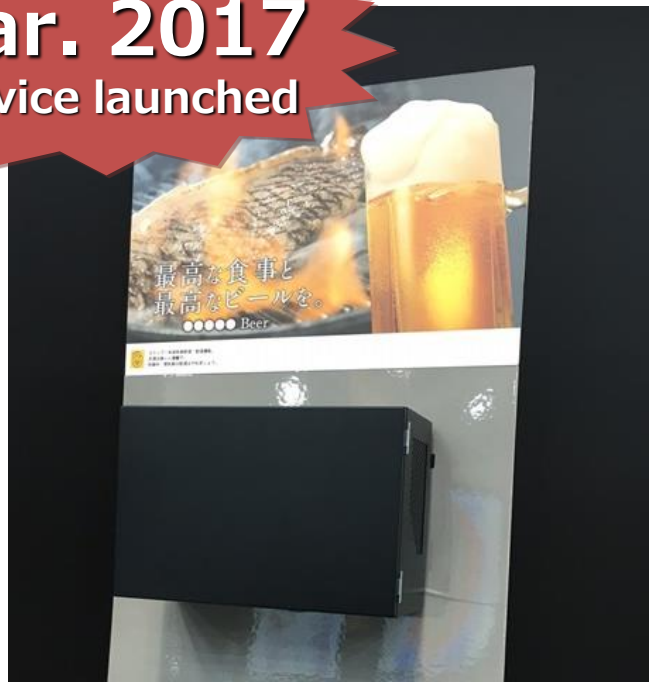
DNP & NTT Communications

A magical lighting system to produce illusory movements in static photos and paintings

Creation of brand new contents and display methods

“Transformation lamp (Hen-gen-tou)”

Mar. 2017
Service launched



New Values Created by R&D

Innovative R&D by NTT

Facilitating Business Functions by Supporting Thought and Action

Even inexperienced people can carry out efficient work

Improvement of CS | **Enhanced efficiency** | **Human resource development** .....

Improve service quality | **Accelerate judgment** | **Facilitate mutual understanding** | **Automate tasks** .....

ICT supporting thought and actions of employees

Innovative R&D by NTT

Speech Recognition / Distinction Technologies

Speech recognition technology in a variety of noisy environments

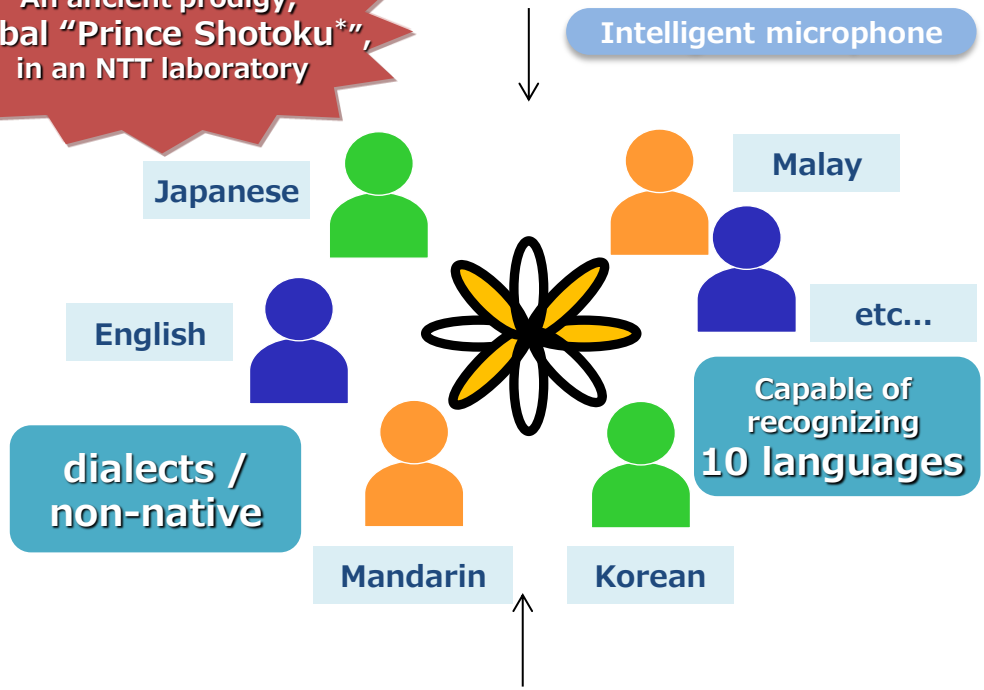
Speech recognition in an environment with various background noise
(Guiding the direction on the streets or in a store)

Ranked 1st place
(among 25 participating institutions) in an international evaluation

Technology of speaker separation and language-identified speech recognition

Separating the voices of different speakers at the same time

An ancient prodigy, Global "Prince Shotoku*", in an NTT laboratory



Multilingual speech recognition

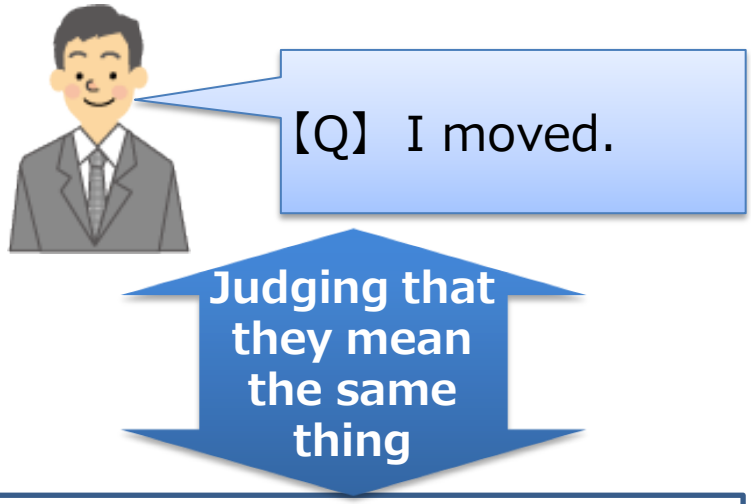
*Prince Shotoku was the imperial prince/politician of the Asuka period in Japan. He was told to have the capability to hear and recognize what is said by several different people at the same time.

Innovative R&D by NTT

Technology for Understanding Speech

Technology for understanding utterances (FAQ search system)

For precise comprehension of diverse phrases unique to Japanese



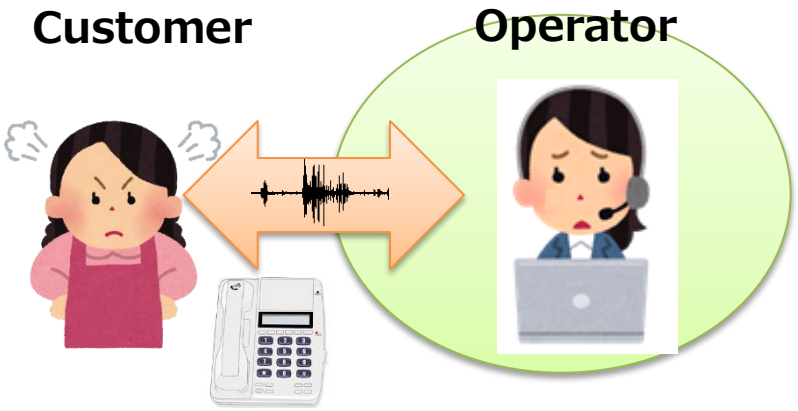
Q&A contents

【Q】How can I change my address?

【A】We accept the procedure by telephone･･･

Emotion recognition technology

To identify and understand various emotions of the speaker from the rhythm (pauses) and phrasing of the conversation



Hot Anger	Cold Anger
Yelling	Calm and quiet (This is difficult to identify with conventional technologies)
Satisfied	Confused

Contact Center Solution with AI

Improvement of customer satisfaction

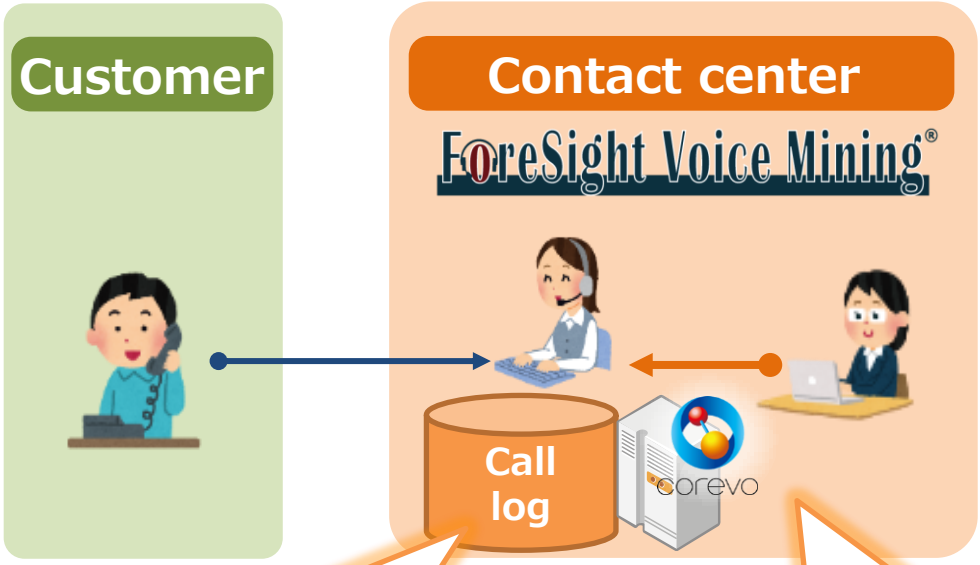
Improvement of operational efficiency

Expansion of business

This service will be applied to 10,000 seats in contact centers

NTT Communications　NTT-TX

Sompo Japan Nipponkoa



Automatic searching of FAQ according to inquiries

Trend analysis by recognizing speaker's voice and emotion

Voice recognition technology

Emotion recognition technology

Technology for understanding utterances (FAQ search system)

Communication Engine “COTOHA®”

Improvement of customer satisfaction

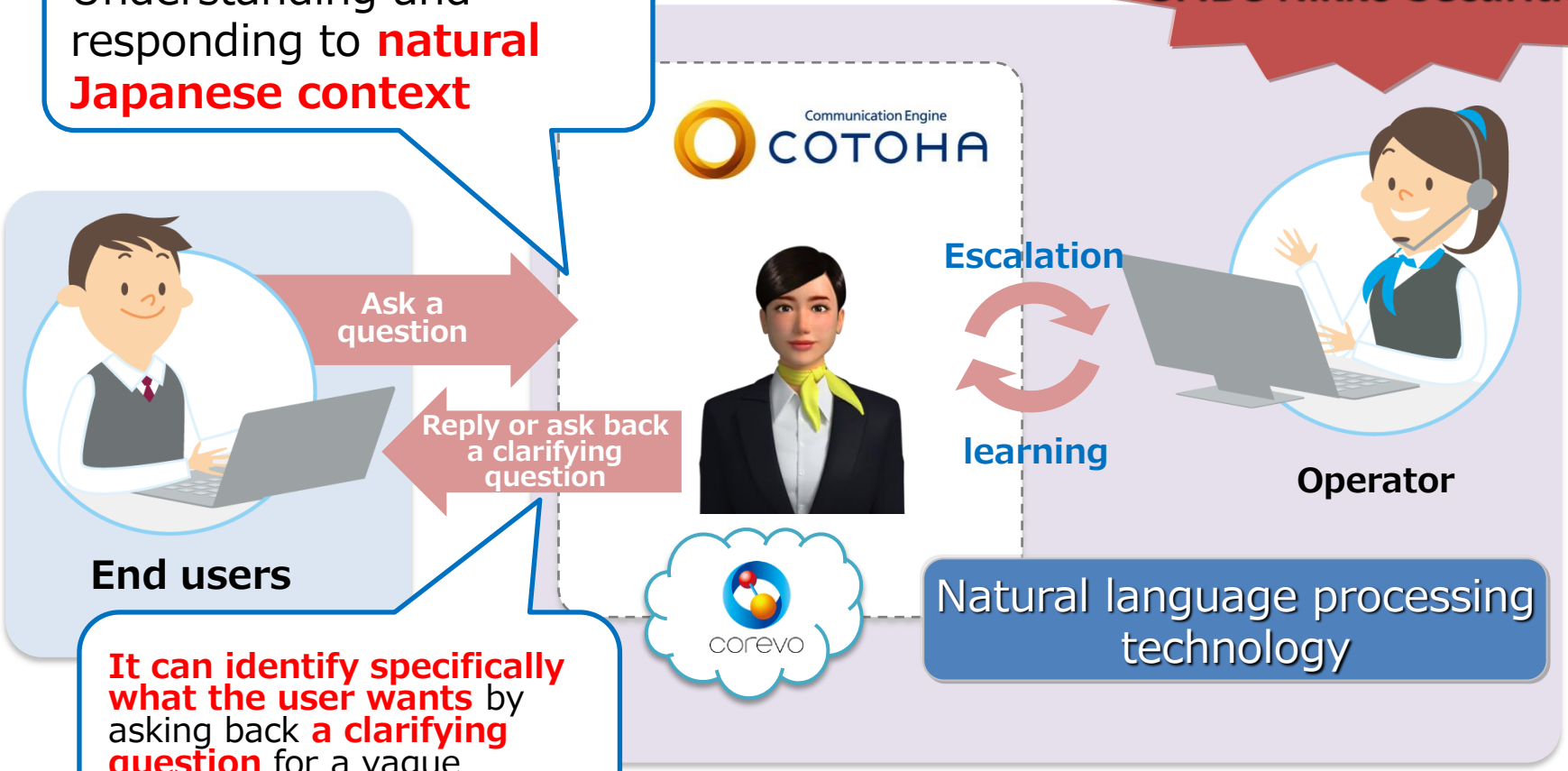
Improvement of operational efficiency

Expansion of business

NTT Communications

Applied to support chat inquiry service at SMBC Nikko Securities

Understanding and responding to **natural Japanese context**



It can identify specifically what the user wants by asking back **a clarifying question** for a vague question from a user

Innovative R&D by NTT

Demand Forecasting of Taxi Usage

Occupancy optimization

Newcomer training

Tokyo Musen Taxi

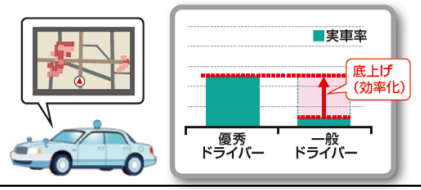
Tsubame Taxi Group（in Nagoya）

Real-time demand forecasting technology

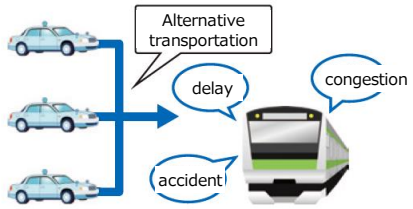
Forecasting demand after 30 minutes to optimize driver placement

Reduce waiting time

Growth of sales



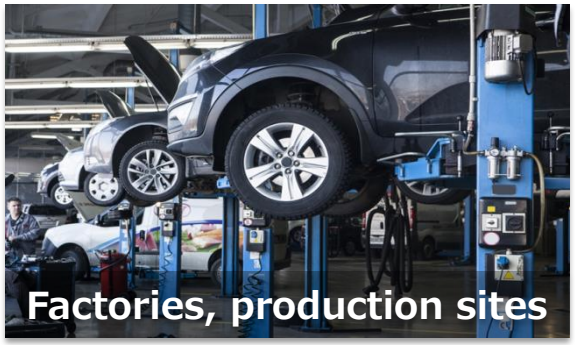
Handling sudden demand increase



Innovative R&D by NTT

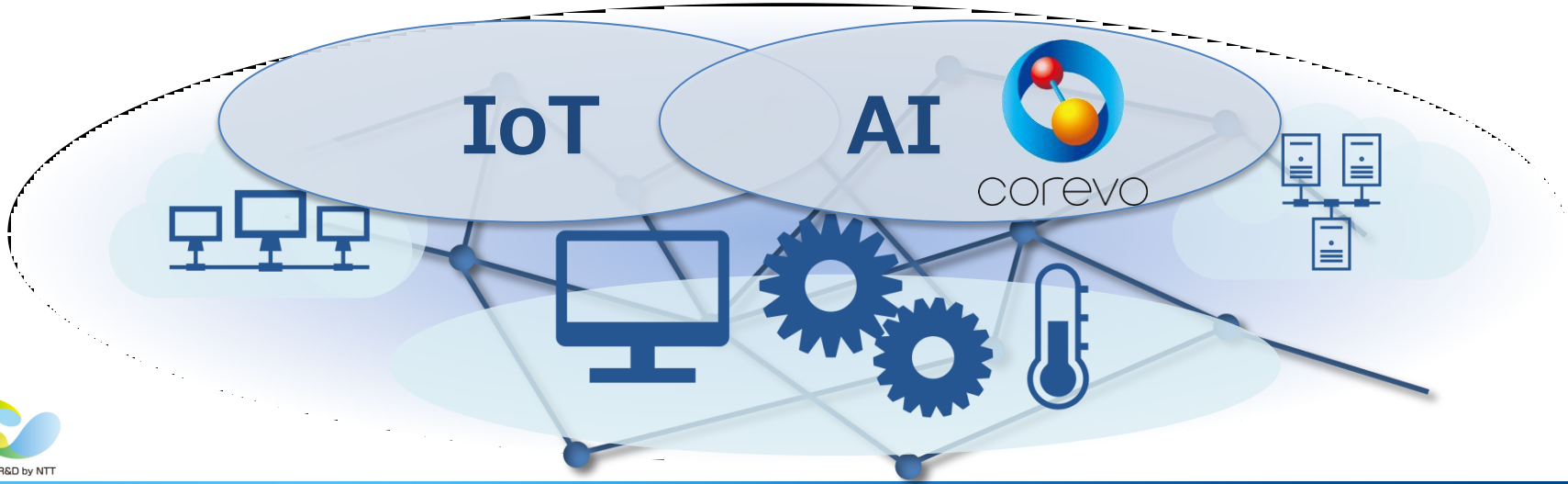
AI Taxi is trademarks of NTT DOCOMO, INC.

Enhancing Efficiency of Facilities and Social Systems



Cost | Human resource | Energy | .....

Improved productivity | Efficient operation | Predictive maintenance | Optimal operation | .....



Innovative R&D by NTT

IoT Technologies to Support System Efficiency Enhancement

Application distribution

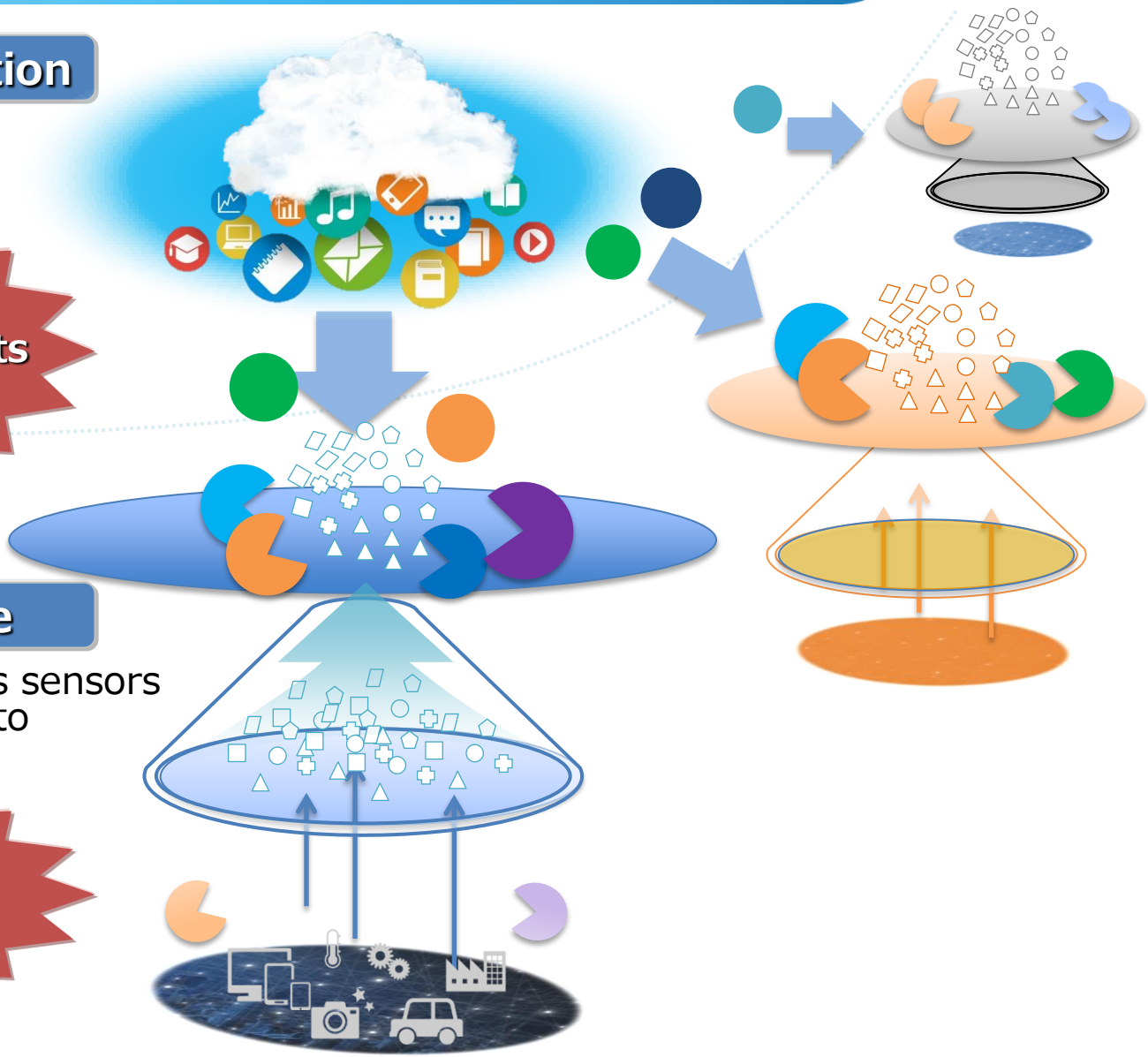
Distribute application as appropriate

Distributing to various environments as appropriate

IoT data exchange

Collect data from various sensors and devices and deliver to appropriate applications

Compatible with various devices



Innovative R&D by NTT

Enhancing Efficiency and Safety of Marine Vessel Operations

NTT

NYK LINE NIPPON YUSEN KAISHA　Monohakobi Technology Institute　&　NTT　NTT DATA

Optimization of vessel operation

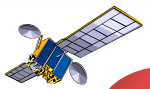
Reducing work load of operation

Environmentally friendly vessels

Joint development of vessel IoT platform

Container vessels

Onboard utilization



Satellite communication

Quickly utilize data onboard

Detailed analysis at onshore operation centers

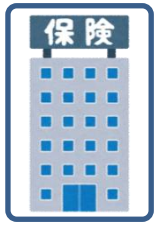
Engine data

Various instrumental data

Onboard data collection box

IoT data exchange

Application distribution management



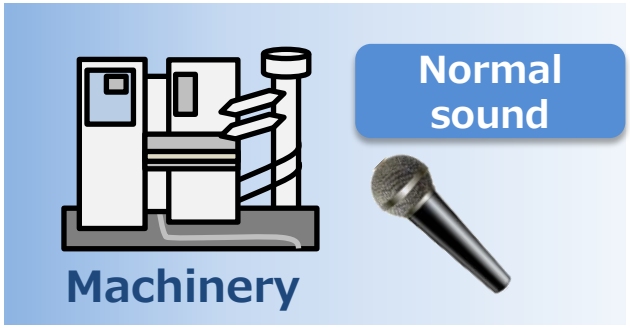
Innovative R&D by NTT

Corevo(AI) to Support System Efficiency Enhancement

corevo

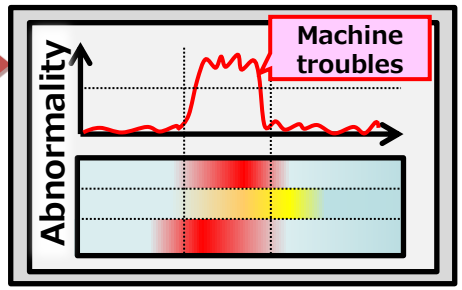
NTT

Anomaly sound detection technology



Only the normal sounds need to be entered to train the machine to detect anomalous sounds

Detection rate **85%** or more



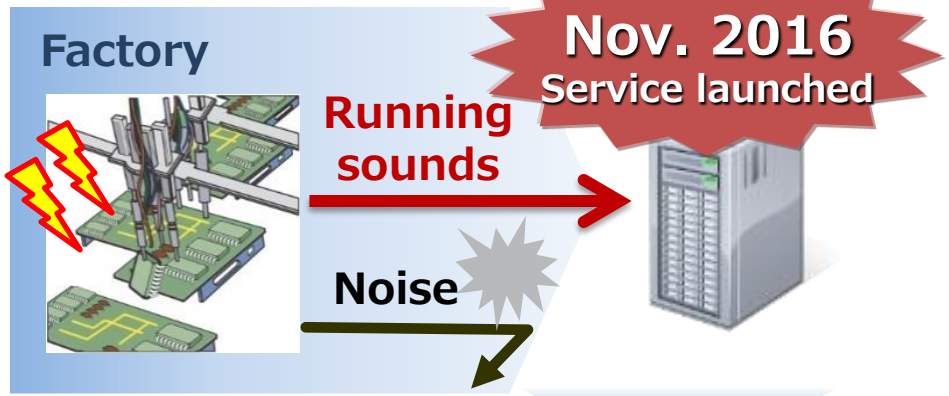
Productivity enhancement

Maintenance efficiency

Abnormal noise detection「Monone®」

Hitz Hitachi Zosen

NTT DATA



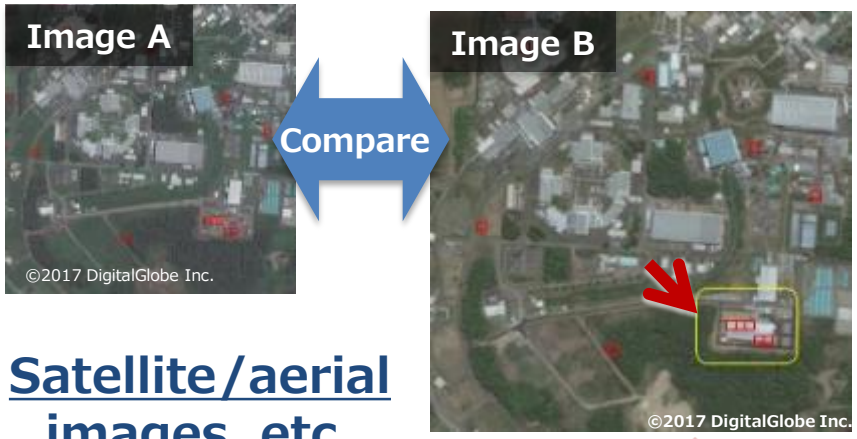
Minimizing negative impact

Remote monitoring

Innovative R&D by NTT

Corevo(AI) to Support System Efficiency Enhancement

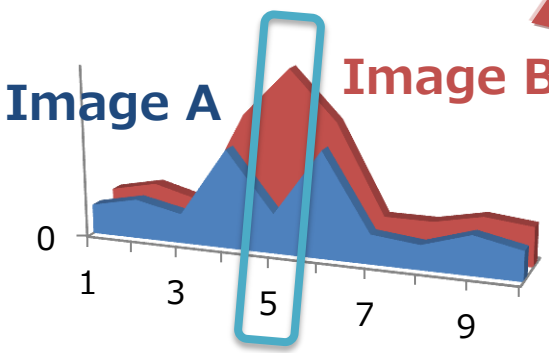
Change-point detection



Satellite/aerial images, etc.

Extract change in the distribution of information amount

the rate of successful detection of change-points **90%**



Productivity enhancement

Maintenance efficiency

Inspection solution of solar panels

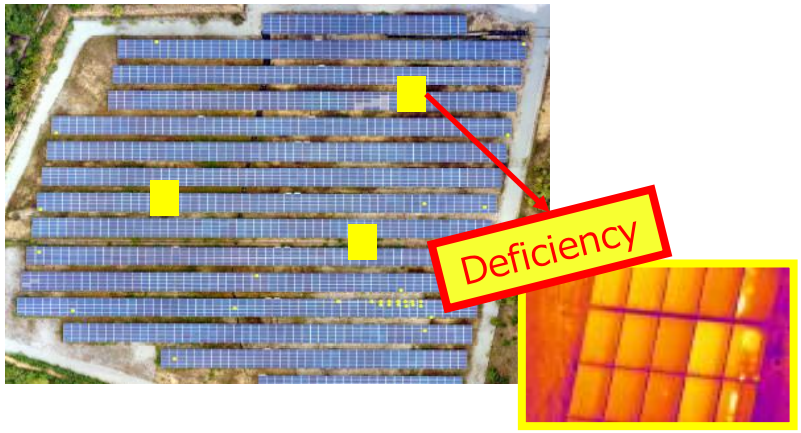
NTT WEST NTTネオメイト

Inspection with drone

Mar. 2017 Service launched

Deficiency detection with image analysis

Under consideration for future application



Innovative R&D by NTT

Data Analysis Tech which Supports System Efficiency

High-speed & large-scale data analysis

Large-scale graph mining technology

Grapon

50 times faster or more

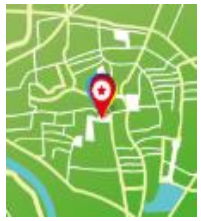
Example: clustering huge traffic network

High precision & deep analysis of various data

Various big data in real environment

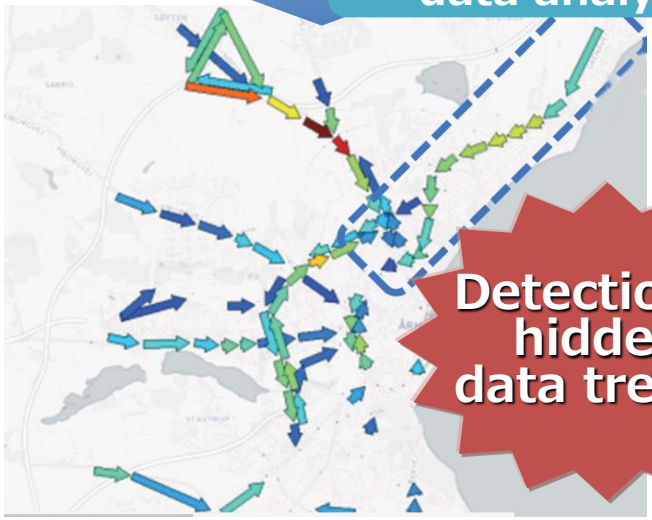
Location information

Vehicle sensor



Geographical information

Multidimensional data analysis



Detection of hidden data trends

Innovative R&D by NTT

Traffic Management based on Traffic Congestion Prediction

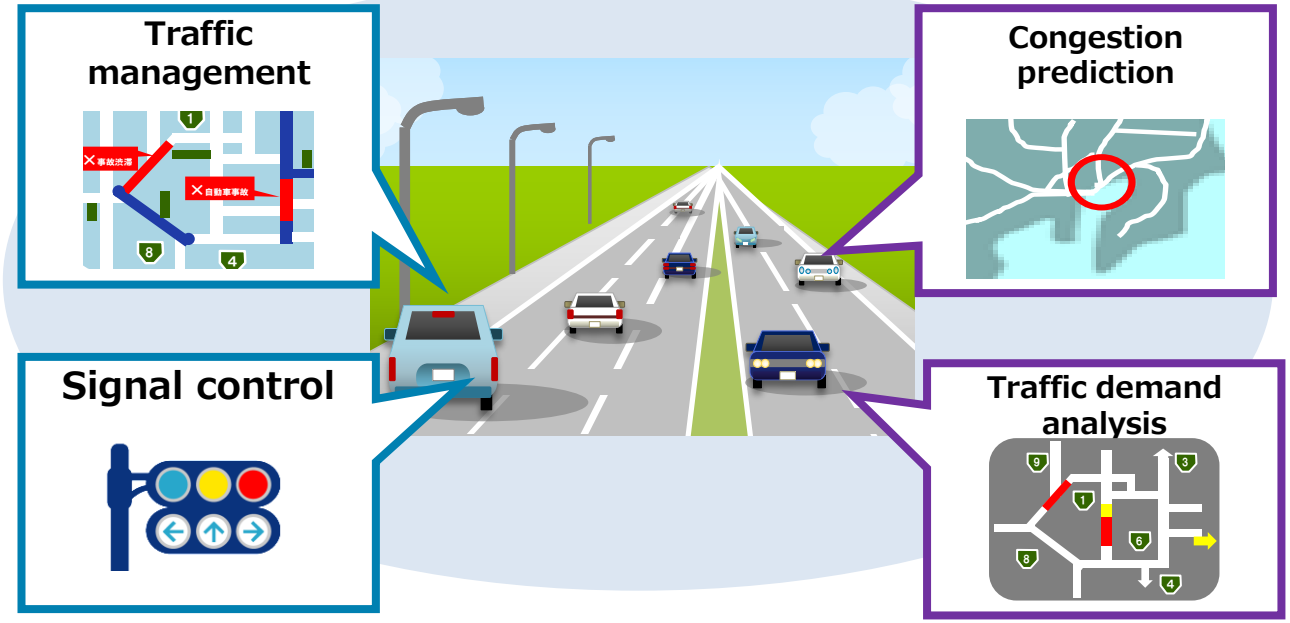
corevo NTT

Congestion mitigation | **Optimization of traffic volume**

Guiyang City etc. (China)

NTT DATA

Cameras・Road sensors・Data probes



Jilin City, China (Demonstration experiment Nov. 2014) Improved operation schedule of route buses
Guiyang City, China (Demonstration experiment Feb. 2016) Improved travel time and traffic processing capacity

Innovative R&D by NTT

Currently, development of the real-time solution is ongoing in a joint laboratory with Guiyang city

Optimization of Area Management

Energy conservation **Congestion mitigation**

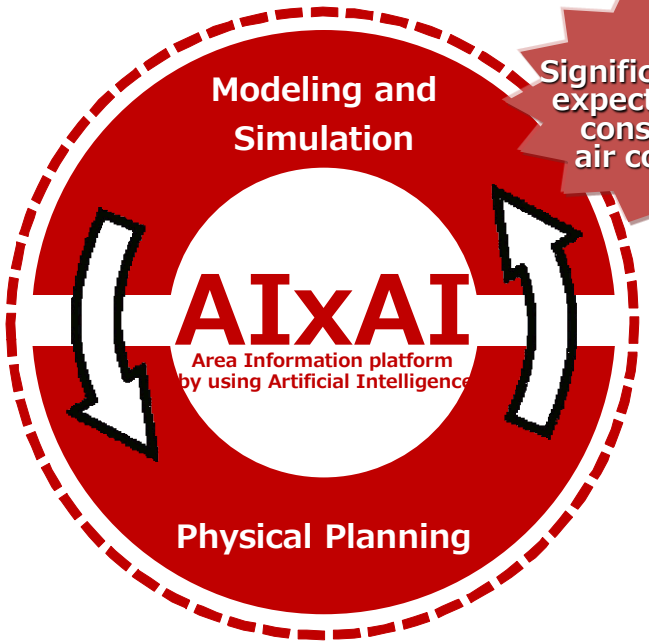
NTT & NIKKEN & 三井不動産

NTT corevo

Field test to be conducted in Nihonbashi Muromachi area

Data collection/analysis

- Human traffic data
- Sensor data
- Weather data
- Energy data
- :



NIKKEN

Spatial planning/management

Optimization of air conditioning

Significant reduction expected in energy consumption of air conditioning

Application examples

Innovative R&D by NTT

Supporting Safe and Secure Operations

Minimization of business risks

- Improved security
- Prevention of system failure
- Improved safety
- Accident prevention

Maintain safe operation through prevention of incidents and accidents

- Cyber
- Real(Human)

Innovative R&D by NTT

Requirements for Cyber Security




Maintenance of social and corporate infrastructure

Adapting to the era of IoT

Prevention of information leakage and tampering

Promotion of data utilization

Network security

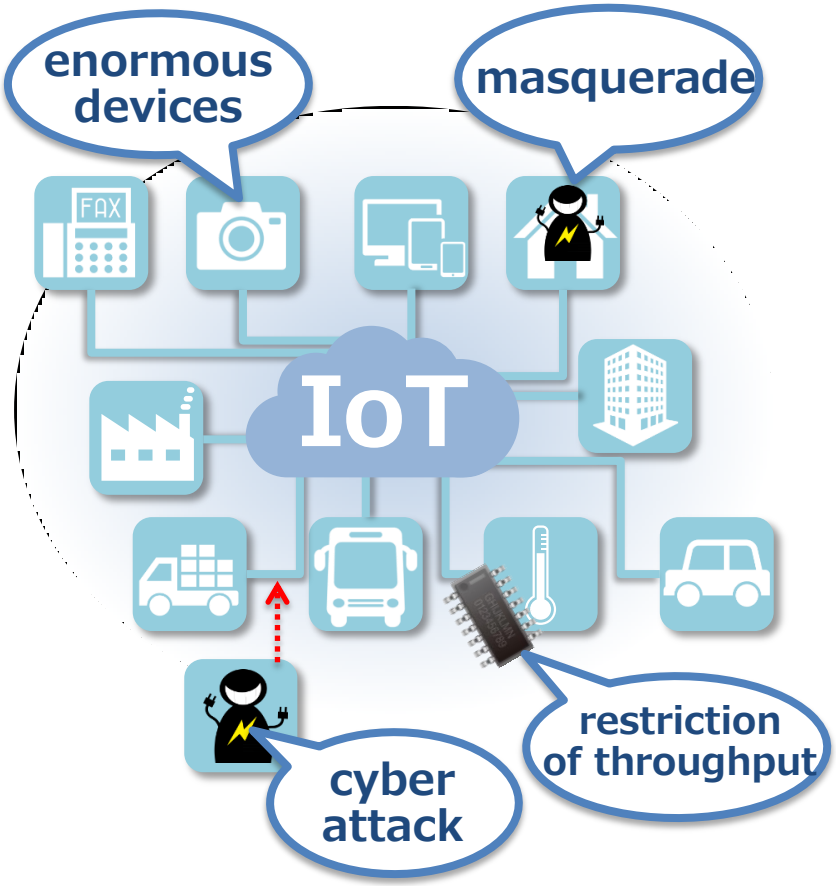
IoT security

Data security

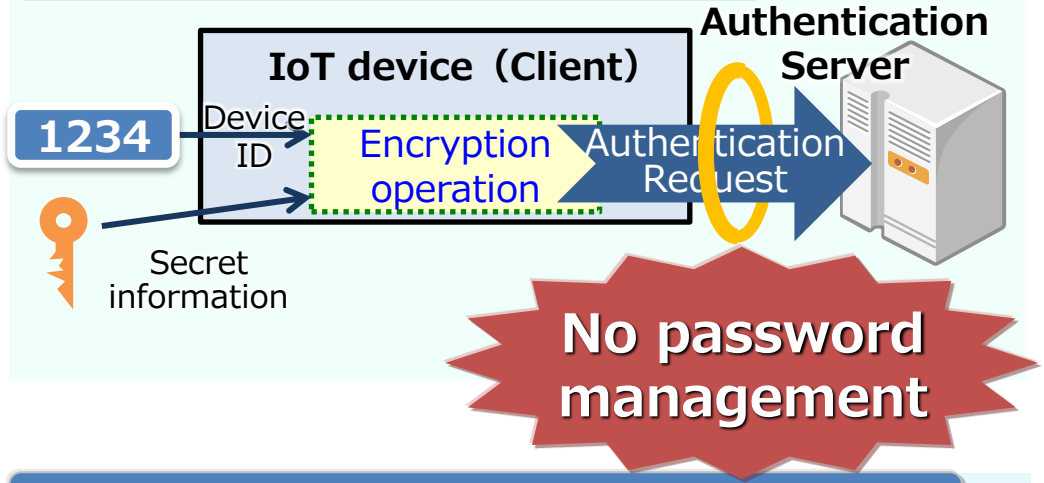
Innovative R&D by NTT

Technology Protecting IoT Security

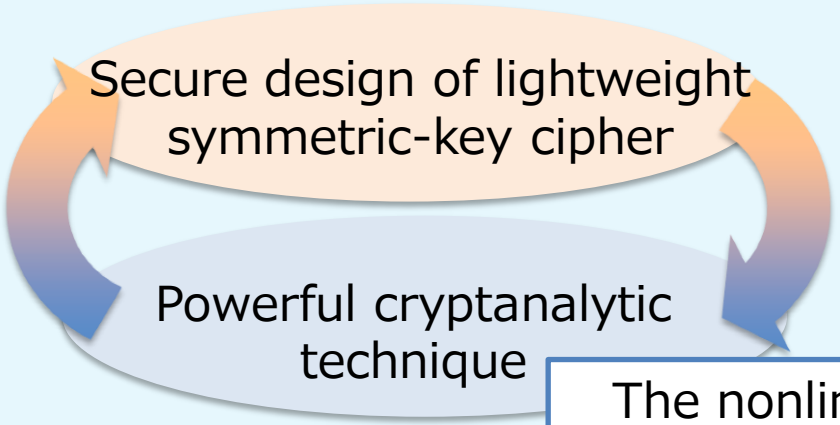
Problems of IoT Security



Password-less authentication technology



Lightweight cipher technology



The nonlinear invariant analysis

Innovative R&D by NTT

Data Utilization without Data Leakage Risk

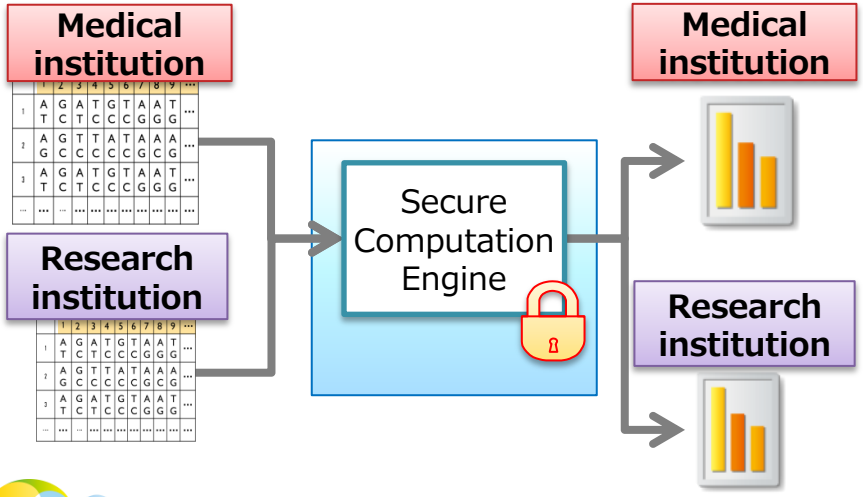
Company holding data
- **Confidential data**
- **Personal data**

Process for secure utilization

New value made by third parties

Secure Computation System "San-Shi®"

Enables statistical analysis without mutual disclosure of data among multiple institutions



An example

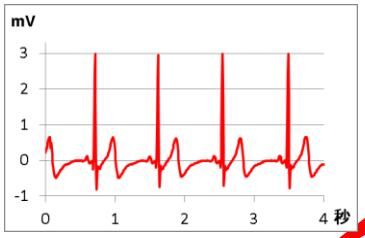
Tohoku University Collaboration research

analyzing genomic data (totally 1,000 records)

Innovative R&D by NTT

Data Obtained by hitoe®

hitoe®

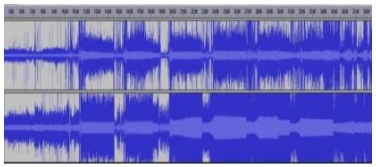


Fatigue level

Electrocardiogram

Mental condition

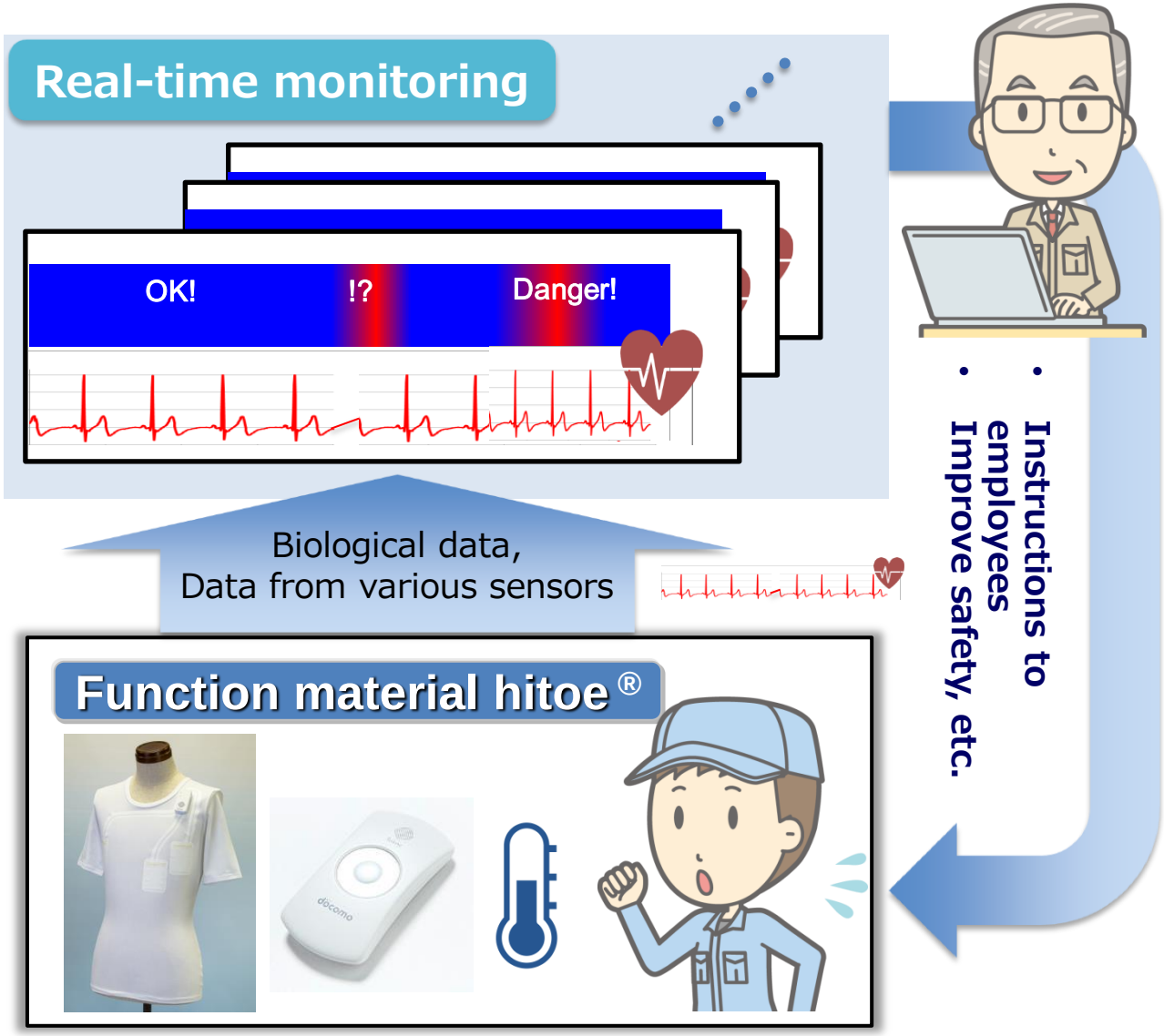
Electromyogram



Activity amount

Innovative R&D by NTT

Technology That Supports Employee Safety



Innovative R&D by NTT

Health Management of Workers Using hitoe®

Improvement of safety

TORAY

Obayashi Corporation

“Watch Over” Service

“Envital” Service

NTT Communications

Innovative R&D by NTT

Safe Vehicle Operation Using hitoe®

Keifuku Bus

Field test

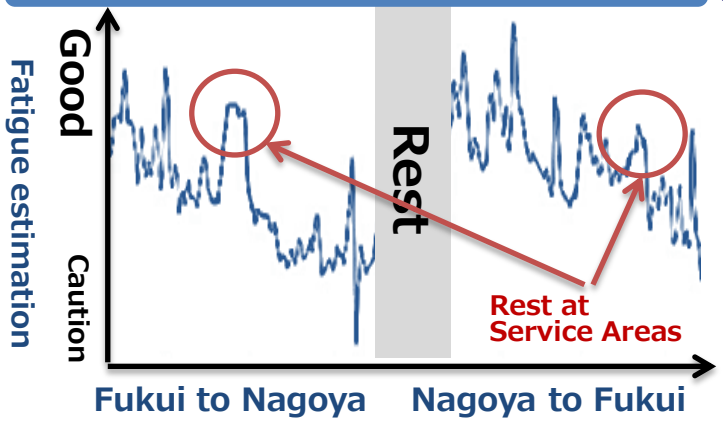
Safe operation

SAP

NTT Communications

Vehicle operation management solution

Sample fatigue analysis (highway bus driver)



Instructions to drivers

Improved operation management

Innovative R&D by NTT

New Values Created by R&D

Innovative R&D by NTT

R&D Initiatives for Future Network

IoT/5G Services

Declining workforce

Network as a social & critical infrastructure

Constructing efficient NW to correspond to CAPEX suppression

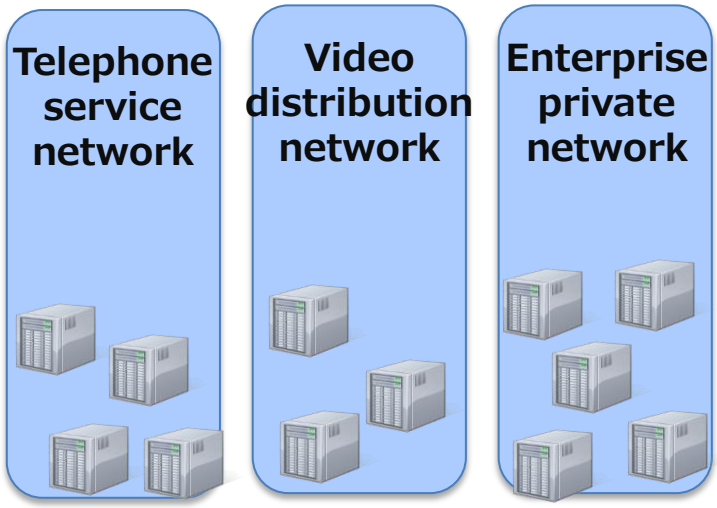
Operating skill-free NW to correspond to diminishing maintenance personnel

Innovative R&D by NTT

Efficient Launch of Network Services

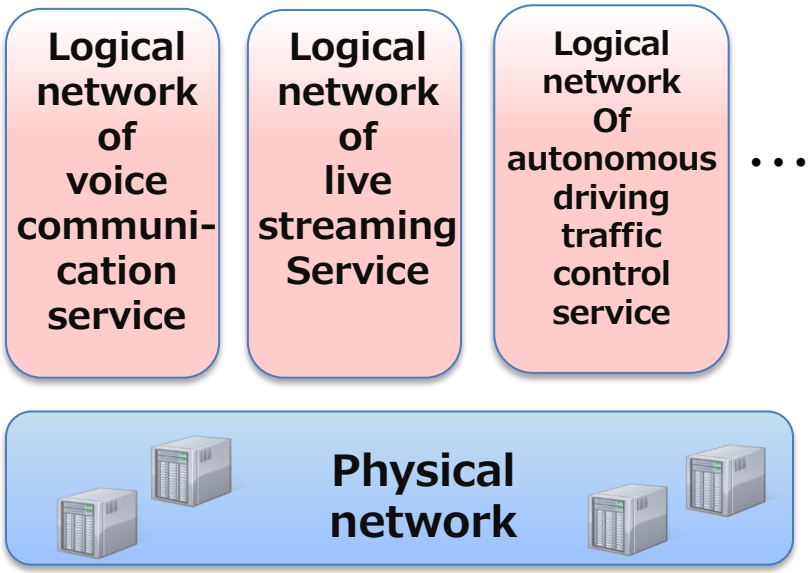
Conventional network

Networks are built by dedicated systems for each service.



Efficient network

Logical networks are provided efficiently by software on commodity hardware products.



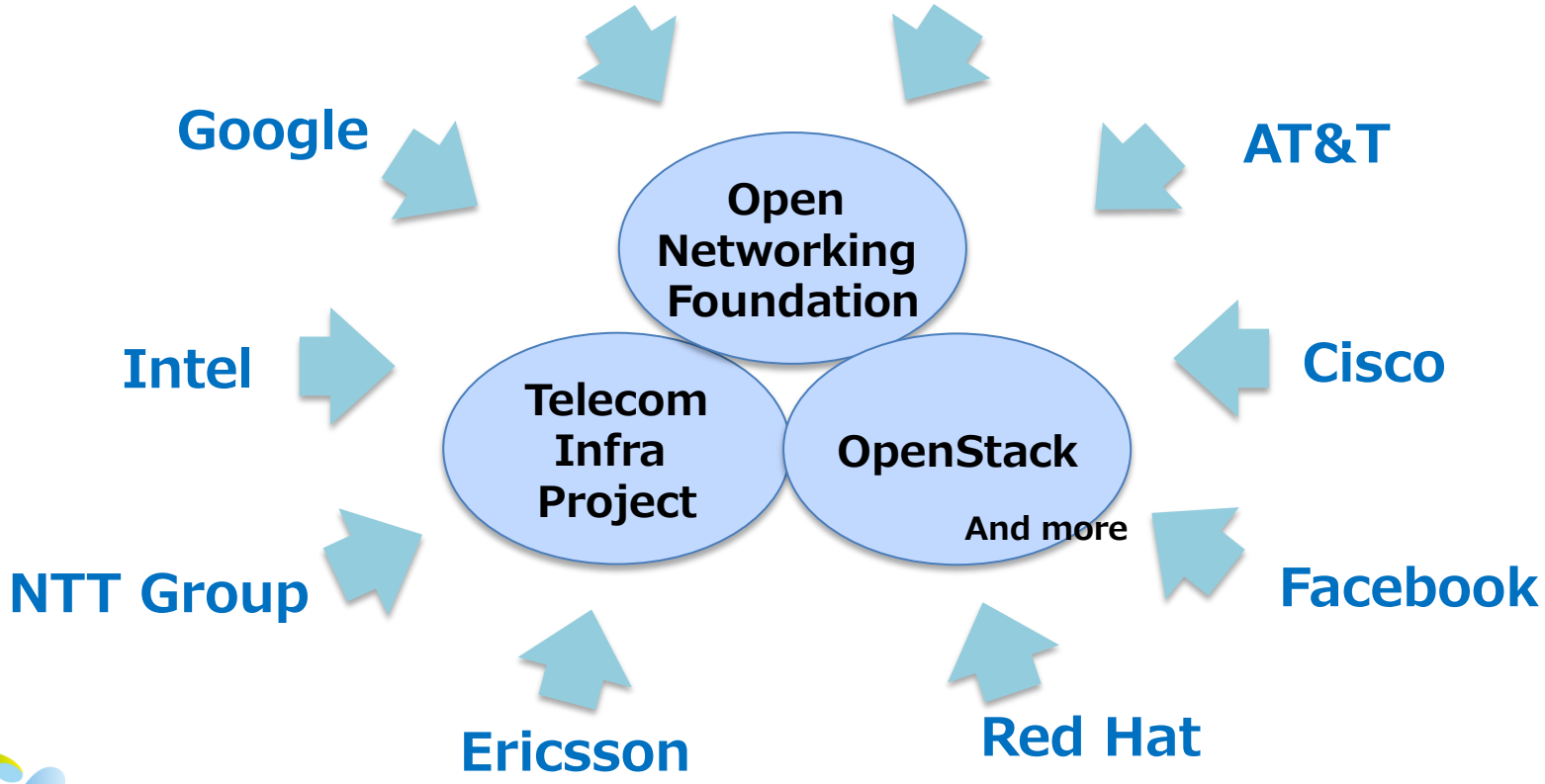
Innovative R&D by NTT

Open Innovation for Networking Technologies

Consortium/Community Activity

Open collaboration for making use of general IT technologies with Google, Facebook, etc.

Reduction of development cost and capital investment

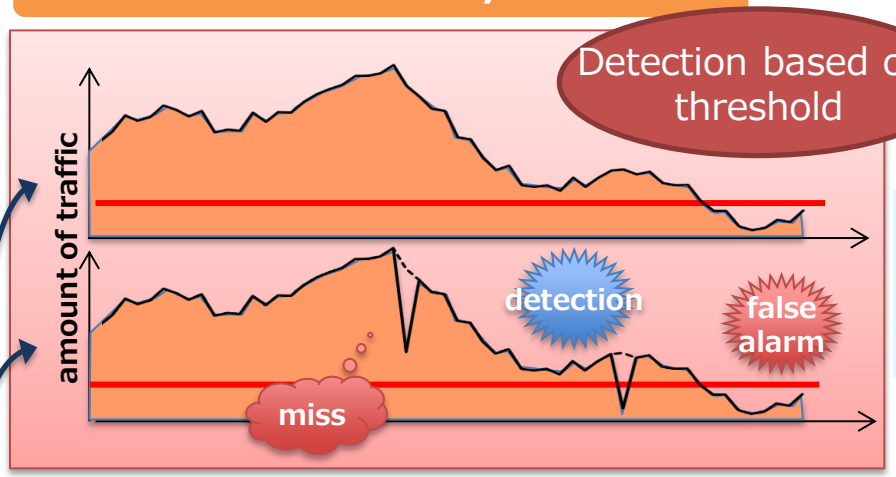


Innovative R&D by NTT

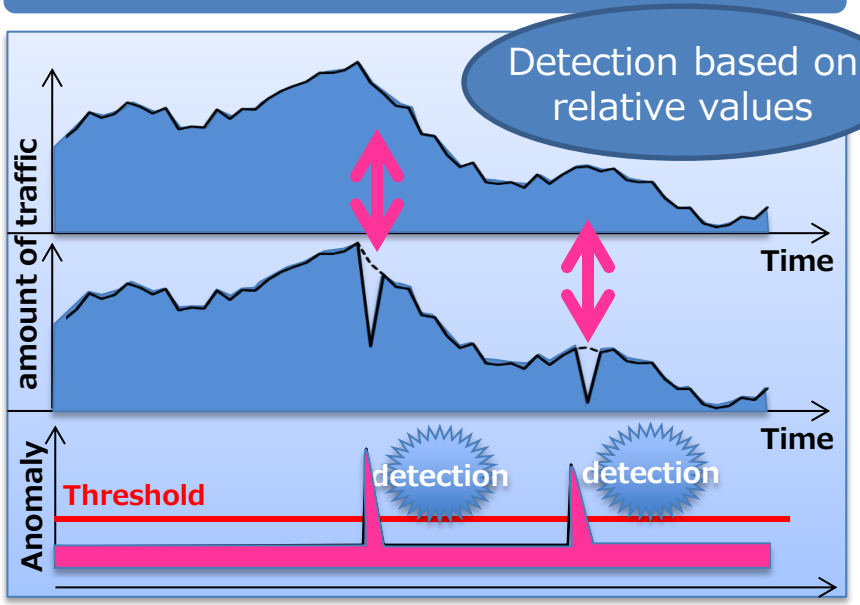
Skill-free Network Operation

Efficient and skill-free 'anomaly detection'

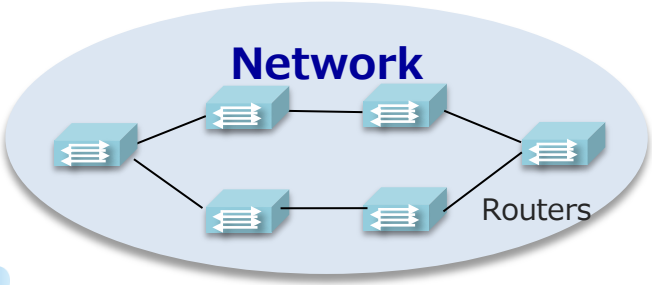
Conventional anomaly detection



Anomaly detection with corevo®



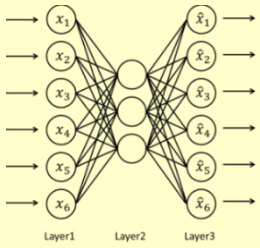
Communication traffic data are collected from the routers throughout the network.



corevo

Autoencoder learned with normal state

Input (communication traffic data)



Output (anomaly detection)

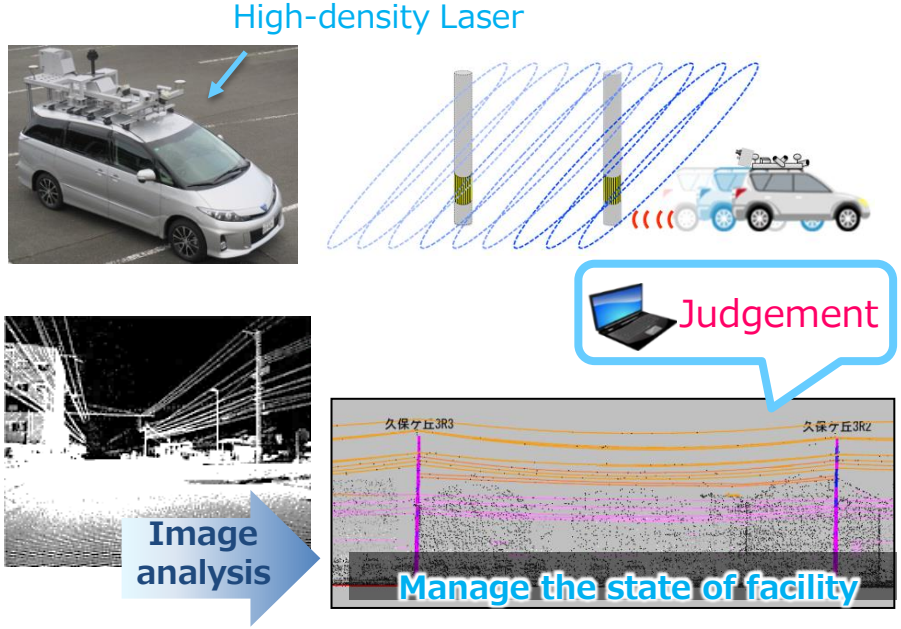
Innovative R&D by NTT

Skill-free Network Operation

Time leaning and skill-free ‘facility inspection’

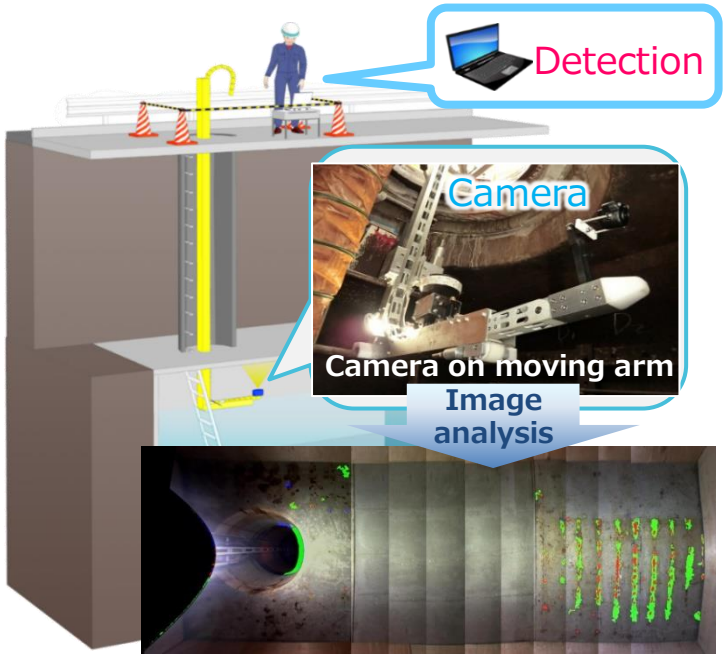
3D Facility management

Grasp / record deterioration of facility without visual inspection



Remote inspection

Grasp / record deterioration of underground facility remotely



Innovative R&D by NTT

Progress of B2B2X Business

Innovative R&D by NTT

New Values Created by R&D

R&D Toward a Better Future

New Computer Framework

New computer may resolve various social issues

Resolve traffic jams

Develop new drugs

Planning optimal production

IBM, Google Quantum Computer

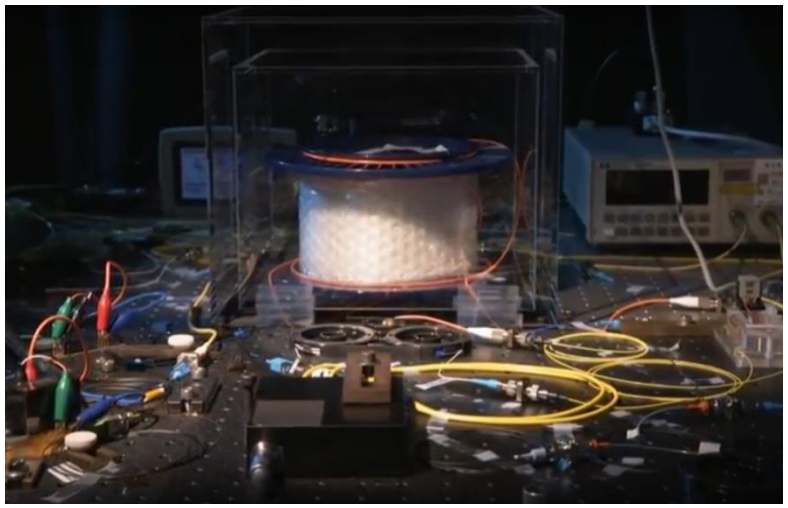
IBM, Stanford Neurochips

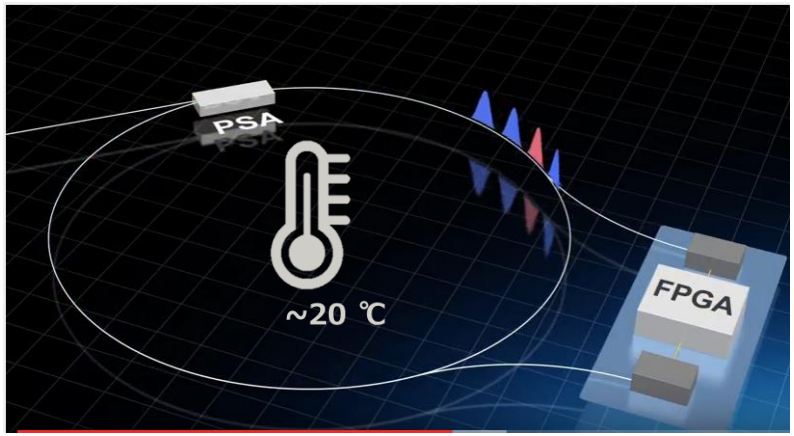
Google, NASA Quantum annealing (D-Wave)

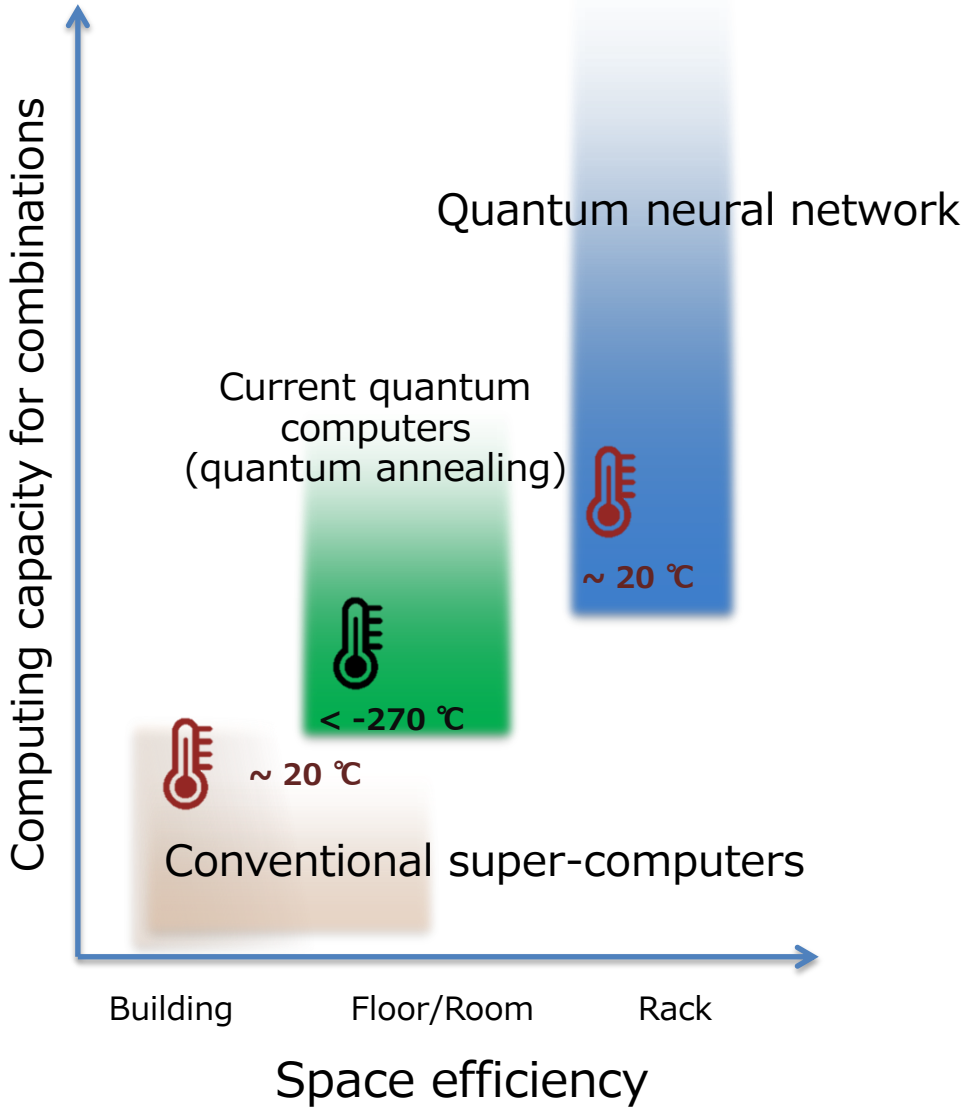
日立 CMOS annealing

Innovative R&D by NTT

Computer with New Structure Using Optics







Innovative R&D by NTT

Sports Brain Science Project

SBS
SPORTS BRAIN SCIENCE PROJECT

Brain Science

Implicit brain function

Action, Perception, Mental state …

ICT

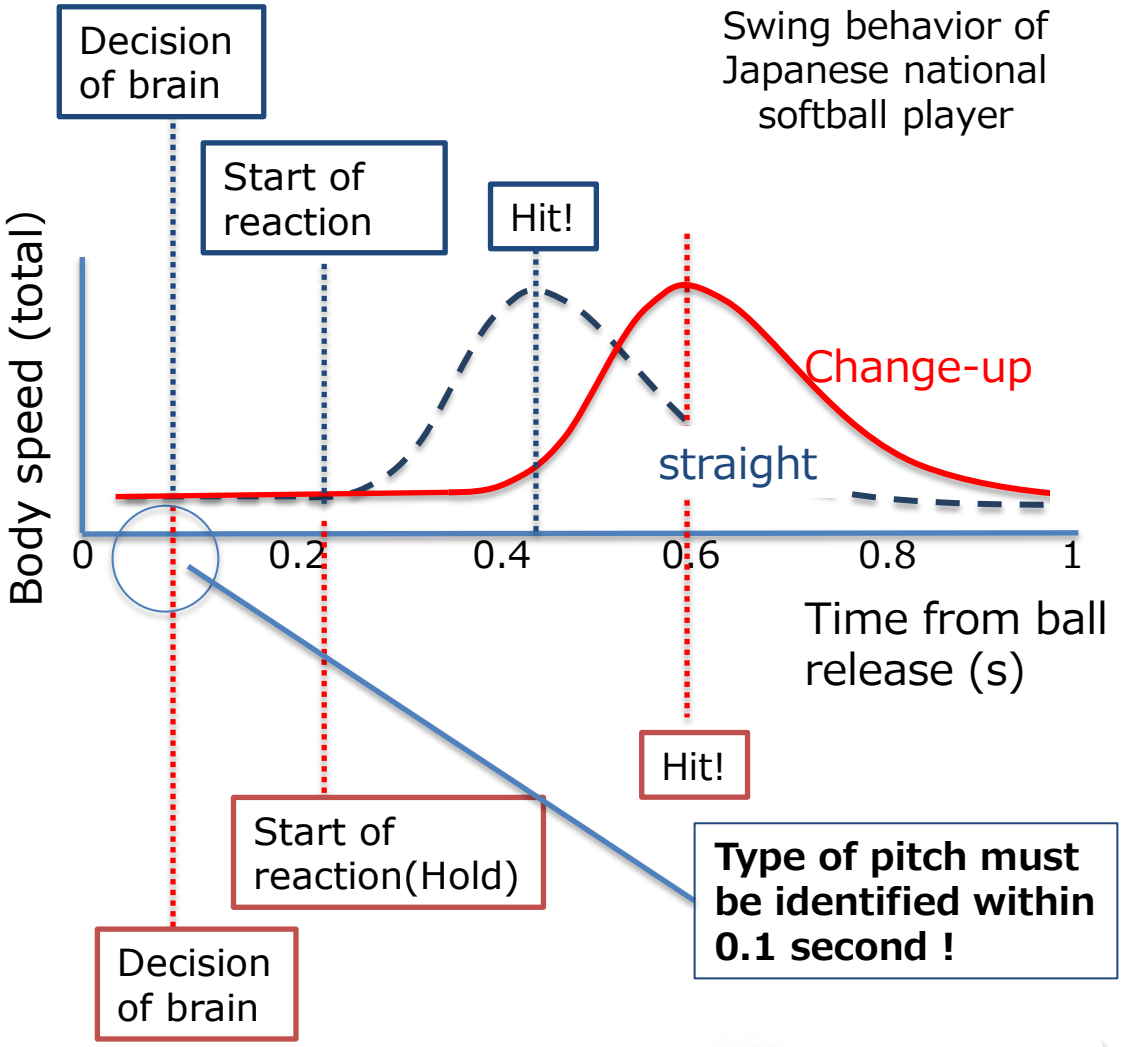
hitoe

Smart sensing

Big data analysis

Good Batters Can React Faster

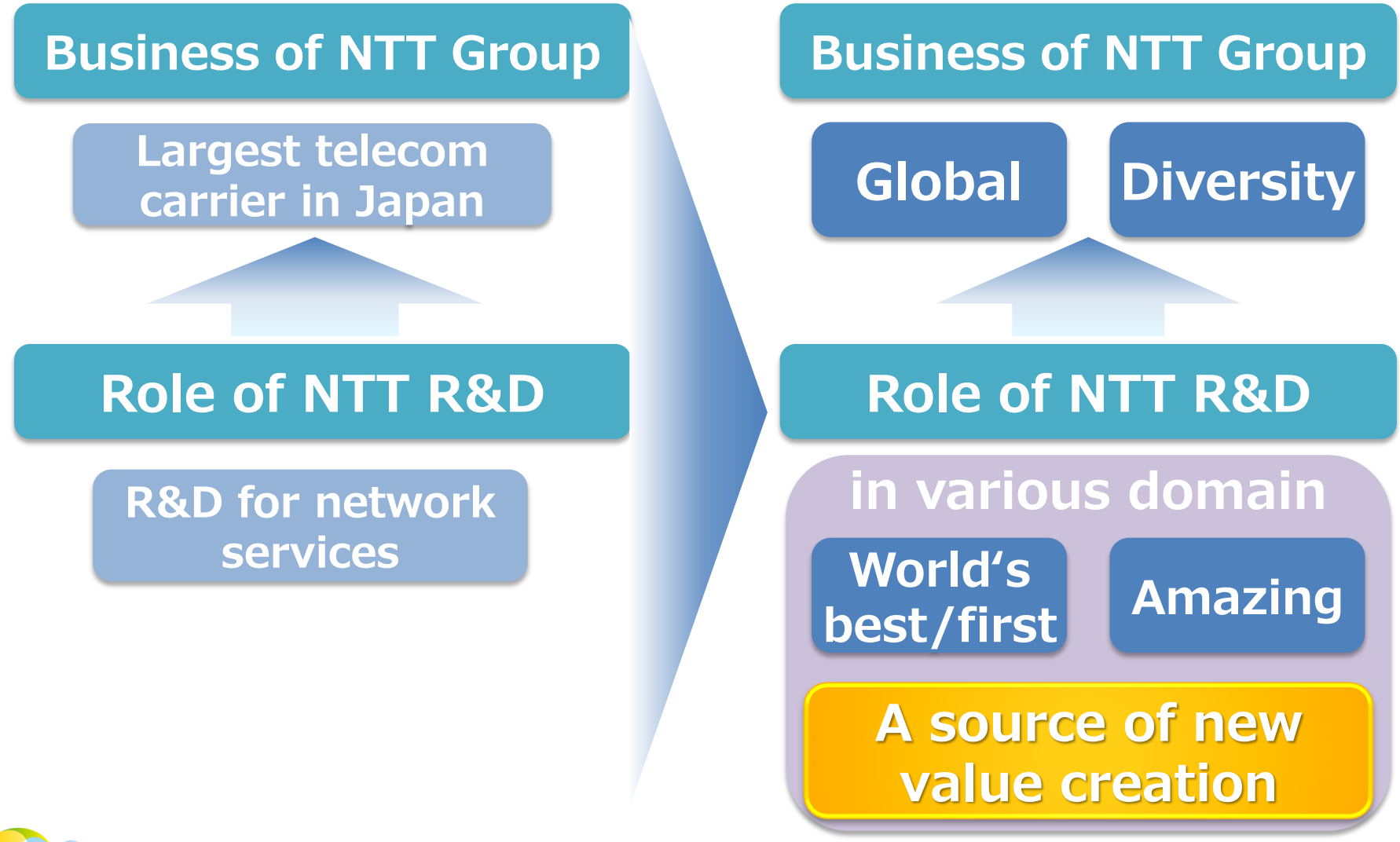
Swing behavior of Japanese national softball player



Innovative R&D by NTT

SBS SPORTS BRAIN SCIENCE PROJECT

Changing Role of NTT R&D



Innovative R&D by NTT

Toward Further Value Improvement

Being selected	• Cutting-edge technology • Ability to coordinate and complete projects
Collaborating	• Redefine goals interacting with partners
Leading to business	• Cooperation with group companies at an early stage
Expanding to global business	• Role allocation among group companies

Innovative R&D by NTT

The forward-looking statements and projected figures concerning the future performance of NTT and its subsidiaries and affiliates contained or referred to herein are based on a series of assumptions, projections, estimates, judgments and beliefs of the management of NTT in light of information currently available to it regarding NTT and its subsidiaries and affiliates, the economy and telecommunications industry in Japan and overseas, and other factors. These projections and estimates may be affected by the future business operations of NTT and its subsidiaries and affiliates, the state of the economy in Japan and abroad, possible fluctuations in the securities markets, the pricing of services, the effects of competition, the performance of new products, services and new businesses, changes to laws and regulations affecting the telecommunications industry in Japan and elsewhere, other changes in circumstances that could cause actual results to differ materially from the forecasts contained or referred to herein, as well as other risks included in NTT's most recent Annual Report on Form 20-F and other filings and submissions with the United States Securities and Exchange Commission.