Good afternoon. Under the title of "Trust and Co-creation in the Digital Era," I would like to explain our research and development strategy.

Looking back, it has been 83 years since the foundation of Fujitsu Limited. This year is also the 80th anniversary of the foundation of Fujitsu's Kawasaki Research & Manufacturing Facilities, and the 50th anniversary of Fujitsu Laboratories. Kanjiro Okada, the fifth president of Fujitsu, said at the time of Fujitsu Laboratories' founding, that to drive the growth of the Fujitsu Group, Fujitsu Laboratories was founded to develop world-class cutting-edge technologies, where researchers can carry out their work in an independent and free setting. Fujitsu's business has expanded from communications equipment to computers, software and solutions, and recently to digital services.

Through the course of all these businesses, Fujitsu has conducted business with the fundamental principle of bringing happiness and wellbeing to people and resolving issues in societies around the world as a technology company.

Announced in 1976

信頼と創造の富士通
Reliability and Creativity

Looking back at history, in 1976 we announced "Reliability and Creativity" as Fujitsu's slogan. This was after the Japanese economic miracle, and Fujitsu had to develop high quality products through a product-out strategy in order to further develop. For this reason we conducted business by creating new things, centering on developing highly reliable products, and technology that could be used for long periods of time.

Transition of Reliability and Creativity

FUJITSU

1950- : Assaulting expansion of Computer Business
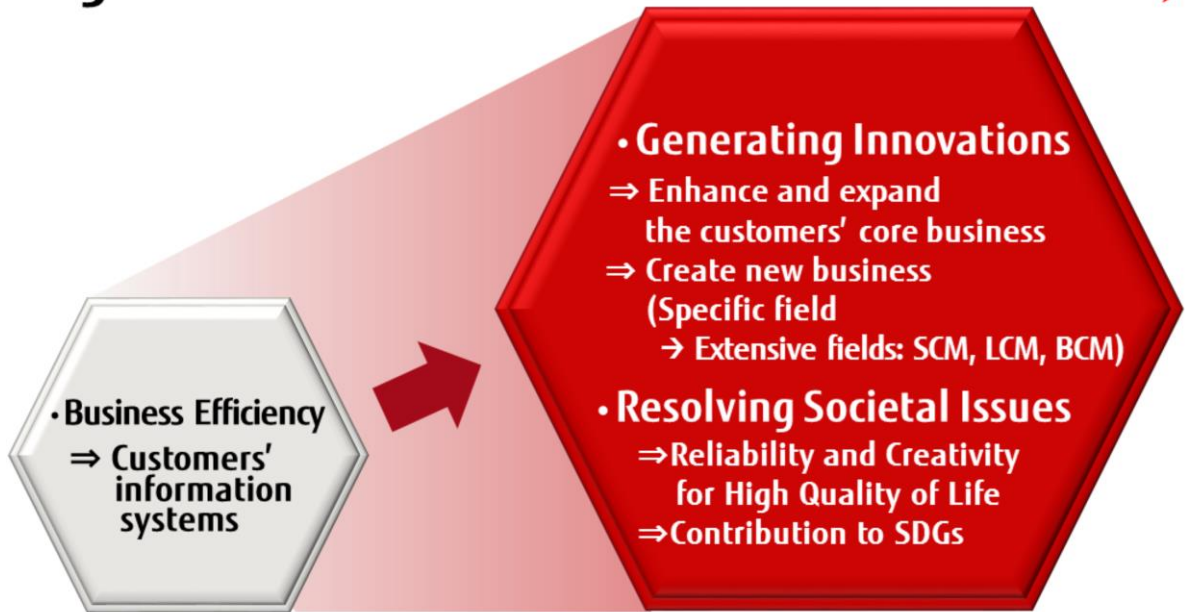Acceleration of rapid growth in Japanese economy through promoting computing business

1976- : Leading ICT business under the slogan of "Reliability and Creativity"
With mainframes as a starter, providing leading-edge, highly-reliable products/services to develop new ICT markets

2010- : Driving sustainable development of society and economy in the digital era
- Ensuring "Trust" in the hyperconnected society / economy
- Propelling Co-creation to generate persistent innovations
- Contributing to achieve SDGs for realization of sustainable and resilient society

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Beginning in 1976, we were trying to become a leading company in the ICT business under the banner of "Reliability and Creativity." Then from 1979 into 1980, we became the number one computer business in Japan, and since then we have continually maintained a sense of ourselves as a leading ICT company. Recently, as digital has become the key word, we have entered an era when the market, our customers, and we ourselves, had to change. This is what is driving the continued development of society and the economy in the digital era. In other words, in this current digital era, we must consider questions, such as how to provide trust when all sorts of things are connected—in short, in a hyper-connected society and economy. Other questions we must consider include what form ICT should take to support the Co-creation, as we call it at Fujitsu, that will continually generate innovation, or the question of what sorts of technologies and services are needed to contribute to the SDGs set forth by the UN, in order to create a more sustainable and resilient society.

Changes in ICT's Role

- **Generating Innovations**
  ⇒ Enhance and expand
     the customers' core business
  ⇒ Create new business
     (Specific field
        → Extensive fields: SCM, LCM, BCM)

- **Resolving Societal Issues**
  ⇒ Reliability and Creativity
     for High Quality of Life
  ⇒ Contribution to SDGs

- **Business Efficiency**
  ⇒ Customers'
     information
     systems

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Looking at trends in this year's Fujitsu Forum, customers had previously been using ICT primarily in increasing the efficiency of their operations, but recently our customers themselves have begun to change, working to strengthen core businesses, expand their businesses, and create new businesses. At the same time, we must also resolve issues in society with our ICT. In other words, the role of ICT is changing in providing the reliability and creativity necessary for a high quality life.

Changes in the Digital Era

FUJITSU

- In the connected world, the number of elements concerning in combinations among company, people, business, data and system is extremely high, resulting in structures with "complexity" and "immensity"

"Complexity"
"Immensity" → Difficulty in judging the "Quality"
"Noise" contamination inevitable

- Through realization of the world that ensures "Trust," a huge number of elements which configure complex combination sets are to be connected more easily, accelerating "Co-creation"

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The changes of the digital era will connect data, companies, and even individuals within that data. In other words, the elements combined within systems have become extremely immense and complex. As for what sort of issues this will create, because systems are so immense and complex, quality becomes extremely difficult to judge. Another issue is the risk that "mistaken facts" will be created by the introduction of "noise". Fujitsu, as an ICT company in the digital era, hopes that by making it even easier to connect individuals, companies and businesses by creating a world of trust, it will thereby expand co-creation, accelerating the development of new businesses.

Trust and Co-creation in the Digital Era

「Reliability」 → 「Trust」

「Creativity」 → 「Co-creation」

In light of these thoughts, Fujitsu is redefining Reliability and Creativity for the digital era, moving instead to Trust and Co-creation.

R&D Strategy

■ **Generating innovations through Trust and Co-creation**
in the digital era and promoting societal and economic development

> ## Trust:
> Develop safe and secure cutting-edge technologies to create "Trust" in society and customers business environment
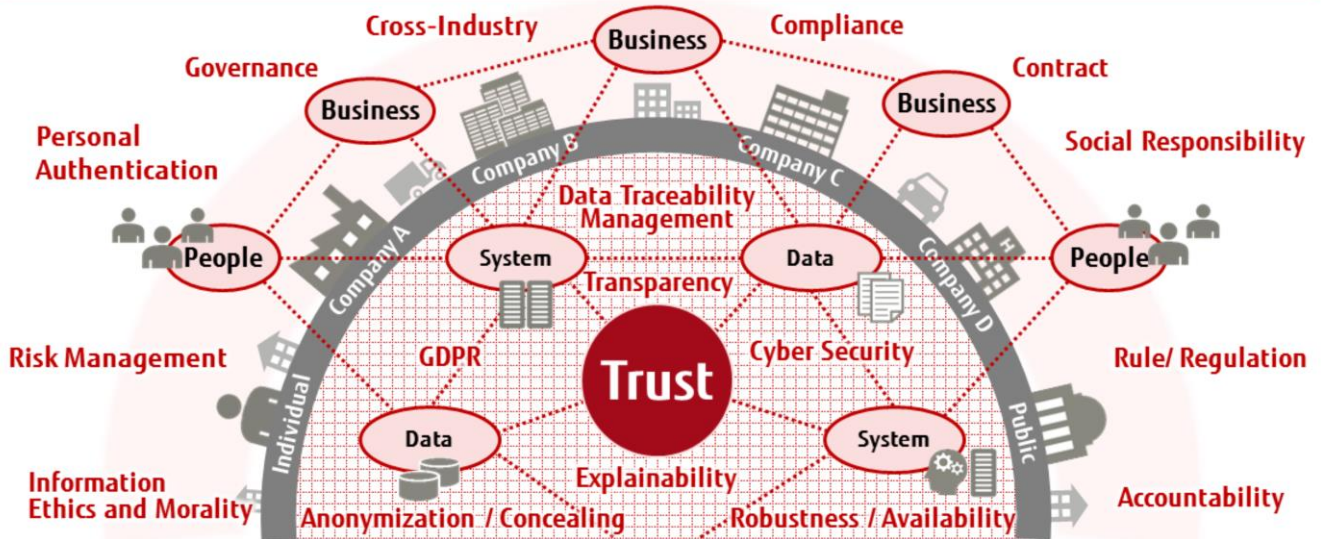
> ## Co-creation:
> Enhance and expand the customers' core business for mutual growth through cutting-edge technologies

With this preamble, our research and development direction is to create innovation through trust and co-creation for the digital era, driving the development of society and the economy. In short, what we aim for with Trust is to develop and provide the cutting-edge technology necessary to provide our customers with a business environment of trust. What we aim for with Co-creation is to support the enhancement and expansion of the core businesses of our customers with cutting-edge technology, and thereby also grow Fujitsu's business.

Values created through Trust of the Digital Era

To illustrate this, the value generated by trust in the digital era is represented by the key words in the box at the top of this slide. The exterior of the semicircle diagram below, with a shape suggesting Earth, represents our physical spaces, while the interior represents the cyber world created by ICT. In other words, in our real, physical society, our customers come together to co-create, giving rise to businesses such as new cross-industry collaborations. In the midst of this, we have the data of each company, as well as their contracts, compliance, social responsibilities, rules, regulations, and so forth. There are also the problems of morality and information ethics, and there is also accountability. In this current physical society, there are issues with trust relating to the cyber elements in the center. We talk about data, but there are many kinds of data— individual data, corporate data, and even data from countries. Systems grow by reusing and utilizing a variety of data, but there is also a need for transparency, explainability, anonymization and encryption, and usability. For cybersecurity problems, we must provide systems that have a level of social responsibility that meets GDPR standards in order to develop business around the globe. This diagram expresses these sorts of issues.
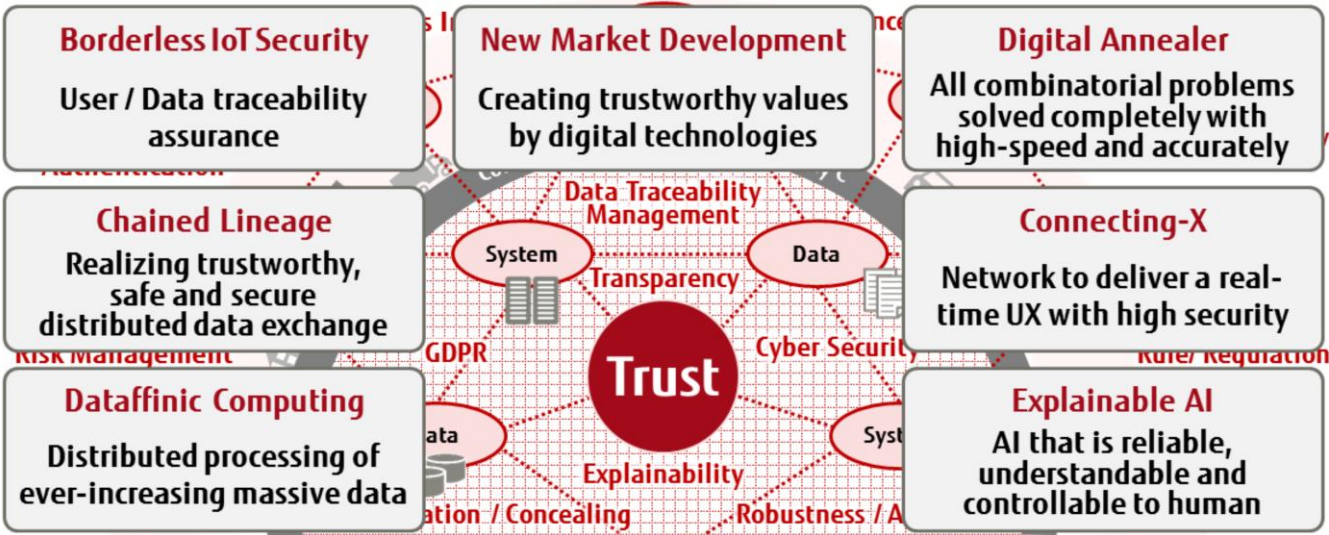
Trust is difficult to build, and can be broken in an instant. If we let our guard down, it will break easily.

Achievement of Trust by Technologies

FUJITSU

● Privacy Protection ● Big Data Utilization ● Work Style ● Corporate Growth / Development ● Rule Revision ● Social Infrastructure Maintenance
● Data Portability ● Data Business ● SDGs ● Brand Promotion ● Co-creation Business ● De facto Standard ● Business Continuity ● AI Social Implementation

Borderless IoT Security
User / Data traceability assurance

New Market Development
Creating trustworthy values by digital technologies

Digital Annealer
All combinatorial problems solved completely with high-speed and accurately

Chained Lineage
Realizing trustworthy, safe and secure distributed data exchange

Connecting-X
Network to deliver a real-time UX with high security

Dataffinic Computing
Distributed processing of ever-increasing massive data

Explainable AI
AI that is reliable, understandable and controllable to human

Data Traceability Management
System — Data
Transparency
GDPR — Cyber Security
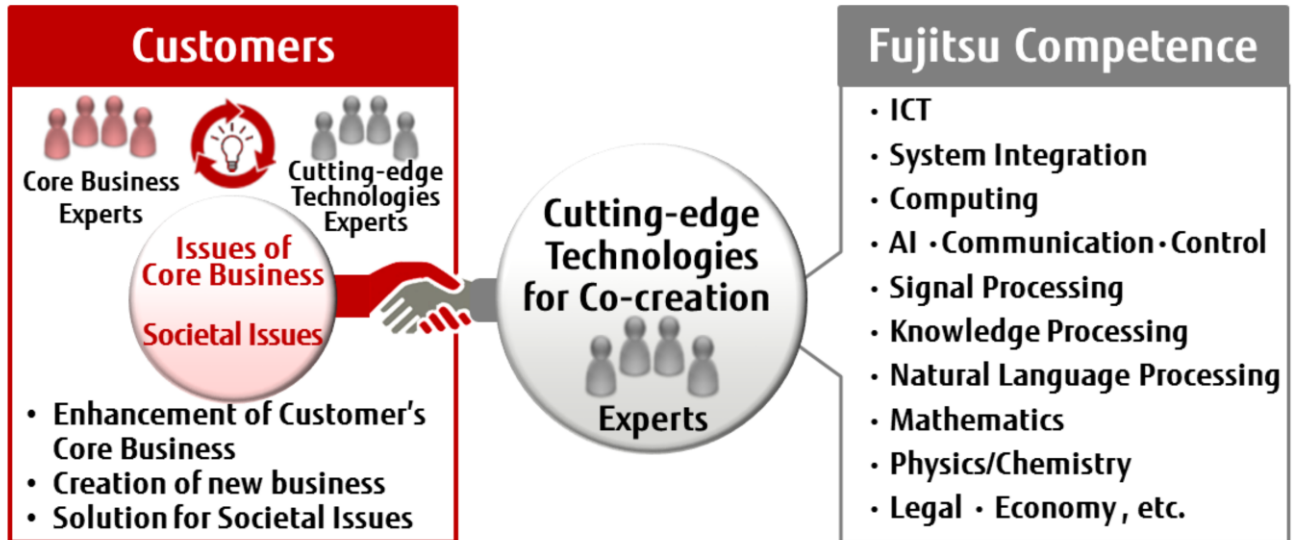**Trust**
Explainability
Robustness

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What does it mean to create trust using technology? If we apply the previous diagram as an example, an important question is under what sort of philosophy we conduct research and development for such technologies as borderless IoT security, the development of new markets, the Digital Annealer, and Explainable AI. Our way of thinking is that through trust, through the Co-creation with customers that it leads to, and through supporting the core businesses of our customers in this way, both our customers and Fujitsu will grow together.

Co-creation through Technologies

FUJITSU

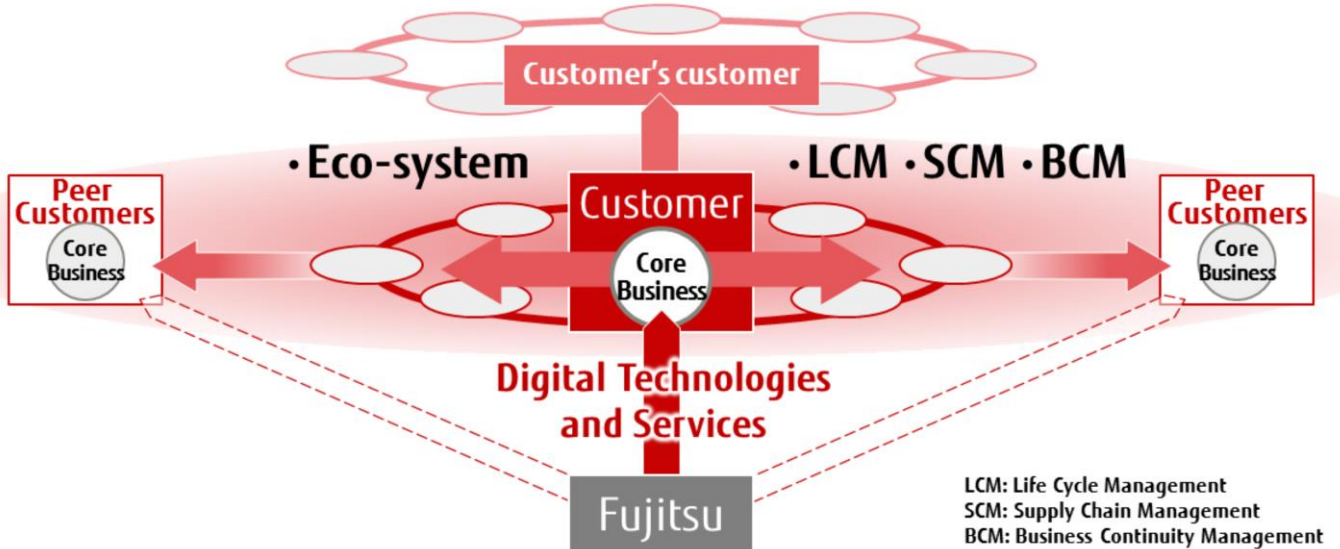■ Co-creation beyond the relationship of IT vendor

Customers

Core Business Experts

Cutting-edge Technologies Experts

Issues of Core Business

Societal Issues

- Enhancement of Customer's Core Business
- Creation of new business
- Solution for Societal Issues

Cutting-edge Technologies for Co-creation

Experts

Fujitsu Competence

- ICT
- System Integration
- Computing
- AI · Communication · Control
- Signal Processing
- Knowledge Processing
- Natural Language Processing
- Mathematics
- Physics/Chemistry
- Legal · Economy, etc.

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What are our specific tactics to achieve this? There are some things that even we in Fujitsu Laboratories have only understood by coming to the front lines. Recently, our customers have also been facing issues in their core businesses. Our customers would also like to expand their core businesses. We have heard them saying, however, that they do not understand how to properly make use of things such as ICT, the Digital Annealer, quantum computing, and AI. Fujitsu's competence is in the fact that we have experts who understand topics such as ICT, AI, natural language processing, and physics, but by the same token, they cannot clearly see customer issues. This is why we would like to develop personnel to serve as intermediaries, researchers who can take cutting-edge technology and go listen to customer issues in order to facilitate Co-creation, and experts who can join customers in developing new technology.

In this way, Fujitsu will provide customers with digital technology and services, thereby allowing customers from various different companies in the same industry to form ecosystems, or allowing customers to also grow, not just through products, but through life cycle management, supply chain management, and business continuity management. Then it will be possible to expand the market with digital technology and high-value business models.
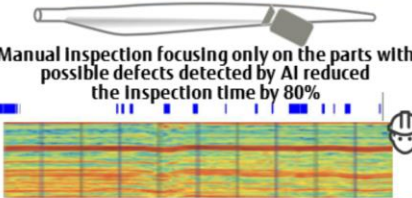
Digital Co-creation Use Cases

SIEMENS Gamesa

Manual Inspection focusing only on the parts with possible defects detected by AI reduced the inspection time by 80%

Social Infrastructure Inspection

Hospital Clinico San Carlos

Analysis of patient's medical interview chart/medical record

Presumption of disease for the next hospital visit

Diagnostic Support for Medical Specialists

Mitsui O.S.K. Lines Ube Shipping & Logistics

Great Circle Route (Shortest Route)

Recommended Route

Fuel Consumption / CO_2 Reduction

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Let me give a specific example. On the left, Europe's SIEMENS Gamesa handles the sort of wind turbines you see in the photo. The turbines seem to turn slowly as they generate power, but in reality, they can turn at over a hundred kilometers per hour. If one of these 75 meter propeller blades were to break and go flying at 100 kilometers per hour, that would be a significant problem for society. For this reason, SIEMENS Gamesa has to thoroughly inspect these propeller blades. Its issue was whether it could replace its previous visual inspections with AI. The result was that, in this case, we were able to successfully replace inspection tasks that were currently being done by experts with AI, which also shortened the time required. In this field of inspecting the infrastructure of society, there are many similar cases. In other words, trust is also essential for the product itself, and for its operation and management. This is an example in which we achieved that through Co-creation. In the center is the example of San Carlos Clinical Hospital in Spain. Medical records from patient exams are available as data, but their details are something that cannot be evaluated except by expert doctors with many years of experience. When considering whether it could supplement the knowledge of its doctors and support them in their diagnoses with AI, the customer trusted us enough to join us in co-creation in this case. On the right is something that we did in collaboration with Mitsui O.S.K. Lines and Ube Shipping & Logistics. The issue here was that the customers wanted to reduce fuel consumption, or in other words, they wanted to contribute to solving environmental problems by reducing CO2 emissions. In order to achieve this, it was necessary to predict optimal shipping routes, and when AI was used to analyze a variety of sensor data, it found that the most optimal routes were not the routes specified by the human captains, but rather routes that were thought to be slightly longer, and these routes were able to significantly reduce fuel consumption and CO2 emissions. This is another example of Co-creation.

Open Innovation

Kyoto University

"Explainable AI" Integrated Database for Genomic Analysis

A large number of academic articles and knowledge DBs scattered around the world

Literature DB	
PubMed	MedGen

Gene mutation DB	
ClinVar	HGMD

Medicine DB	
KEGG MEDICUS	drugBank

LOD Utilization Platform — LOD4ALL

Gene → Protein → Function → Disease ← Medicine

LOD knowledge graph

Toronto University

"Digital Annealer" Advanced Cancer Treatment

Cobalt source
Radiation beam
Diseased part
Collimator

Source: National cancer research center
https://ganjoho.jp/public/dia_tre/treatment/radiotherapy/rt_03.html

MITSUBISHI ESTATE CO., LTD. SoftBank Corp., and The University of Tokyo

"Blockchain" Field trial of new service creation and urban development based on data utilization platform

Data Distribution / Idea Exchange
Blockchain
Data — New Services

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Next is open innovation. These are examples of what to do to generate new ideas with the technology and expert knowledge we have. On the left is something we did with Kyoto University, where we used Explainable AI to generate knowledge graphs of a genome analysis database. When new information is input, it can show reasons why it thinks a certain type of genome structure is best based on these knowledge graphs made up of past papers, which is advancing new scientific discoveries. The example in the center is the Digital Annealer, the product of joint research with the University of Toronto in Canada. In cutting-edge cancer treatment, which previously had been difficult and time-consuming, we were able to start treatment earlier by calculating the optimal ways and places of applying beams of radiation in real time. I think this announcement could someday have a global impact. On the right is an example in which we came together with Mitsubishi Estate, SoftBank, and the University of Tokyo to use blockchain technology to analyze peoples' movements and activities, while beginning a field trial to design new cities.

Fujitsu's R&D Strategy:

Developing Cutting-Edge Technologies for Promotion of the Growth in Customers' Trustworthy Business through Co-creation in the Digital Era
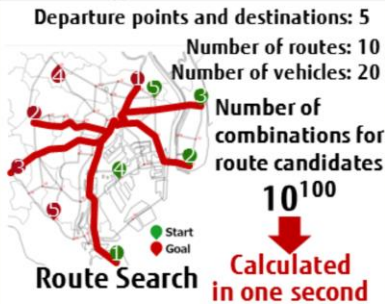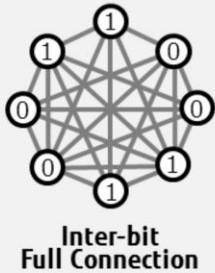
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I would like to introduce some representative examples from when we redefined Fujitsu's R&D strategy as developing cutting-edge technologies essential to customers' trust-based businesses.

First is the Digital Annealer. We have announced this product many times in various places. It is not a quantum computer, but a technology that achieves quantum behavior with digital circuitry, which is capable of quickly solving optimal combinations. It is a technology that can instantly compute things that would take any number of years with current general-purpose computers. If you ask what makes the Digital Annealer trustworthy, it is that, because it can solve problems instantaneously without simplification while checking all combinations, it is capable of such feats as efficiently finding new candidates in drug discovery and alleviating traffic congestion through optimized logistics routes. In the field of manufacturing, customers have actually applied the Digital Annealer, optimizing work schedules and improving productivity while avoiding waste. I introduce this as an example of target markets spreading to new areas by looking at all combinations in this way.

Explainable AI

- **AI that is reliable, understandable and controllable to human**
  - Innovating cancer treatment by inferring the disease from genetic mutation
  - Forecasting the corporate growth rate from past results and economic indicators
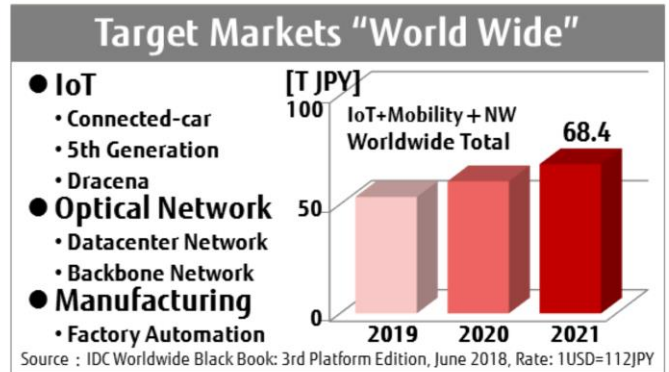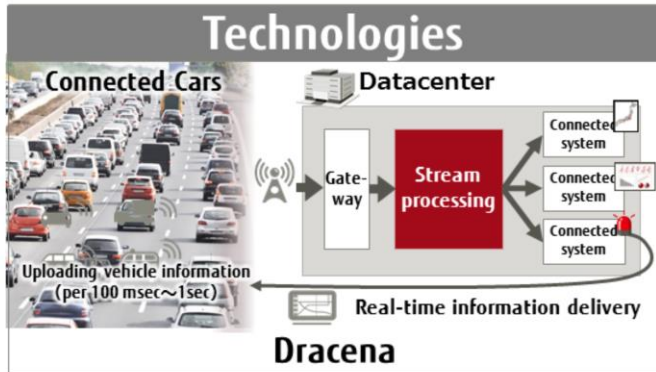 - Work style reform based on expected changes in employees' health from daily activity data

Technologies

Deep Tensor

Input → Output

Auto generation of feature amount

Extended error Backpropagation / Classification error

Output: **Estimation and Reason**

Findings + Inference factors

Consisting Basis by Knowledge Graph

a b c d e f g

Knowledge Graph

Target Markets "World Wide"

- Cancer Genomic Medicine
- Social Infrastructure check
- Fintech
- Logistics
- Quality Control
- Manufacturing
- AI Simulation

[T JPY]

Cognitive AI Worldwide Total

10 — 5.9

5 —

0 — 2019 2020 2021

Source : IDC Worldwide Black Book: 3rd Platform Edition, June 2018, Rate: 1USD=112JPY

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Another example is our Explainable AI. This is something we absolutely had to do as a company. It is an AI people can trust, understand, and manage. Even if you expect that you will get an answer just by training an AI with large volumes of data, if you cannot explain why it got a certain result, why it was mistaken if it made a mistake, or why it was correct if it was correct, this is a problem for companies. If the people using the AI are doctors, for example, they may simply say that they have no use for AI that cannot explain its reasoning. This is why we are using our Explainable AI in an approach aimed at transforming cancer medicine by inferring the disease from genetic mutations. There is also the approach of using it to predict the growth of companies from past results and economic indices, or to transform the ways people work by detecting changes in health from employee activity data. This is something we have evaluated using internal employee data. With this explainable AI, Fujitsu is adding to what AI previously could not do. In other words, we will win significant market share by adding Explainable AI to the sorts of AI that can be created by deep learning. This is our strategy.

Connecting-X

- **Network for delivering a real-time UX with high security**
  - Real-time digital twin for processing large amounts of IoT stream data
  - Collecting / Analyzing the data from connected cars and feeding the required data back to users in real time
  - Optical fiber network for connecting data centers securely to transmit large-capacity data

Technologies

Connected Cars → Datacenter

Uploading vehicle information (per 100 msec～1sec)

Gate-way → Stream processing → Connected system / Connected system / Connected system

Real-time information delivery

Dracena

Target Markets "World Wide"

- **IoT**
  - Connected-car
  - 5th Generation
  - Dracena
- **Optical Network**
  - Datacenter Network
  - Backbone Network
- **Manufacturing**
  - Factory Automation

[T JPY] IoT+Mobility+NW Worldwide Total

2019 / 2020 / 2021 — 68.4

Source : IDC Worldwide Black Book: 3rd Platform Edition, June 2018, Rate: 1USD=112JPY

Connecting-X refers to the connections between all sorts of things. This is a network that delivers user experiences in real time. Large amounts of data will be produced in the era of IoT. We are developing new technology to process this data in real time, whether processing at the front end or passing it through a network to process in a datacenter, including load distribution, which we call digital twin technology. This trend can be seen in the automotive industry as well, where cars are connected to all sorts of things, and it is expected this will create new services. In this field there are methods for collecting and analyzing data, as well as methods for feeding that data back into the system, and these methods require a transmission system that can be trusted. If a car is hacked, it can turn into a major problem. There is a movement toward asking such questions as how to provide services while preserving safety. By pushing ahead with this sort of technological development, we are again expanding our target market.
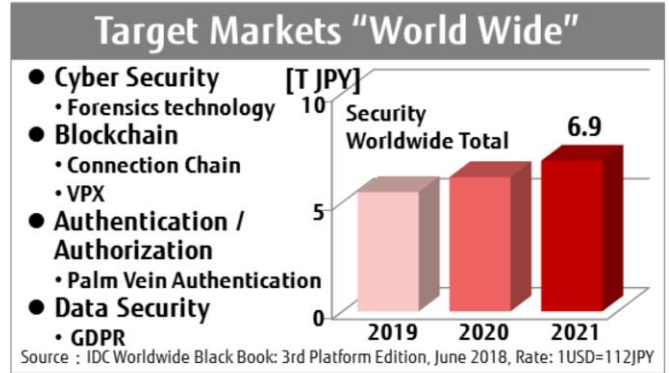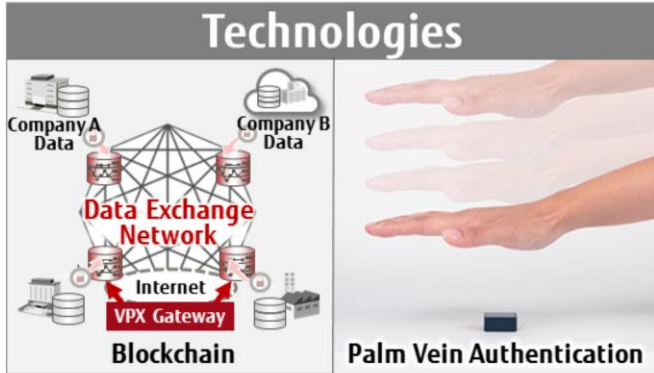
The next example is Borderless IoT Security. Because all sorts of things are connected, it is hard to know who to trust, and as more and more things are connected, we are entering an era in which we do not know what will happen. One method of resolving this is not coins created using blockchain technology, but rather history and commercial records secured using blockchain technology. Many are worried that, without managing the transaction history and traceability of data, they will not know where data came from, who created it, or how it was created. A new connection business will grow from resolving those sorts of concerns. These records will include the person who created the data, including biometric authentication data and how that data is used at unmanned stores, so there will also be demand for technology that can properly provide data while protecting privacy through biometric authentication.

New Market Development

- Creating trustworthy values by utilizing digital technologies
  - Scoring support by 3D sensing that revolutionizes the world of sports
  - Sensecomputing to analyze human psychology by sensing data
 - Integrated surveillance for facilities by optical fiber sensing

Technologies

Scoring support system by athlete sensing

Target Markets "Potential Markets"

- **Athlete Sensing**
  Gymnastic scoring support, Application for Training,
  Healthcare "Rehabilitation",
  Entertainment "Commercial/Movie Production"
- **Sensecomputing**
  Sensitivity Digital Marketing, Work Style Reform
- **Facility Surveillance**
  Temperature measurement by Optical Fiber,
  Deterioration predicting solution

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We can open up new markets through trust. This is the world that will be created using digital technology, and the scoring support system using 3D sensing that is transforming the world of sports, and we aim to have this ready for practical application by 2020. It is a system that will provide neutral support. There is the possibility that people might overlook parts of complex techniques, such as elements in a routine whose difficulty ranking is a D-difficulty Kovacs. Computers can thoroughly watch for this sort of thing, and can neutrally display suggestions as to the score for a technique. While I think the final score will be left to a person, this is creating a new approach. In addition, we are also entering new markets for things such as safe and secure technology for deterioration estimation solutions that can continually monitor facilities using sensors, including fiber-optic temperature sensors, a new technology that can help prevent interruptions in the infrastructure of society from momentary carelessness on the part of electrical companies, for example.
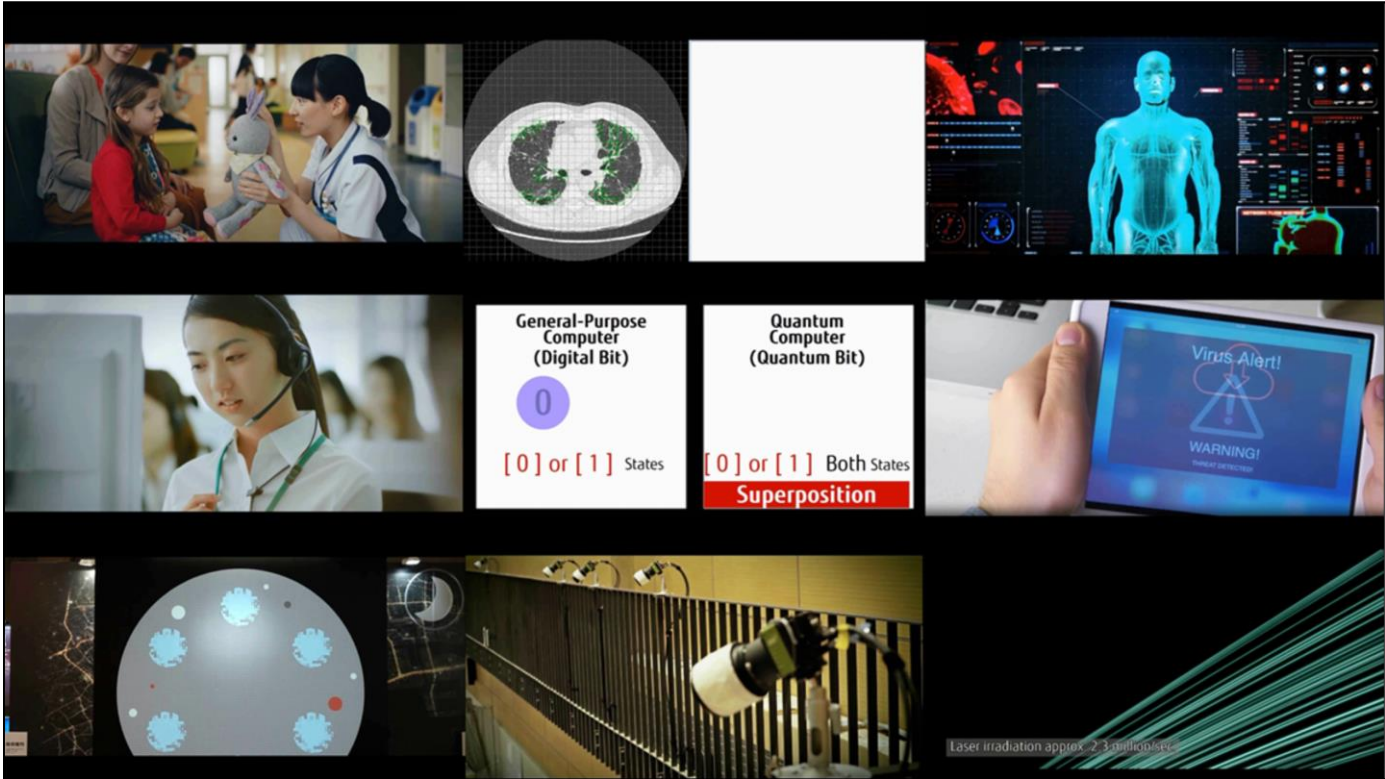
In short, if we define the necessary conditions using this sort of trust-centered way of thinking, using a human-centric way of thinking, and for using co-creation to address issues in the core businesses of customers with digital technologies, then ICT still must continue to grow in the future. Our most recent status is that we are working to advance these areas while developing new technologies.

Exhibits: Fujitsu Laboratories' 8 Emerging Technologies for Leading the World with Trust
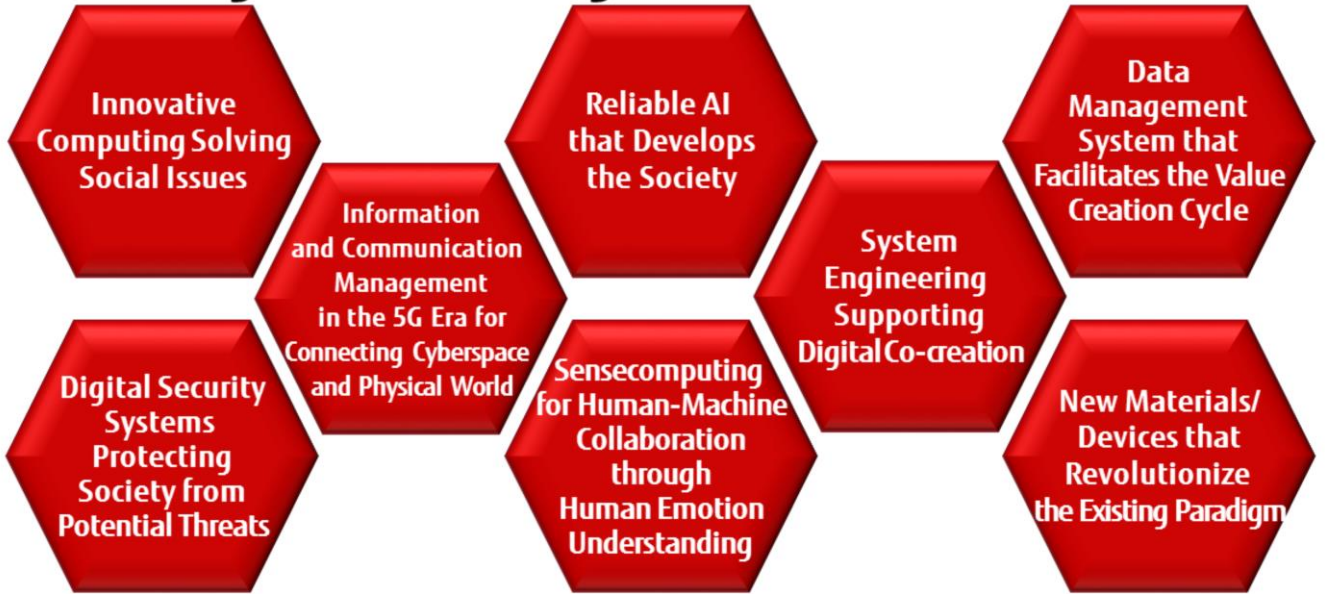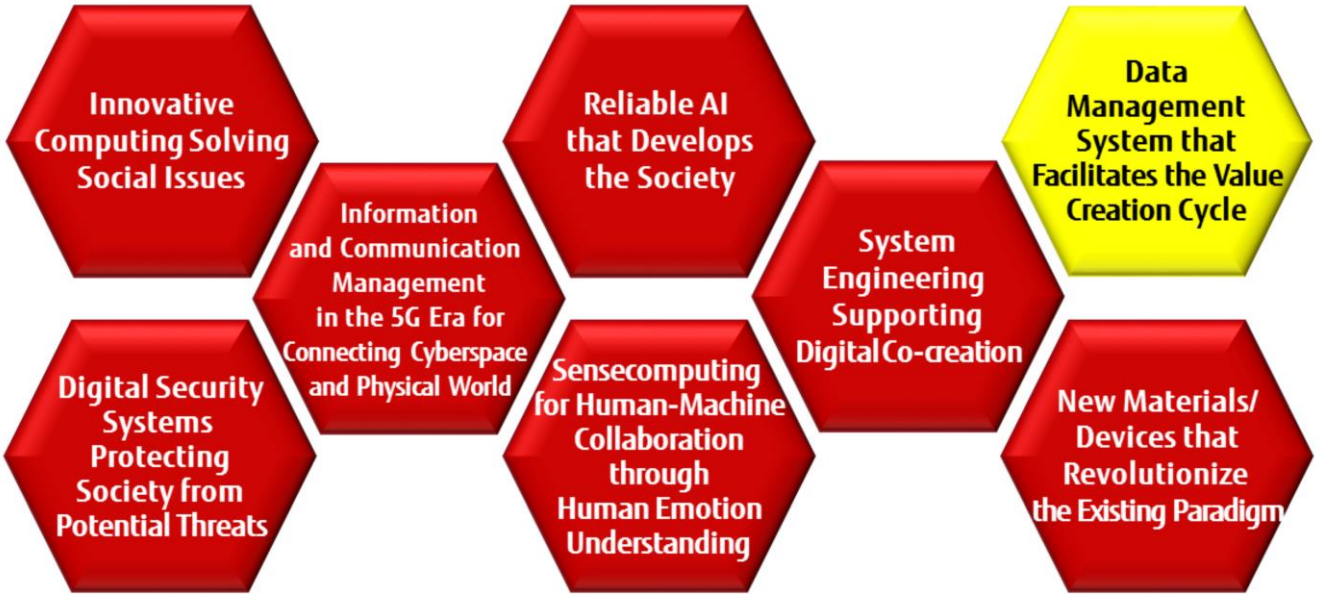
信頼と創造の富士通
Reliability and Creativity

As I said at the beginning of my remarks, Fujitsu announced "Reliability and Creativity" in 1976, but in order for us to grow further in the digital era, we are redefining them as "Trust and Co-creation," moving forward with a way of thinking centered on providing customers with new technology developments while growing together.

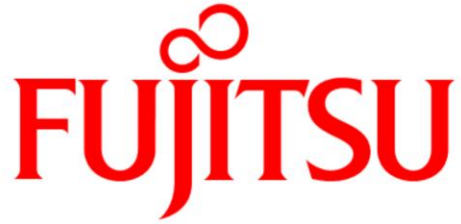This concludes my remarks. Thank you all for your attention.

In the Digital Era
信頼と創造の 富士通
Trust and Co-creation

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