FUJITSU

Fujitsu Technology and Service Vision 2019

shaping tomorrow with you

Trust – we've never needed it more

We are living in a world that is more connected, more globally integrated and faster paced than it has ever been. The benefits that have been brought by digital technology seem obvious and ubiquitous. But the world is increasingly becoming chaotic.

In the spaghetti-like complexity of the networked world, many of the traditional structures and institutions that we relied upon are proving inadequate or even breaking down. Governance struggles to keep pace with technology, data grows faster than it can ever possibly be controlled. In an era of 'fake news' it is harder than ever to distinguish the signal from the noise.

Our data can be monetized for commercial purposes that don't necessarily have our best interests at heart. Or worse, put in the hands of people who would do us harm. Even if we wanted to, there is no option for us to withdraw from the digital world, when so many of the things we need to do rely on having a digital identity.

The paradox of the digital world is as it becomes smarter and more connected, it becomes harder to control and seemingly more vulnerable. The contrast between the opportunities and threats from digital technology have scarcely ever been as marked as they are in 2019.

Is there any way out of the chaos?

In today's complex world, trust is a big issue. How can we trust businesses to look after our data? How can businesses better manage their reputations, when their employees and customers have higher expectations than ever before? How can we ensure powerful new technologies like AI, Blockchain, and especially, when it arrives, Quantum Computing, are created and used in ethical ways? How can businesses focus on the longer term, on delivering outcomes that are good for society, over short term and narrow objectives of profitability and shareholder returns?

When we think about trust, we also need to revisit what it means to be human. For a long time, businesses have seen people as resources. Going all the way back to Adam Smith, in 'The Wealth of Nations', the aim of business has been to make people more productive. Smith used the example of a pin factory to demonstrate the efficiency of dividing labour into specialized tasks, a business template for the industrial economy that has been in place ever since. It is fine if you are making a standardized commodity product like pins.

But in today's complex world, consumer needs are more sophisticated and diverse, as are the opportunities to satisfy them. Business today needs people as creators, not just as resources. Business needs people who can respond to changing needs, who can collaborate, who can make new links and relationships. They need people who can solve the challenges of customers and create value which they truly want. Business needs imagination.

Yet trust between people, or 'social capital' as businesses often call it, has eroded in the rise of modern economy and technology. We need to revitalize trust in the context of the digital world.

Fujitsu has for many years promoted a human centric approach. We believe this is still important, but the need for it has accelerated. We also believe that co-creation is a key approach of realizing this. In a networked world, innovation comes much more from the bringing together of different perspectives, and the power of ecosystems is key to deliver this. These have been key ideas in the Fujitsu Technology and Service Vision of previous years.

We believe that the chaos that we see today is a period of transformation as we move from a supply centric, industrial paradigm to a new human centric, digital paradigm. There is no guarantee that we can escape the chaos. To emerge from the chaos, we need to fully understand the role of trust and how it enables us to deliver a human centric world.

Rebuilding trust has become the central issue to a better future.

CONTENTS

2 Introduction
Trust – we've never needed it more

8 Chapter 1
Rebulding Trust in a Chaotic World

16 Chapter 2
Co-creating a Trusted Business

28 Chapter 3
Technology for a Trusted Future

42 **Customer Stories**

68 **Portfolio**

Related information and website

The Fujitsu Technology and Service Vision 2019 was created by a team of Fujitsu people from around the world. We are communicating globally it in booklets, web, and video.

This booklet sets out our vision and insights on how business leaders can leverage digital transformation along with real examples of successful digital transformations as well as our portfolio of products and services.

For a more concise view of the key messages, see our Executive Summary.

For more information, visit our website : https://www.fujitsu.com/global/vision/

President's Message

We are now in the middle of the so-called fourth industrial revolution. Innovative technologies and services are being deployed in rapid succession. Things that were only considered dreams a mere decade ago are now a reality. This trend will undoubtedly continue to accelerate in the future.

At the same time, a sense of unease pervades society. We have seen many natural disasters and the development of an increasingly unstable global political situation. Also, as technology drives the future, transforming our expectations into reality, new concerns have begun to emerge. Will AI truly bring happiness and wellbeing to people? Can we overcome cybersecurity and privacy issues?

At Fujitsu, we believe that for customers to drive their digital transformations with confidence – and for people around the world to enjoy the benefits of technology with peace of mind – the element of trust is essential. We are building trust in data and technology as well as investing in technologies that assure trust in businesses and society, to contribute to the creation of a prosperous future.

Fujitsu is undertaking many initiatives to strengthen the technologies that underpin trust. For example, we are assuring the reliability of increasingly complex transactions, enhancing our ability to respond to cyber risks, and making transparent the decision-making process for AI. We are also reaffirming the goal of our Human Centric approach to technology use and reflecting it more broadly in our activities.

Based on a vast array of advanced digital technologies, Fujitsu provides value and robust support for the trust underlying our customers' businesses. We are working to help create a prosperous future where people can live with peace of mind and trust in the technologies that enable it. This is Fujitsu's vision of a Human Centric Intelligent Society. We are contributing to the achievement of the UN's Sustainable Development Goals (SDGs) through the realization of our vision and will co-create a Trusted Future together with our customers.

July 2019
Fujitsu Limited
President and Representative Director
Takahito Tokita

Human Centric Innovation

Driving a Trusted Future

Amid the transition to a digital society, the principle of being human centric is becoming more important than ever. Amid the growing concerns over the rapid advance of AI and other powerful technologies, the priority of global business leaders is shifting back to 'human-centered management'. Fujitsu has advocated our Human Centric vision since 2009, co-creating innovation and contributing to solving social challenges.

Digital technology allows people to benefit from many new services, enriching our everyday lives. At the same time, we are increasingly worried over breaches of private data and intensifying cyber-attacks. Trust of business is at risk today. Rebuilding trust must be big on the business agenda.

Fujitsu's global message for 2019 is "Human Centric Innovation: Driving a Trusted Future". We are committed to working together with our customers and partners to take actions to build a trusted society.

Fujitsu Technology and Service Vision 2019

Over the pages that follow, we describe an approach to rebuilding trust in this complex world, and how we want to co-create trusted business and society.

Chapter 1: Rebuilding Trust in a Chaotic World

Our world is becoming more complex. Data is growing beyond our control, and we are growing concerned about the trustworthiness of data. AI is advancing, but we are not sure if we can rely on its judgement. We are facing serious social challenges such as aging. How can we rebuild trust?

Chapter 2: Co-creating a Trusted Business

To build a trusted business requires three actions. This chapter introduces the first two actions. How can we architect a purpose-driven business? How can we build a human centric organization?

Chapter 3: Technology for a Trusted Future

The last action is to drive the business with digital. This chapter shows how we can create value from data and use it to drive the business. We explore a new model of trust, that can enable an increasingly autonomous, distributed world.

Trusted Society

We believe that sharing societal goals and co-creating human centric value through ecosystems will lead to an inclusive, sustainable and trusted world. We call this a Human Centric Intelligent Society.

We hope that the ideas presented here will help you consider your future strategy.

Design Concept: Layers

We have chosen a design style that represents 'layers of trust'. The 'flowers' on the front cover and the introductory pages of Chapters 2 and 3 represent our commitment to building a trusted future together with various stakeholders. By co-creating through the layers of trust we make the flowers bloom.

We will continue to use the hexagonal design to express our Human Centric vision. Hexagons are stable as well as scalable. We find many hexagonal patterns in the nature, like beehives and turtle-shells, or crystals and stone columns. This design pattern conveys our idea that many people and organizations organically shape ecosystems and co-create human centric value.

Building Trust is a part of Fujitsu's DNA

Illustration Akihiro Ikeshita

Trust has always been a core value of Fujitsu. We have always striven to be a company that our customers can place their trust in. Our business has been built on helping our customers secure the trust of their customers or citizens. We build and operate technologies and services, all over the world, on which key social infrastructure depends. From large-scale trading systems capable of processing hundreds of millions of daily transactions without errors, to hardware products that reliably function in harsh environments. Throughout Fujitsu's 80-year history, our motivation to build trust has been unchanging.

Working in ways that build trust is a vital part of realizing our vision of the future. We aim to realize a safer, more prosperous and sustainable society. We call this a Human Centric Intelligent Society. Human Centric is the belief that to get the best outcomes we must put people at the center. We think the mission of technology is to empower people and deliver positive outcomes for society.

Fujitsu Technology and Service Vision

We launched the Fujitsu Technology and Service Vision in 2013, to articulate the future we wanted to see, and how we could realize it. Our vision is a fixed goal. But we publish this paper annually to share our perspective with you about how technology is changing and what new possibilities and risks are emerging. Internally, for Fujitsu people, this is our journey of transformation. We outline our thinking on how organizations can create and deliver innovation.

Thinking about our future vision has helped us to develop the technologies and services that our customers tell us are most relevant, useful and needed for their own business success.

2019

Human Centric Innovation

Driving a Trusted Future

2018

Human Centric Innovation

Co-creation for Success

2017

Human Centric Innovation

Digital Co-creation

2016

Human Centric Innovation

Driving
Digital Transformation

For example, we have developed 'Zinrai' our Human Centric AI, blockchain solutions, and industry platforms to support specific business outcomes. We have developed a design thinking approach which we now use in many engagements with customers to drive innovation and the kind of outcomes that are most beneficial.

2015

Human Centric
Innovation in Action

It is one thing to set out an ambitious vision, but we recognize we cannot do this alone. This is why collaboration has always been at the heart of our approach. We believe that working together with our customers and partners is most important of all.

2014

Human Centric Innovation

As digital technology comes to dominate our world more and more, we believe that by working together and making the right choices we really can make a positive difference to the world.

2013

Fujitsu Technology and
Service Vision launched

Human Centric Intelligent Society

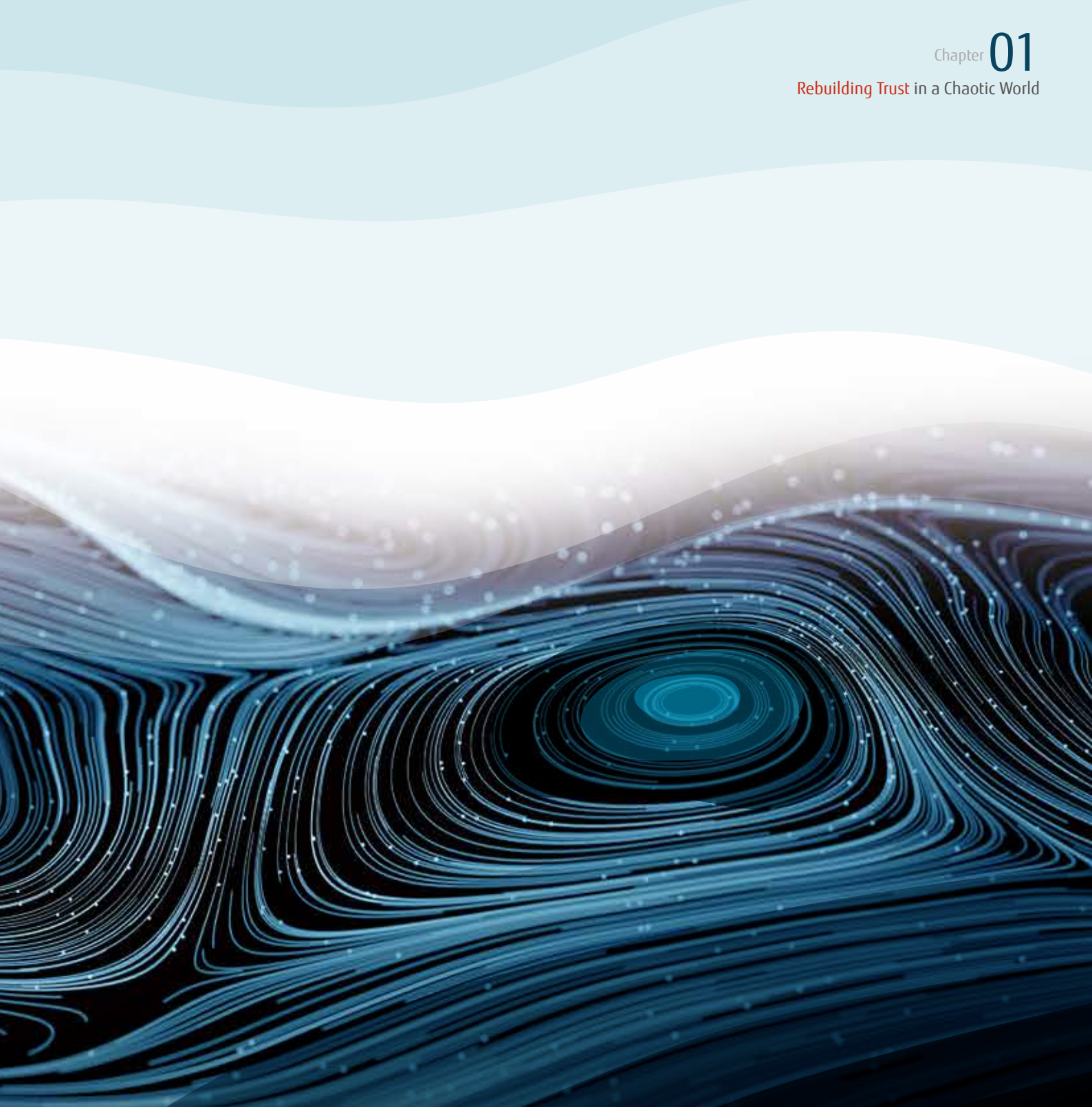
01

Rebuilding Trust in a Chaotic World

Digital technology is changing our lives. It is changing the way business works. Everything is becoming faster and more convenient. But we are facing a big challenge of growing volume of data and the complexity of network connections is becoming hard to control. In this increasingly complex world, we are losing confidence in what we can trust. What can we do to regain it?

2018 marked a significant turning point for the digital world. The number of people connected to the internet hit 3.9 billion, or 51.2%, over half of the world's population. Digital is now the norm. 'Non-digital' is becoming the exception. With fewer people left to connect, growth in smartphone shipments and in the number of people connecting to the internet slowed for the first time in its history. But does this mean we are coming to the end of the transformation?

Far from it. Now, the impacts of digital are being deeply felt. As digital technology and data weave their tentacles further and deeper into our everyday lives, the real consequences of change are materializing. How we work, how we consume products and services, how we obtain information, how we connect and socialize, how we think, even our beliefs are being transformed.



The consequences are not all positive. The flood of information that has accompanied the rise of the digital world is leaving us dazed and confused. It is difficult to judge what information is trustworthy when there are so many sources. Worse, our personal data, our privacy even can be compromised by the organizations we engage with. Often we have no say in this.

Cutting-edge technology like AI has more power to impact lives than ever before. If life-changing decisions are going to be made by computers, it is crucial that we can trust the technology, the data and the organizations that use them.

And all of this is set against a backdrop of a society in crisis. Our environment is under greater pressure than ever before, and we have a host of challenges to deal with as society transforms, from the movement of people into cities to the difficulties presented by an aging population. How can we use digital technology to address these shared issues?

The world may still have a long way to go on its digital journey, but it has reached the end of the beginning. Now the real challenge begins ...

Is the Data on Your Side?

The internet was built on the vision of technology pioneers, who saw it as a common good, a way for expensive technology and valuable data to be shared by all. From the start, its architecture has reflected this vision. Governed by open, technical standards agreed by its community of technical experts. The optimism of the early internet continued into the new millennium and was seemingly justified. The rise of online services like mobile payments and e-commerce has brought huge convenience into people's lives.

The digital world has become so pervasive in all of our lives, there is scarcely any of our activities it doesn't touch. U.S. adults spend 5.9 hours a day on digital media,*1 which amounts to around a third of waking hours spent online. Technology has become our eyes and ears, our primary source of information.

But today, is all well with our relationship with the digital world? Our daily lives leave digital footprints everywhere. Our every interaction with technology, our every piece of data is recorded somewhere. Is the data on our side? There are growing areas where our ability to trust is being compromised.

*1 Kleiner Perkins 2018

Identity and Privacy

When we engage with online services, we create digital identities in order to receive more personalized services – our stored preferences, for instance. Increasingly it is becoming impossible to operate without digital identity, whether that is shopping, financial services, or interaction with government services. But it is hard for people to know what their digital identity actually is, what data is being held about them and by who. According to our research, 82% of people feel it is important to have full control of their personal data. But it is often not something that people can control. There is little alternative choice. We have to rely on organizations having robust privacy and data protection controls.

Trustworthiness of Information

A consequence of the open architecture of the internet, is that anyone can say anything. How do you know if it is true? There is no authority to guarantee trustworthiness in the digital world. Often popularity is conflated with legitimacy – the number of followers, the number of 'likes', the number of good reviews. Truth and popularity are not the same thing. What's more, it's becoming easier to manipulate data and create false information. A technique of AI called Generative Adversarial Networks or GANs can already generate hyper-realistic images of people. The technology is reaching a point where it can falsify video in a convincing way, to take a video of a person and literally put words into their mouth. These so-called deep fakes are one problem, but equally technology could be used to convincingly fake legal evidence, like CC TV footage or documents.

Privacy

Feel it is important to have full control of their personal data

82%

Worried organizations exploit personal data without permission

72%

Trustworthiness of Information

Are concerned that data they use may have been falsified

59%

Find it difficult to judge if online information is correct and trustworthy

70%

Failures of Security

Are concerned about the risk of leakage of customer data and confidential information

68%

Are worried about the risk of cyber-attacks to social infrastructure

68%

Fujitsu Global Digital Transformation Survey 2019
We asked 900 business leaders in 9 countries about digital transformation.
The survey was carried out in February 2019.

This is a major concern for people. In our research, 59% were concerned data they use may have been falsified, and 70% claimed to find it difficult to tell if online information is correct.

Failures of Security

Information can also be compromised. Either through the malicious acts of third parties or equally through negligence or failure to follow proper procedures. Security has long been cited as a concern, but the problem is escalating. According to the World Economic Forum the cost of global cybercrime is expected to reach $3 trillion by 2020, and 74% of the businesses can expect to be hacked in the coming year. Our research found that 68% of business leaders are concerned about the risk of customer data and confidential data leaking.

Even more concerning, critical infrastructure is increasingly a target for malicious attacks. The US Department of Homeland Security reported that foreign hackers had penetrated the control rooms of U.S. energy utilities, with the potential to control and do harm to energy infrastructure. The WannaCry virus impacted millions of computers across the world, including thousands in the UK's National Health Service (NHS), seriously compromising its ability to deliver critical care. In our research, 68% were concerned about the risk of cyber-attacks against social infrastructure. The problem will become worse in the future, when more things like connected cars and autonomous vehicles could be targeted.

Complexity

All of these issues are compounded by the complexity and interconnectedness of the digital world. It is good that we can consume innovative new services made from connecting distributed services. In mobility and financial services, for instance, many services are delivered across an ecosystem. But how can we be sure of the end-to-end trustworthiness and security of the ecosystem?

Black Box Technology

The pace of development of AI is breath-taking. In 2014 AI overtook humans at visual recognition. The technology passed the milestone of a 95% success rate at recognizing images, which is what an average person is capable of. In 2017, another milestone was reached, this time in speech recognition. AI is now better than humans at recognizing speech, although it doesn't yet fully understand it.

AI has advanced primarily because of development in machine learning and deep learning, essentially data processing techniques that leverage neural networks to find patterns in data. Most of the time when we say AI we mean systems that use some kind of machine learning, although AI covers a far wider scope including sensing, knowledge creation and decision support. AI has been the subject of much hype, which often has ignored its clear limitations. The technology is significantly different to human intelligence. AI does not understand meaning or purpose, it lacks a physical body so has no concept of experience. AI is less effective where context is required, for instance interpreting nuances of language and expression, or explaining its own reasoning.

Nevertheless, it is a powerful technology and will soon deeply affect how businesses work and the way we live our lives. AI is especially good at transactional tasks, like interpreting information to make diagnoses or decisions, or routine tasks where context is not required.

Yet we need to think and act carefully. How can we be sure that AI will create benefit and not cause harm? How can we trust the technology? In a world where AI is commonplace, will we be better off? Let's look at some of the challenges.

Bias in AI

AI doesn't set out to deliver bias. But AI can only interpret data, and data can only reflect the human world. And the human world is asymmetric. The majority of CEOs are males and middle-aged or older. Based on this pattern of data, what would a recruitment AI conclude about the suitability of a young female candidate to be a CEO?

Furthermore, an AI might itself reinforce asymmetries in data and skew it further. Property prices in a particular area, for instance, might be further depressed if AI concludes, based on local amenities, crime levels and other available data, the area is unattractive. A self-fulfilling prophecy.

Our research pointed to the fact that business leaders haven't quite made up their minds on the question of bias in AI. 60% thought decisions made by AI were fairer than those made by people because people were subject to biases. But 52% of leaders couldn't trust AI because data can be incorrect or biased.

Bias in AI

Think that decisions made by AI are fairer than those made by people because people are subject to bias

60%

Couldn't trust AI because data can be incorrect or biased

52%

Black Box

Would not trust AI on its own. The final decision should be made by a person

60%

Would trust a decisions made by AI if the AI shows substantial reasons for reaching the decisions

63%

The Ethical Imperative

Would not trust AI or would have greater trust in person than AI to make this decision

Court decision

69%

Medical diagnosis

54%

Judging or refereeing decision in sport

44%

Quality inspection of a product

40%

Fujitsu Global Digital Transformation Survey 2019

Impact on Work

There are huge potential benefits from AI to drive efficiency and better productivity in the workplace, and major potential for automation of many tasks. The World Economic Forum predicts that 75 million jobs will be lost globally to automation. But 133 million jobs may also be created.

But what kind of activities will be automated? There is potential for both lower-skilled and higher skilled tasks to be performed by AI. For instance, a conversational AI in a call center can deal with some basic queries, like confirming account status or password reset, which might remove a large proportion of the cost. However, certain higher skilled tasks, like analyzing X-rays or medical images, could also be automated with AI.

Black Box

With the power of deep learning, AI can identify patterns through learning from data. You can train it for what to look for, an imperfection in products for instance, or signs of disease in body tissue, but the AI finds its own path from data to the outcome. It is a classic black box. You can see what goes in and what comes out, but not know what happens in between.

How can we trust AI if it can't explain its workings? How do we know if insights are genuine or a result of a flawed pattern recognition? What's more, there are many industries like healthcare and financial services where all decisions must be accountable and auditable. GDPR, the EU's landmark regulation on data protection mandates that automated processing should be able to provide 'an explanation of the decision reached.'

Our research found that 60% would not trust AI on its own. The final decision should be made by a person. But if AI was able to explain its workings 63% of business leaders reported they would trust AI.

The Ethical Imperative

AI will raise many ethical questions. Would you trust AI to make a decision that impacted a human life, even if it may have saved many more lives? If AI is used to allocate medical resources, or operate vehicles, it may have to make these kinds of decisions.

Our research found that there was lower trust in AI to make life-changing decisions like legal judgments or medical diagnosis, than less impactful verdicts like a quality inspection or a sports refereeing decision.

While technologies promise a world that will be faster and more automated than ever before, will it be an equitable world? Could AI widen the gaps in inequality? Could the technology only benefit people and companies who are already wealthy enough to afford to invest in it? Could it drive down wages for lower-skilled, mass occupations? Consideration of ethics is crucial, not just for the functionality of the technology, but for its social impact.

Society in Crisis

The acceleration of change is having deep consequences on our society. We have discussed already how technology is driving change. But at the same time the world is globalizing and society is undergoing transformation. The news is not all good. For the first time, we have to question whether our society will be resilient enough to respond to the global challenges that we have created for ourselves.

Environment

Perhaps the most serious and immediate challenge is to prevent irreversible damage to the environment. Pollution to the atmosphere is a major problem. Around 91% of the world's population live in places that fail to meet the World Health Organization air-quality guidelines.

Emission of greenhouse gasses is driving climate change, with the likely impact that sea levels will rise. Around 800 million people live in low-lying cities, and would be impacted by an expected 0.5 meter rise in sea levels by 2050. At the same time we are damaging the planet's natural ecosystems. We dump 12.7 million metric tons of plastic in the oceans every year,*2 at huge cost to our sea life. There has been a 60% decline in the average abundance of species of wildlife since 1970.*3

Health and Well-being

We have made huge progress to human well-being over recent decades. Infant mortality and famine have reduced considerably. Yet different, more complex problems are emerging. There are now, for the first time in history, more people aged over 65 than aged under five. Populations are aging, people are living longer, impacting work life balance but putting pressure on resources like healthcare and financial planning. We have to find new ways to look after our older generations, using resources of what is a relatively declining working population. We have to find ways to deal with major diseases. According to the World Health Organization, cancer is the second leading cause of death globally, and is responsible for an estimated 9.6 million deaths in 2018. Across the world, cancer kills one in six people.

Inclusion and Urbanization

In spite of advances, many people are being left behind. According to the World Bank, it is estimated one billion people have no formal identity globally, which means they are excluded from accessing basic services and effectively unable to participate in society. In low-income countries, half of women do not have an identity, restricting their participation in society and their access to education, political or economic life. Poverty is still a huge problem, in 2015 more than 10% of the world's population were living on less than $1.90 a day.

*2 Science 2015 *3 WWF 2018

Environment

Sea levels expected to rise by 0.5m by 2050

C40

0.5m

Health

1 in 6 deaths worldwide are caused by cancer

WHO2018

1/6

Aging

There are now more people older than 65 than younger than 5

Deutsche Bank 2018

Urbanization

68% of people will live in cities by 2050

United Nations 2018

68%

The Importance of Purpose

Consider SDGs as part of the business agenda and integrate them into their strategy

66%

Fujitsu Global Digital Transformation Survey 2019

Over half of the world's population now lives in cities, by 2050 this is expected to have reached 68%. Urban mobility is a major problem for many cities, with infrastructure failing to keep pace with growth of population. City authorities need to find ways to reduce traffic congestion, and find investment for much needed public services.

Many cities live in the shadow of the threat of natural disasters. How can they take the necessary mitigating actions to provide for the safety of their citizens if a disaster strikes?

The Importance of Purpose

These global problems are becoming more severe and solving them must be a top priority. Finding solutions requires collaboration on a wide scale. The United Nations has set out Sustainable Development Goals (SDGs) to objectively define and categorize these challenges and help organizations work towards finding answers for them. SDGs provide a way for organizations to align social outcomes with their business strategies, as we have been doing at Fujitsu.

For many business leaders this could be a tough ask. They may feel that making a positive social impact can be at odds with the immediate operational needs of the business, of hitting profit targets and satisfy shareholders. But our research has found that many organizations are using SDGs. 66% of business leaders in our survey have integrated SDGs into their business strategy in some way, and 21% reported a strong alignment.

Enterprises must rediscover their sense of purpose. Purpose is the way to bring together business and social goals. People, especially younger generations, increasingly choose businesses with clear social purposes. Institutional investors are also preferring those companies. The more trusted, the more likely to succeed, and organizations are now recognizing they cannot sustain without social trust. This is now becoming mandatory for businesses to deliver on.

In this chapter we have set out some of the challenges that businesses are facing. From the disruption of information and technology are driving in business and in people's lives, to the crises created by globalization. At the heart of this, is trust. Now is the time to rebuild trust. In the next chapter, we look at how organizations can respond, how you can build a trusted business.

Co-creating a Trusted Business

02

An organization's size and track record has long been key to its reputation. However, in a chaotic, complex world a business reputation built up over years can be instantly compromised. Customer data can fall into the wrong hands, rumors of corporate wrongdoing can travel far and wide. All in the blink of an eye. But an organization that is able to secure trust from its customers, can grow and scale a sustainable business. How can businesses build trust and gain the resilience they need to thrive in this complex world?

The business world is undergoing a paradigm shift, driven by digital transformation. How should organizations respond? How does business reconfigure itself for the new world?

Complexity, as we have seen, is becoming a core problem. Much of the chaos that we experience is a result of the increasing complexity of the world around us. Complexity increases uncertainty. How long into the future can you plan for with any certainty? For many organizations this number is measurable in weeks rather than years – and is falling, too.

How can organizations build strategies to cope with chaos and complexity? How can organizations bridge the contrasting aims of short term business goals with longer term societal goals? Can we build an approach that allows an organization to navigate the paradigm shift and resist the chaos?

Trust gives you resilience like nothing else. So how can trust be used to overcome both the uncertainty and complexity on one hand, and make the shift to a new digital business paradigm? In this chapter we will set what we believe is the answer, to build a human centric trusted business.

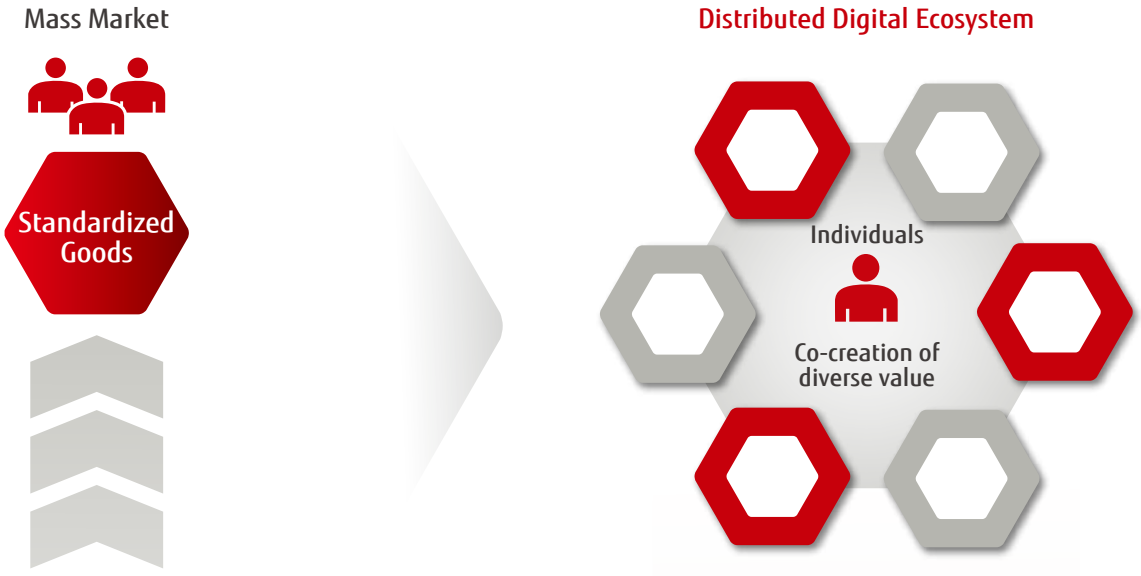
The Next Generation of Business

Shift to a Human Centric Business

The template for a modern business was established way back in the industrial period. In this model, customers appear at the end point of a value chain. They are offered standardised products and services aimed for the mass market through a single channel or at a single point of consumption, like a retail outlet or service center. In the public sector, too, standardized services are offered for citizens. People on the supplier side of this model are often treated as resources, factors of production, carrying out repeatable functions, uncritically and unthinkingly. The needs of customers or citizens were set and frozen in the planning stage of the production process. This is a supply centric, monolithic model.

In the digital era, we are seeing the emergence of a very different business paradigm. The unique needs of customers or citizens can now be met by a unique combination of services co-created across an ecosystem. Instead of a single point, consumption can be at multiple points in physical and digital spaces. The customers or citizens, instead of having a passive role, can now actively tailor the product or service to their needs. Instead of vertical industries, value is delivered through human centric ecosystems. Fujitsu calls these 'Digital Arenas'. In this model, people on the supply side also play an active role. They use their creativity and are able to continually respond to changing needs. This is a human centric model and it will define the next generation of business.

The rise of ecosystems in the digital era has been a key trend and this shift is engulfing and disrupting every industry. Seven of the top twelve largest companies by market capitalization are ecosystem players. Where once companies operated from behind a fixed boundary, they are becoming open. Daimler and BMW have joined forces to produce self-driving cars and provide mobility services. Banks are looking to embed digital services invisibly into non-banking services, like retail payments



Supply Centric		Human Centric
Mass market	**Customer**	Individuals
Standardized value	**Value**	Diverse value
Vertical value chain (Industry)	**Value creation**	Distributed ecosystem (Arena)
Part of production resources	**Role of people**	Value creators
Trust 2.0	**Primary mode of trust**	Trust 3.0

or real-estate services. We are only at an early stage in the evolution. Media, advertising and e-Commerce have been part of the first wave, now finance, mobility and retail and logistics are in transition. Industries with physical assets, like manufacturing, will also be significantly transformed, for instance through IoT technology.

Today, supply centric is the norm and human centric the exception. But this is changing. The World Economic Forum estimates 60-70% of new value will be based on data-driven digitally enabled networks and platforms.

Reinvention of Trust

So what does this have to do with trust? As we saw in Chapter 1, we are entering a period of chaos where trust is under pressure. Responding to the challenge of increasing complexity and growing lack of trust, and moving to new model are closely related.

Businesses and communities use two forms of trust. The basic, the oldest and the most fundamental form of trust is that which exists directly between people. This is personal trust, or 'Trust 1.0'. As economic activities and interactions grow beyond small communities where everyone is known, we need a different type of trust. Institutional trust, or 'Trust 2.0', enables trust to scale as people place their trust in governments, banks and other organizations. Today institutional trust underpins the governance of modern business and underpins how society works. But in a world increasing in complexity, where everything is being connected in a distributed manner, Trust 2.0 doesn't provide enough scale. We need to add a new layer to the model. Digital Trust, or 'Trust 3.0' uses technology to underwrite distributed transactions and assure the trustworthiness of data.

The supply-centric and human-centric businesses are extreme cases. In fact businesses will likely exist as a hybrid of both, with the balance shifting to human centric over time. A key business challenge will therefore be how to operate as a hybrid, spanning across these two generations of business. To do this, enterprises will need to combine the three modes of trust – Trust 1.0, 2.0 and 3.0. We will cover this at the end of this chapter.

Let's look at what will be required for creating a trusted business.

Digital Muscles

- **Leadership**
  Digital Transformation is a priority of the CEO
- **Ecosystem**
  Establishment of a trusted ecosystem of partners
- **Empowered People**
  Ensuring people having the right skills and opportunities to grow
- **A Culture of Agility**
  An innovation supporting culture with an appetite for change
- **Value from Data**
  Being able to use trusted data to deliver outcomes, while keeping it secure
- **Business Integration**
  Enabling technology to become the business operating system

What do organizations need to do to embrace the benefits of the new paradigm and build a trusted business? Organizations have become adept at running a traditional supply-centric, monolithic model of businesses. To use the human body as a metaphor, it is as if the organization has developed a strong set of muscles to work in this way. They enable the organizations to develop and supply reliable products and services without failures. But responding to the challenge of business and trust requires a different approach. It requires a different set of muscles, enabling the enterprise to collaborate with ecosystem partners and co-create value.

We call these 'Digital Muscles'. These are: Leadership, Ecosystem, Empowered People, A Culture of Agility, Value from Data, and Business Integration. All of them must be underpinned by trust.

According to Fujitsu research, companies that have stronger digital muscles can deliver bigger business outcomes. Digital transformation is not realized solely by introducing digital technology. Instead, it is a mid to long-term process of developing maturity. To train its digital muscles and to continuously transform the business. These digital muscles are required to build a trusted business. Let's look at how organizations can use digital muscles.

Three Actions to co-create a Trusted Business

The challenges of chaos and complexity we have described so far, the emergence of new ecosystem-based business paradigm and the changing nature of how trust works requires a radical new approach. Becoming a trusted business is not easy. Where can you start? We believe there are three concrete actions organizations must take to realize a trusted business. Each action requires organizations to use a particular set of digital muscles. These are shown below.

1 Architect a Purpose-Driven Business

Being able to ask the right questions is essential for any business, as it is in life. Finding the right question will get you closer to your goal. In your journey to a trusted business, the first question to ask must be what your purpose is. What do you stand for? What outcome does your business exist for to serve society? What value do you create for people? What problem do you solve for your customers? Where do you fit in relation to your partners and customers? These may be difficult for anyone to answer. But to draw a big picture or your purpose-driven business is the first action.

- Leadership
- Ecosystem

2 Build a Human Centric Organization

Secondly, it is important to set up a work environment where people can readily collaborate within their team and with external partners. How can they work more creatively and proactively? It also means rebuilding the foundational trust between people (Trust 1.0) that is at risk today. How can organizations empower people and build a culture of agility that allows failures? How can they rebuild their organizations so they are centered around people? The second action is to build a human centric organization.

- Empowered People
- A Culture of Agility

3 Drive the Business with Digital

The third action is to use digital technology to drive your business. Today, many businesses are driven by software. For example, the core of financial business is digital technology to process data. Today, a substantial part of auto development is software coding. Manufacturing and marketing processes are being similarly transformed, too. Key here is to turn data into value while maintaining the trustworthiness of data. It is vital to secure trust in this complex distributed world (Trust 3.0).

- Value from Data
- Business Integration

Let's look in more detail at the first two actions and the role that digital muscles play in enabling them. We will investigate the third action in the next chapter.

Architect a Purpose-driven Business

Defining your vision, your values, what jobs you do for your customers, and who is in your ecosystem.

Digital Muscle #1: Leadership

A business needs to be able to ask the right questions. Why are we in business? What purpose does the business serve? What is the relationship between business and society? Reinventing business for a new paradigm relies on rebuilding trust, which means bringing people along with you. To do this, a business must stand for something. In this disrupted, digital era, knowing what you stand for is more important than ever.

Today, attracting the best talent, especially younger generations (Millennials and Generation Z) may depend on the business having a compelling vision. Being a 'responsible business' is important of course, but what really matters is having the intent and appetite to deliver real outcomes. As we discussed in the previous chapter, we will only be able to tackle the tough global and societal problems if businesses make it a priority. The United Nations Sustainable Development Goals are an excellent model to enable organizations to make connections between business and societal outcomes. Having a purpose correlates with success in many areas. In our survey, having a vision was the number one way of creating trust, cited by 76%.

Our research found a correlation between delivery of outcomes from digital transformation and incorporating SDGs into strategy. Those who reported using SDGs as part of their business strategy were more likely to have completed transformation projects. Business leaders seem to be aware of the potential of trying to make a positive social impact. 74% felt social challenges could provide new business opportunities, and another 74% thought it was important to align business and social goals.

Yet this is also a difficult challenge. Our research found that more than half (56%) of business leaders would put immediate business priorities over working towards a longer term vision.

Having established purpose, organizations must understand how they meet the needs and desires of their customers. What human centric value do we deliver for our customers? This is not what product or service the organization delivers. This is about understanding the job that people want to be done. For example, what people truly want may not be a product in the form of a car, but experience of mobility enabling the most comfortable transportation from Point A to Point B. Similarly, an individual may not want auto insurance but rather the feeling of safety in driving without any accidents.

Purpose

Would trust an organization that sets out a clear vision

76%

Believe it is important business goals and social goals are aligned

74%

Say they tend to put immediate business concerns ahead of long term vision

56%

Believe social challenges provide new business opportunities

74%

Ecosystem

Say that their organizations leverage an ecosystem

66%

Actively promote open innovation

71%

Fujitsu Global Digital Transformation Survey 2019

Digital Transformation Center
Create business ideas with design thinking

To think about the purpose, vision and value of business, business leaders need to be creative. To innovate, they may face internal resistance. This calls for a different style of leadership. Not just an ability to manage and operate, but having passion and empathy, to inspire people to take new directions. Our research also indicates empathy is an important leadership skill for driving digital transformation.

Design thinking is a useful approach to help business leaders to ask these questions. It is a method originally used for product design, but now extensively used for designing business. Fujitsu has our own unique design thinking framework called Human Centric Experience Design. We have opened spaces for this – we call them Digital Transformation Centers - in Tokyo, Osaka, Munich, New York and London. And we have already worked with many customers and co-created outcomes with them. For example, in the UK we have worked with Nottingham Trent University to co-create an app to provide work place support for people with autism. It would have been difficult to realize such an outcome without a co-creation approach.

Digital Muscle #2: Ecosystem

The next generation of business will make extensive use of ecosystems in delivering human centric value for customers. Instead of the internal value chain, the digital business model will be distributed, across what Fujitsu has called digital arenas – ecosystems oriented around the co-creation of a specific human centric value, like mobility or well-being. In our research, 66% of organizations claimed to be using ecosystems. 71% said they were actively pursuing open innovation.

Again, organizations must ask new questions. Where do you play? Now you play in cross-industrial arenas instead of a vertical silo industry. Who are your trusted partners? They might be companies in different industries, public sector, or start-ups, or academics. They may even be competitors, or so-called 'frenemies'. What kind of role will you play in the ecosystem? Will you be an orchestrator or a value contributor?

Most importantly, how do you create trust in the ecosystem? How will you apply governance, incentives, and especially transparency? These are crucial questions. In our survey, 88% of business leaders cited information transparency as important for ensuring trust in an ecosystem.

Again we found correlation between having a strong ecosystem and delivery of outcomes from digital transformation.

Fujitsu wants to help build and grow ecosystems with you. We partner with a huge number of organizations, from established companies, start-ups, to public sector organisations and academics. For example, we run an accelerator program to link ourselves as well as our customers to the start-up community. We have over 150 start-ups in our community and more than 60 collaborative projects ongoing.

Build a Human Centric Organization

As well as having a purpose and a clear understanding of value to deliver, organizations will need adaptability and flexibility to navigate in a complex world. Above all, they will need to leverage people for growth and innovation. For this, it is vital to rebuild trust between people. In an increasingly fluid environment, organizations need to find ways to 'flow'.

Digital Muscle #3: Empowered People

Businesses have huge unused, latent capacity of their people, in their ideas and understanding of business challenges. Many people in a business have deep understanding of certain issues, like specific customer needs, or understanding the potential of a technology, in a way that the leadership often does not. But people who perform transactional tasks, acting only as 'business resources', are using a minimum of their potential. As business shifts to the new paradigm, so organizations will draw from this latent capacity of people to deliver growth and innovation. This means developing different types of skills, like creativity, empathy and problem solving, in addition to skills of digital technology.

It is not just about the skills of individuals but also the ways in which individuals are able to interact with each other, to connect outside of their immediate business silo. The unused potential value of people to a business is hard to calculate, as is social capital. Social capital is a measure of the value of connections between people. This is Trust 1.0, a foundational trust, which organizations need to revitalize to grow in this uncertain environment.

Our research found that many organizations recognize the value that comes from their people. 78% said that work-life balance was important to their organization, 74% cited diver-

Believe having a good work-life balance is important **78%**

Believe inclusiveness is important **72%**

Believe diversity is important **74%**

Encourage employees to act proactively **71%**

Encourage employees to collaborate within their teams and external partners **72%**

Develop products and services in collaboration with customers **74%**

Fujitsu Global Digital Transformation Survey 2019

FUJITSU Agile Lab

sity as important and 72% cited inclusiveness. Enabling people to collaborate within their teams and with external partners also scored highly, 72% of organizations reported this was something they were encouraging. And encouraging employees to act proactively was also recognized. 71% of business leaders said this was true for their organization. We found that those who did cite 'enabling people to collaborate' and 'encouraging employees to act proactively' were more likely to have delivered outcomes from digital.

In order to help develop digital talent for both colleagues and customers, Fujitsu has opened a training institute called the Fujitsu Digital Business College. The program includes a digital strategy course for business leaders as well as digital skill development such as AI, design thinking and security for developers.

Digital Muscle #4: A Culture of Agility

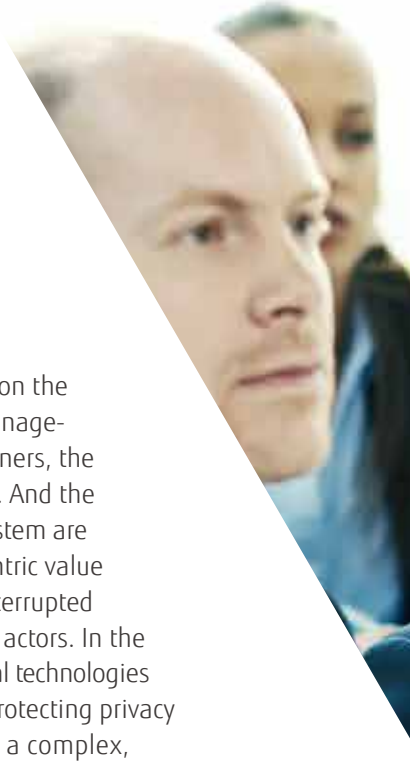
In an environment where new technology and innovation is continually introduced, customer needs are no longer fixed, they are fluid. In this uncertain world, organizations need to ask a question of what problems of their customers they solve, create a new business idea and move to test it swiftly. This requires a new mind-set, supported by a culture of agility.

'Fail fast' is a key part of this, a concept which has been well documented. Creating a prototype of a new business and experimenting is the most effective approach. Being able to see failed experiments as a necessary route to success, rather than as negative business performance requires a certain type of business culture. Organizations need to create an environment that supports this.

Digital transformation is a continuous process to enhance business outcomes by co-innovating with customers, iteratively and in short cycles. Our research found that many organizations are prioritizing this as a way of working. Three quarters reported they reflect customer feedback in product development, the same number reported they are engaged in co-creation activities. Co-creation, and reflecting customer feedback in development processes were correlated with delivering outcomes from digital transformation.

Fujitsu recently opened Fujitsu Agile Lab in Tokyo, where we create joint teams with our customers for agile development and lean start-up. The goal is to run the processes of development and operations (DevOps) across a cohesive team in a seamless manner. This requires a radical change of culture, skills and metrics.

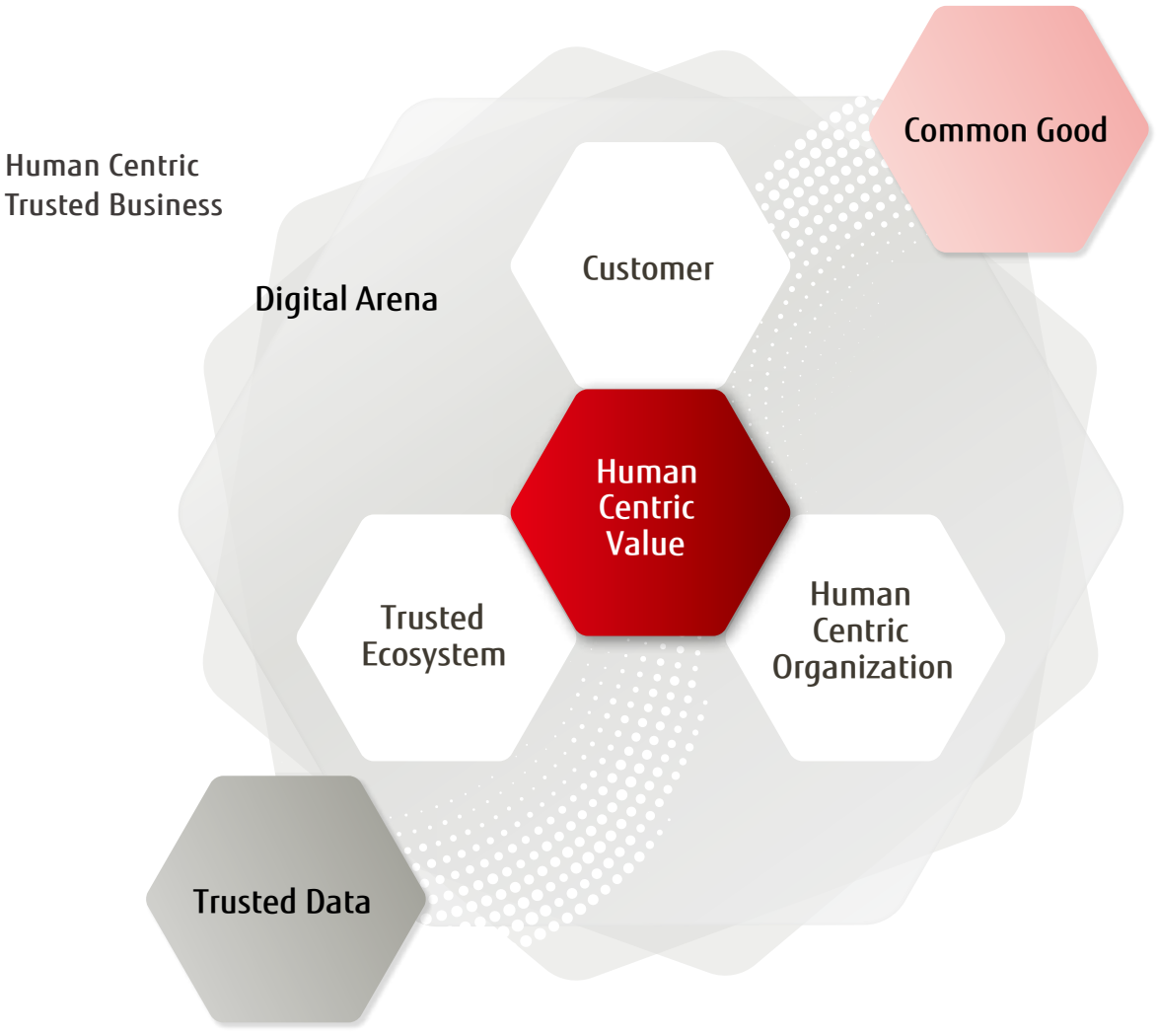
Managing a Trusted Business



The outcome: Trusted Business Model

All of the elements of this chapter come together into a single model, what we call a human centric trusted business. In this model, the business has a clear purpose, which is in alignment with common good, and it delivers on that purpose by creating human centric value. Recall that human centric value is about satisfying the needs and desires of people, for example, better mobility in a city or better quality of life in an aging society. Human centric value is delivered through a digital arena, where empowered people act together – they may be customers, suppliers or other ecosystem partners. The customers are no longer passive, but have an active role in shaping the outcomes. Ecosystem partners may come from different industries or academic areas, form large organisations or small start-ups.

The model is built on trust. It works on the basis of a purpose shared by the management, the team, the ecosystem partners, the customers and even the community. And the transactions across the entire ecosystem are ensured by trusted data. Human centric value can be created by secured and uninterrupted flows of trusted data between these actors. In the next chapter, we will look at the digital technologies that create value from data, while protecting privacy and trustworthiness of this data in a complex, distributed world.



The challenge: Managing a Hybrid Business

The traditional paradigm of a supply centric business, and the new, human centric business we have set out are theoretical extremes.

In reality businesses are not one or the other, but a mixture of the two. Let's take the example of a bank. It has a traditional banking service, the core that its business is founded on. This part of the business is monolithic and supply centric. It has a clearly defined, non-porous boundary, such that it is obvious what is inside of the organization and what is outside. The bank has also set up a new digital innovation entity, to offer new services to customers. This is built around an ecosystem and connecting services with Fintech firms as well as companies in other industries. It has a 'porous' boundary, and it may not even be clear where the boundary is.

Each part of the business requires different approaches to how it is operated. In contrast to the supply centric core business, the ecosystem-based digital business typically embraces a more open and agile way of working, and takes on more risks. While the core business focuses on exploiting value by increasing productivity and efficiency, the human centric business places a priority in driving value from exploring diverse future possibilities.

A key challenge is hybrid businesses essentially have to operate a hybrid trust model. The core business rests on Trust 2.0, institutional trust. But the digital innovation is driven by Trust 3.0, distributed trust, which leverages digital technology.

Enterprises need to take a portfolio approach to these businesses. While they grow new digital innovation, they must also work on transforming their core businesses to meet the challenge of the new digital world. It is important to apply different goals as well as aligned sets of investment, metrics and incentives to the two business models. Enterprise must bridge the two parts of the business together, bringing successful innovation initiatives into the next core business in the long term.

03 Technology for a Trusted Future

Digital technology has led to countless innovations that have enriched our lives. But at the same time, personal information on the internet is at risk, and the costs of cyber-attacks now exceed that of natural disasters. Today, new technologies are needed to rebuild trust in this chaotic world. Fujitsu will provide services based on breakthrough technologies to build a trusted future together with customers and partners.

In Chapter 2, we set out the first two of three actions to deliver a trusted business in a complex world. The third action is 'driving business with digital'. How can technology become the foundation of a trusted and sustainable world?

We envision a future where AI, which uses data to generate knowledge, and physical machines such as robots, will collaborate closely with people. The physical world and the world of data (the digital world) are converging around people. We believe that technologies like 5G (fifth generation mobile communication system) and VR/AR (virtual reality and augmented reality) will support communication between people, AI, and machines, enabling everyone to gain better experience, work actively, and enjoy better well-being.

How can we take a rapidly evolving technology like AI and build it into our businesses and into society? We need to consider the negative aspects that AI may bring. For example, we need to make sure that AI will not make biased decisions that discriminate against people, and people will understand and be able to scrutinize the reasons for the decisions. We need to create a society where everyone can benefit from AI with peace of mind.

The convergence of the physical and digital worlds will accelerate, driving the emergence of cross-industry ecosystems. These will underpin how business and society function in the future. AI will be embedded at the edge, forming a distributed interface between these physical and digital worlds. For instance in urban infrastructure, connected cars, operational equipment, and workplace tools. These distributed AIs will communicate between them to support people's lives and work.

In such a complex, autonomous and distributed world, it is not enough for governments, banks, and large corporations to ensure the trust of business transactions in a way it has been done in the past. Digital technology should ensure the trust in transactions and data. In this chapter, we share our thoughts on how we can use digital technology to build a trusted future.

Evolution of Human Centric Innovation

Things and people are increasingly connected to networks, and the information from them is used to empower people to create innovation. This is the approach we have called Human Centric Innovation. Fujitsu introduced this concept in 2014. Innovation is driven by people's creativity, empathy, and the ability to solve problems. We can create new value by combining the three foundations: the power of people, knowledge derived from information, and connected physical things and infrastructure. Through this approach, we have delivered digital innovation with our customers and partners.

We believe that Human Centric Innovation will evolve further and have a significant impact on future businesses and society. This will be driven by the increasing power of AI, the advances of connected machines such as robots, and technological advances in the area of interfaces between humans, AI and machines.

Increasing Power of AI

The advance of AI is driven by three factors: the continued development and evolution of new algorithms, the availability of training data, and the compute power available for training. This latter factor has increased rapidly. The amount of compute has doubled every 3.5 months since 2012. The amount has grown by more than 300,000 times.*4 This has enabled AI to achieve many new milestones. As mentioned earlier, AI has reached and exceeded the abilities of people in the image recognition and speech recognition.

Advancement of Connected Machines

The Internet of Things (IoT) is becoming more advanced as more things can be connected. For example, digital medicines such as tablets with minute sensors are now available. Cars are becoming connected. Today, some cars are capable of what is called 'level 3 autonomous driving' which means automated operation in limited environments. In the 2020s, it is expected that 'level 4 autonomous driving' - fully automated operation - will become a reality on the roads. In the field of manufacturing, the next generation of industrial robots is emerging. Cobots (Collaborative Robots) will work safely with humans in the same space.

*4 OpenAI

Evolution of Interfaces

5G technology is expected to have a transformational impact on our ability to connect people, AI, and various machines. It has already been rolled out in some regions. 5G is designed to achieve higher speeds (300 Mbps to 10 Gbps), more connections (100,000 to 1 million devices per 1 km²), and lower latency (10 ms to 1 ms) than existing mobile communications. In addition, the combination of 5G and VR/AR technology is expected to realize telemedicine and provide new customer experience in sports and entertainment. Fujitsu will drive the 5G ecosystem by providing advanced 5G network systems and solutions.

Innovation in the digital age is being created at the intersection of people, artificial intelligence (the digital world), and various machines (the physical world). For example, in the field of mobility, in-vehicle AI exchanges information from sensors with in-vehicle AI of other vehicles in real time using the high-speed communication provided by 5G. By controlling the car autonomously, traffic congestion will be reduced and accidents will be avoided. Automated driving that everyone can use with peace of mind will be realized. These mobility examples imply the following two major trends, which will impact the future.

Convergence of Physical and Digital

The convergence of the physical and digital worlds is becoming real in the form of Digital Twins, alternatively called Cyber Physical Systems (CPS). A digital twin is a real-time, virtual representation of events in the physical world. A digital twin for example, might be used to simulate a factory production line. The system collects data on the operating status of production lines as well as others through a number of sensors, and reproduce the production status in a digital space. It uses AI to learn and analyze data to control and optimize. As technology advances, it will become possible to create digital twins of highly complex and dynamically changing objects, like the traffic conditions of an entire city or even the human body. We believe that the convergence of the physical and digital worlds will advance in a multiple fields.

Evolution of an Autonomous and Distributed World

In the digital age, the services of diverse partners are connected to form a distributed ecosystem, creating new human centric value. In the financial services sector, for example, a variety of innovative services are already being delivered by connecting services of Fintech companies with those of banks and insurance providers. As in the case of autonomous driving, AI is implemented at the edge, in a connected car. It communicates with each other autonomously to optimize the traffic. The world is increasingly becoming autonomous and distributed. But it brings us a new challenge: how to ensure the trust of services and data in a complex and distributed world.

The third action for a trusted business is to drive your business by integrating these evolving technologies. So let's now look at how AI can be used to make business run autonomously and seamlessly, and how difficult business and social problems can be solved, through the convergence of physical and digital.

Solve Complex Problems through Trusted AI

Digital Muscle #5: Value from Data

AI technology is expected to advance to make our daily lives more comfortable and to contribute to solving difficult problems in fields like healthcare. But there are concerns about people using AI safely. What do we need to do to apply AI to solve business and social challenges?

Trusted AI

The problem of bias in AI, especially deep learning technology, is becoming an issue. There are also growing concerns about the 'black box' nature of the technology. Many decisions need to be open to scrutiny. For example, how could we determine the cause of an accident involving a self-driving vehicle? What if the condition of a patient whose condition was diagnosed by AI suddenly deteriorates? We cannot use AI with confidence, unless such issues are resolved.

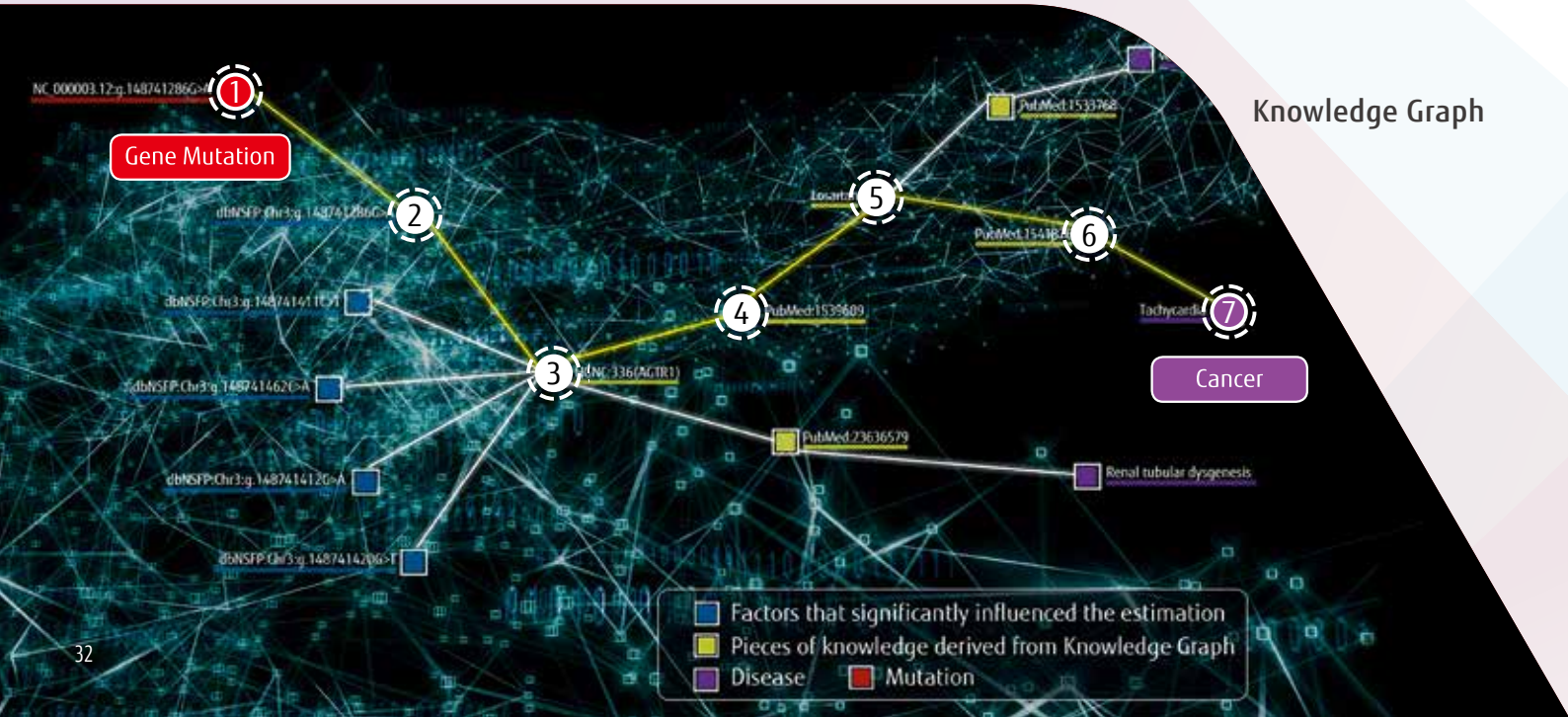
Fujitsu researches and develops AI under the philosophy of 'Human Centric AI'. We believe in the importance of developing AI that collaborates with people. Our AI offering, FUJITSU Human Centric AI Zinrai, has delivered many business outcomes for our customers. For instance, it has helped our customers engage with their customers through the use of chatbots, or automated quality inspection processes through image recognition. It has even been used to improve the safety of social infrastructure by diagnosing degradation of the hidden internal structures of bridges.

Our aim has been to develop a trusted AI that can be used with confidence by people. So that AI can be applied to complex business and social issues. AI decisions must be understood and safely controlled by people.

With this in mind, Fujitsu has succeeded in developing the world's first 'Explainable AI'. This is our original technology that can explain the reason of judgment derived from the real information, rather than just explaining how AI works. This is achieved by combining two unique AI technologies from Fujitsu.

The first is the 'Knowledge Graph', which builds a knowledge base in a format that the AI can handle. It visualizes relationships between the pieces of the knowledge. The building of reliable, digitalized knowledge bases in respective domains is an essential part of making AI usable by business and society in the future. For example, Fujitsu has worked with Kyoto University to build a knowledge base consisting of over 10 billion pieces of knowledge out of 17 million medical papers.

The second technology is machine learning technology with a function to explain the reason for its judgment. Fujitsu offers two original technologies: 'Deep Tensor', a deep learning technology that enables high-precision analysis of graph-structure data, which represents connections between people and things; and 'Wide Learning', a technology that enables high-precision analysis even from a small amount of data. For example, in the field of cancer genomic medicine, Deep Tensor learned from 180,000 pieces of gene mutation data to estimate the gene mutation that caused cancer. Combining this with the Knowledge Graph has resulted in a significant reduction in the time of genomic cancer diagnosis from two weeks to just one day.



New Computer to Solve Complex Problems

In spite of the rapid advances in AI, some problems are just too complex for current computing architecture. For example, combinatorial optimization problems are extremely difficult to solve with conventional computers. There are, for instance, more than 100 quadrillion ways of holding a portfolio of only 20 stocks. To calculate an optimum portfolio is beyond the capabilities of conventional computing technology, at least within a practical time. However, new technology is becoming available. Quantum annealing can provide an optimal solution in an instant.

Fujitsu's 'Digital Annealer' is a new computing architecture, using a digital circuit design inspired by quantum phenomena. It is the only commercial solution that can solve complex combinatorial optimization problems in the real world. Digital Annealer has already proven its exceptional performance in combinatorial optimization problems, from minimizing risk across complex financial portfolios to the optimization of complicated work in a warehouse. We have begun to apply Digital Annealer with our customers to problems in manufacturing, transportation, healthcare, and biochemical research and other fields. Furthermore, since 2019, the second generation of our Digital Annealer service has increased its 'coupling' – a measure of its capacity - from 1,024 bits to 8,192 bits, accelerating processing speed by 100 times and enabling applications for even larger problems in the real world. The second generation of Digital Annealer has the potential to tackle some genuinely large problems. For instance reducing traffic congestion in Tokyo, by optimizing the routes of vehicles traveling through the city. Or to accelerate the development of new drugs by computing potential configurations of 'medium-sized' molecules made up of building blocks of up to 50 amino acids.

As the technology improves, so the scale of the problems it can tackle will increase. By expanding the total coupling to 1 million bits in the future, the technology would be able to optimize traffic flow across the greater Tokyo area, and be able to accelerate the development of new drugs made of much larger molecules.

AI and Ethics

Fujitsu's commitment to trusted AI is more than just a technology approach. Fujitsu has also developed a deeper understanding of the ethical issues discussed in Chapter 1. Based on the concept of Human Centric AI, Fujitsu set out the "Fujitsu Group AI Commitment" in March 2019. It is made up of five pillars:

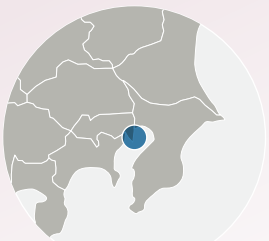
1. Provide value to customers and society with AI
2. Strive for Human Centric AI
3. Strive for a sustainable society with AI
4. Strive for AI that respects and supports people's decision making
5. As corporate social responsibility, emphasize transparency and accountability for AI

Fujitsu continues to work towards realizing a society where people can use AI with confidence and create value from data.

Evolution of Digital Annealer

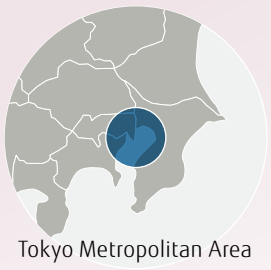
May 2018
Digital Annealer Cloud Service launched
1,024 bits

Traffic that can be optimized



Tokyo Bay Area

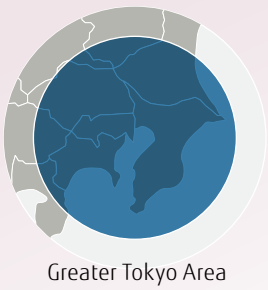
April 2019
2nd Generation available
Up to 8,192 bits



Tokyo Metropolitan Area

Digital Annealing Unit

Next Generation
1 million bit scale



Greater Tokyo Area

On-Premises System

Drive the Business with Digital

Digital Muscle #6: Business Integration

The final step in transforming business for the next generation is to integrate trusted digital technologies into business processes.

Digital technology is transforming every industry. The core value added by financial service providers can be software programs that process complex data at high speed. For retailers, analyzing customer purchasing data and rapidly changing product menus and promotions are directly linked to revenue growth. It is said that business is now technology: business is dynamically driven by data and digital technologies. To this end, DevOps is essential, which is a methodology of integrating cloud-based software development and operations, as well as running them in rapid cycles. So what happens next?

As mentioned at the beginning of this chapter, we believe the future of digital innovation is in the intersection of people, AI, and machines (things). Digital Twins will merge the physical world with the data world. This allows AI to control and optimize physical things. In addition, the various digitalized physical things and services will be connected to shape autonomous distributed ecosystems. This will radically change the conventional structure of industries.

To cope with these major changes, companies must implement two strategies. First, it is important to strengthen the competitiveness of existing core businesses by introducing digital technologies. This is digitization to improve efficiency and productivity. The second is to create a new ecosystem type of business by introducing autonomous and distributed digital technologies. This is digitalization to develop what will become the core business in the near future.

Fujitsu, as a business co-creation partner, supports the realization of these two types of digitalization. For this purpose, we provide advanced digital technologies such as AI, IoT, security and blockchain as services on MetaArc, our multi-cloud based Digital Business Platform. In addition, we provide cutting-edge digital technologies specific to respective industries to digitalize your core businesses as well as co-create the ecosystem type of businesses together. Let us show you some examples.

Human Centric Mobility

A wide variety of real-time data related to the movement of people, cars, and other things can be used by various ecosystem partners such as automakers, parts suppliers, digital service providers, and insurance providers to realize mobility services such as autonomous driving and ride sharing.

Fujitsu provides leading-edge digital technologies in the three areas of 'Collecting' (collecting data), 'Connecting' (connecting to networks), and 'Utilizing' (leveraging data). These help realize human centric mobility services. For example, we have developed technologies to compress the enormous amount of image information of self-driving vehicles to a minimum for use, to safely download and update autonomous driving software wirelessly, and to enable autonomous communication between vehicles. We have also developed a streaming data processing architecture we call 'Dracena'. This technology enables real-time, non-stop processing of event data collected from a huge number of connected vehicles and other IoT devices in the real world. With this technology, we are working to realize a mobility digital twin that will mirror the dynamic mobility of an entire big city and enable the delivery of various innovative services. For instance, management of city traffic, intelligent driver-assistance, and support for safe maneuvers of autonomous vehicles.

Innovative Shopping Experience

In the world of retail, after the expansion of e-commerce and the convergence of real stores with online shopping, there is a new focus on how real, physical stores can be digitalized. For example, there are moves toward cashless, cardless shopping using biometric authentication, as well as store automation that connects the entire store with sensors and IoT technology. For example, Taiwan FamilyMart built next-generation stores using Fujitsu's communication robots and blockchain technology.

The key is not to sell goods, but to realize customers' experiences. Real stores need to respond to the needs of consumers who want to use goods rather than own them. Isetan Mitsukoshi, a major Japanese retailer, introduced a revolutionary sharing service that allows you to easily rent clothes using a smartphone at department stores.

At the same time, the movement to build an ecosystem with companies in different industries through non-monetary tokens such as loyalty points is accelerating. By using blockchain technology, it is possible to program the purpose of points usage freely or to connect different ecosystems.

Customer-engaging Financial Services

As well as automating operations, financial service providers are accelerating the creation of ecosystems with companies in other industries. One of their goals is to embed financial services into various situations of people's lives and provide human centric services that satisfy needs of people in any situation.

Fujitsu supports the digitalization of financial businesses and the creation of an ecosystem by providing financial solutions. 'Finplex' delivers authentication and payment platforms as well as financial services APIs. For example, Shizuoka Bank has introduced FrontSHIP, Fujitsu's financial front service platform, to promote financial products tailored to each customer and to share the financial front service platform with other banks.

These are just a few examples, and digital technology is driving business in a variety of industries. However, ensuring the end-to-end trust of the entire autonomous distributed ecosystem is a big common challenge. Next, we will introduce the technologies that will help to address this.

Trust in an Autonomous and Distributed Society

Various services and physical things will be increasingly connected to form an autonomous distributed ecosystem. We have already seen this in the example of self-driving vehicles. At the same time, the risks of personal data breach, cyber-attacks, and data falsification continue to grow. It is no longer enough to protect data and systems within an organization as in the past. A new type of trust mechanism is required.

First, it is more important than ever to verify the identity of the people and the things that generate data. Second, cybersecurity must be further strengthened, including response to cyber-attacks on physical infrastructure. Third, we need to assure the trust of data flowing through an autonomous distributed society, while protecting personal data.

By applying cutting-edge security and blockchain technologies to these three areas, we can realize a new type of trust: Trust 3.0 (distributed digital trust).

Identity of People and Things

With four billion people, as well as tens of billions of things and devices already connected to the Internet, identity management is becoming increasingly vital. Biometric authentication technology will help prevent impersonation and enable secure transactions. A combination of face, fingerprint, and vein biometrics is the best way to assure the digital identity of people. Fujitsu has developed a biometric authentication technology that can identify a person using palm vein and face information and authenticate the person without physical contact. To transform shopping experience, we are currently working to achieve a cardless, cashless payment that even does not require a smartphone nor passwords.

Cybersecurity using Intelligence

Fujitsu conducts research and development and provides security products and services in five areas: detection, blocking, analysis and recovery of malware and other cyber-attacks, threat information sharing, and protection within virtual systems. In particular, we are strengthening our intelligent security technologies. We support security administrators through analysis using the AI technology Deep Tensor, which is able to automatically and quickly

determine the necessity of responses to cyber-attacks, by learning patterns of security incidents and representing them as graph data. We are also working to improve the trust of connected cars through secure distribution technology and in-vehicle network security technology.

End-to-end Data Security

In an autonomous distributed ecosystem, the security and reliability of personal data must be maintained end-to-end. In addition to developing anonymization and advanced encryption technologies to protect personal data, Fujitsu is working to provide end-to-end data security through the use of blockchain.

Blockchain is sometimes called a trust protocol and is used as a way of underwriting transactions without the need for a third party validation. However, existing blockchain technologies have not been able to address the challenge of ensuring the reliability of data across different blockchains and across enterprises.

Fujitsu is developing technology called 'Connection Chain' that connects different blockchains. In additional we are working on 'Chain Data Lineage' that administers data trails across multiple companies through blockchain.

Expanded use of Blockchains

Blockchain found its first major application in the field of virtual currency and financial transactions. But it is now rapidly being applied in many fields, including supply chains, logistics, and distributed energy transactions. In addition to providing blockchain platform services, Fujitsu offers Virtuora DX, a service platform that enables secure and safe data distribution and usage. With this, we are co-creating new services with customers and partners in a variety of areas. For example, Mitsubishi Estate Co., Ltd., Softbank Corporation, Dr. Ohsawa Laboratory of the University of Tokyo, and Fujitsu are using Virtuora DX to conduct a trial on data distribution and utilization in the ecosystem in the Marunouchi area of Tokyo.

Furthermore, we are envisioning a future in which data can be used safely and securely across regions and industries. This will be realized by building secure networks based on block-chains, and connecting various ecosystems of private companies, governments, public institutions, academic research institutes, NPOs, and others. Based on the security technology that Fujitsu has cultivated over many years, we are working to strengthen our blockchain technology and develop a certification infrastructure for corporations.

Toward an Autonomous Distributed Society

Digital technology will be at the heart of this new form of distributed trust, Trust 3.0. But existing models of trust will not be replaced by it. Trust 3.0 is a means of delivering trust for large-scale distributed transactions that institutional and personal trust are insufficient for on their own. Trust in the digital age will be realized by combining all three models, Trust 1.0 by people, Trust 2.0 by organizations, and Trust 3.0 by technology. It is important to be able for people to leverage Digital Trust and respond quickly and accurately when a security problem occurs. Fujitsu supports both technology and human resources for security by building a corporate security framework and training security personnel.

A Trusted Co-creation Partner

Our three actions for trusted business – finding purpose, becoming a human centric organization and driving the business with digital cannot easily be realized with a conventional waterfall approach of planning followed by execution. Organizations will need to become dynamic and responsive, operating more through experimentation and trial and error. A trusted partner is critical to this kind of transformation.

As a service-oriented company with strong capabilities in digital technology, Fujitsu is committed to make customers' transformation a success. Our strategy is based on building skills and expertise in three areas.

Technology to connect Existing IT and Digital

Digital transformation is not just about creating new digital businesses leveraging innovative technologies like AI and IoT. The great majority of companies have long standing businesses that pre-date the digital era. How they can digitalize their 'non-digital cores', through automating and streamlining is vital.

Fujitsu has extensive experience in building many large-scale mission-critical systems. Based on the knowledge and IT expertise we have accumulated in various industries, Fujitsu works with customers to promote digitization of operations and to create value by connecting new digital technologies with existing IT.

Integration to connect Business and Technology

Industry knowledge and expertise are not enough to transform business with technology. Implementing digital technologies alone will not transform business. The integration capability to combine the knowledge and expertise of both business and technology and to work together toward transformation is required.

At Fujitsu, consultants with expertise in each industry and digital business professionals work together to review customers' business challenges and help them create new businesses. Agile development professionals are implementing cutting-edge digital and industry-specific technologies into customers' businesses. In addition, we are working on new services. 'Enterprise Agile' will enable our customers to flexibly and rapidly build large-scale systems to respond quickly to changes in the business environment. The combined strength of business and technology will help shape customers' business ideas into reality.

Organizational Power to connect Knowledge across Industries

In the future, we believe the needs of customers will be met by distributed ecosystems providing human centric value. Cross-industry collaboration will grow and become a business norm. Connection of knowledge across industries will increase, and knowledge integration is something businesses will look to from their partners.

Fujitsu already has broad industry knowledge through the development of IT systems in all the different fields. We provide the technologies and services that help connect knowledge and co-create innovation. We call this Knowledge Integration. This is about enabling innovation and accelerating digitalization.

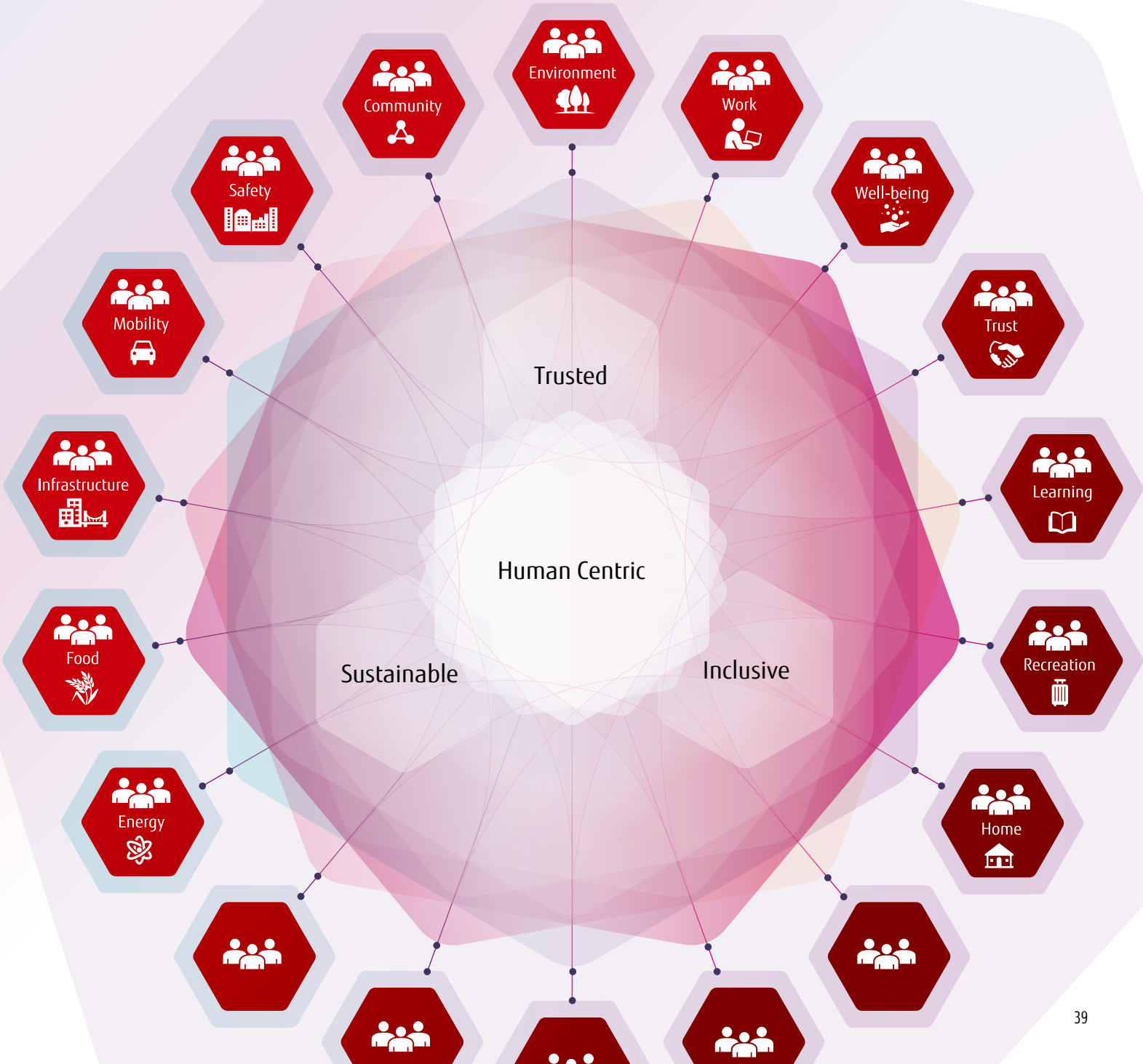
As a trusted partner that connects existing IT and digital, digital and business, and knowledge across industries, Fujitsu will contribute to the realization of a trusted future.

Trusted Society

The increasingly complex world faces numerous social challenges. As we saw in Chapter 1, how can we solve such difficult issues as environmental risks like global warming, healthcare in an aging society, and congestion and social problems caused by urbanization?

We, as a leading technology company, believe that it is our social responsibility to bring happiness to as many people as possible around the world by creating new value around people. Our customers recognize the importance of solving social issues. According to Fujitsu's global survey, 72% of business leaders believe that they have a responsibility to resolve social issues in addition to pursuing profits, and 74% consider it important to align business goals with social goals.

Human Centric Intelligent Society



As we saw in Chapters 2 and 3, it is important to co-create human-centric values and social impact for urban mobility, health and well-being, and others in cross-industry ecosystems. By connecting these ecosystems through an autonomous distributed network protected by Trust 3.0, we will be able to create a society which is inclusive (no one is left behind), sustainable, and trusted. We call such a society a Human Centric Intelligent Society. This is our vision for the future. Achieving this is the purpose we have set for our business. It underlies all of Fujitsu's business activities.

Our vision is aligned with the United Nations Sustainable Development Goals (SDGs). We are contributing to the achievement of the SDGs through the realization of a Human Centric Intelligent Society. Some of these initiatives are introduced below.

Health and Well-being for All (SDG 3)

The global population is expected to reach about 10 billion by 2050. But at the same time, the average life expectancy continues to rise, and is expected to increase by more than 4 years by 2040.*5 In some countries including Japan, more than half of the children born today are already expected to live over 100 years old. As the population grows and life expectancy increases, technology will play an important role in extending healthy life expectancy and providing health and welfare to all. Through partnerships with medical institutions and other organizations, Fujitsu is contributing to realize 100 year lifespans by supporting a smart and healthy way of working, personalized healthcare for individuals, and human-centric healthcare and elderly care.

In the field of advanced medical care, for example, we are pursuing joint projects with Kyoto University for gene diagnosis using AI and the University of Toronto for cancer radiotherapy research. In addition, Fujitsu has developed a new technology to solve combinatorial optimization problems applicable to medium-size molecular drug discovery using Digital Annealer. Through these initiatives, we will continue to work together toward eradicating difficult diseases like cancer.

Sustainable Cities (SDG 11)

Cities face huge challenges around traffic congestion, air pollution, the threat of natural disasters, and mass consumption of energy. These challenges are interdependent too, and intertwined in a complex manner. Fujitsu is working to leverage cutting-edge technologies and collaborate with partners to solve complex urban challenges in the world.

For example, Fujitsu and FOMM (First One Mile Mobility), which supplies small electric vehicles (EVs) with removable batteries, have jointly developed a battery cloud service for managing EV's driving conditions, battery conditions, battery usage, and the inventory of replacement batteries in a smart way. FOMM started production of the small EVs in Thailand in February 2019. The combination of an EV capable of driving on water and a battery cloud is expected to contribute to addressing social issues such as urban congestion, exhaust gas and floods. In Indonesia, Fujitsu built the Disaster Information Management System for North Sumatran Regional Disaster Management Agency. It started operation in January 2019. This system uses a smartphone application to collect information on multiple disaster sites in a timely manner, and

Fujitsu's Initiatives for the SDGs

SDG 2	Sustainable food and agriculture
SDG 3	Well-being in an aging society and eradication of difficult diseases
SDG 8	Promotion of innovation and human-centric way of work
SDG 9	Intelligent industrialization by shaping ecosystems
SDG 11	Realization of better urban mobility and resilient cities
SDG 13	Achievement of zero CO_2 emissions and contribution to a de-carbonized society

*5 Lancet 2018

improves the initial response for prompt decision-making. It accelerates disaster response of local rescue and support activities.

We believe that our leading-edge digital technologies like Digital Annealer and digital twins will contribute to easing the difficult urban traffic conditions and making cities more resilient to natural disasters in the future.

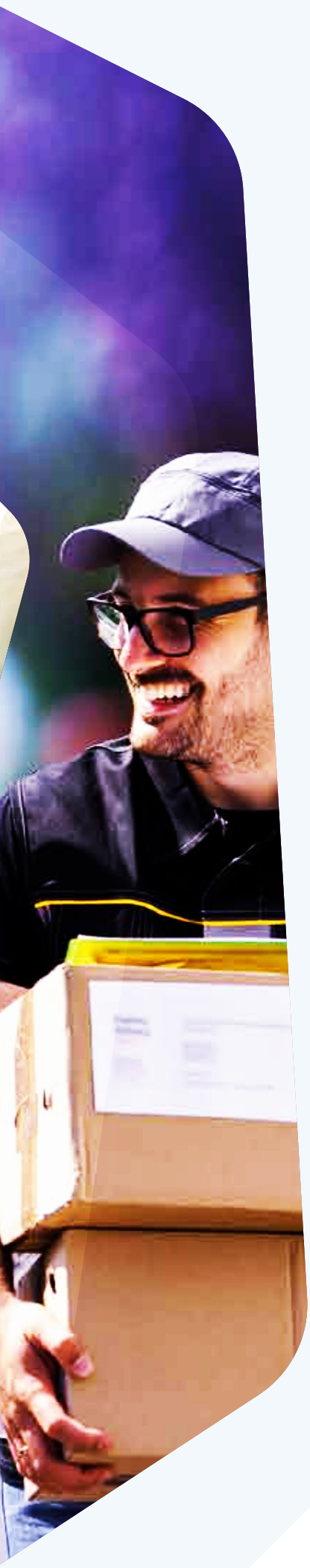
In addition to these initiatives, Fujitsu is working with ecosystem partners to address SDGs in other areas such as sustainable agriculture (SDG 2), human-centric way of work (SDG 8), intelligent industrialization (SDG 9) and contribution to de-carbonized society (SDG 13).

The world is accelerating change with unprecedented complexity. We are confronted by social issues in the real world, like climate change, urbanization, and widening inequalities, and in the digital world by issues like cybersecurity and the coexistence of people and AI. These challenges are increasingly inter-connected and interdependent. To solve them, it is necessary to rebuild trust across society as a whole.

Fujitsu synchronizes our business activities with activities to solve social issues in order to create an inclusive, sustainable and trusted society. The future is not something to predict, but something to create. In accordance with FUJITSU Way, our Group philosophy, we will continue to work with our customers and other stakeholders to build a trusted future.

Customer Stories

Real examples to show how we have addressed complex business and social challenges with customers in the era of digital transformation.



The International Gymnastics Federation (FIG)
44 Changing the world of sports with judging support system

Toray Industries, Inc.
46 Co-creation to open new frontiers,
being inspired by quantum phenomena

The New South Wales Office of Environment and Heritage
48 Uses AI to process thousands of drone image and helped to find and monitor hard-to-reach threatened species

Mitsui Sumitomo Insurance Company, Limited
50 Transforming customer touchpoints – Chatbot technology introduced as part of companywide digitalization

FlexLink AB
52 Automate time-consuming and monotonous admin tasks by RPA making two key processes faster and more accurate

Mitsubishi Estate Co., Ltd.
54 Applying blockchain to facilitate cross-company data usage
Launched consortium to find new insights

Beam Suntory, Inc.
56 Reducing potential risk of error by
tracking production of barrels of bourbon

The Shizuoka Bank, Ltd.
58 Banking channel innovation realizing new community-based financial services

Siam Commercial Bank
60 Co-creation with Siam Commercial Bank delivers
cashless self-checkout for The Mall

SEVEN-ELEVEN JAPAN CO., LTD.
62 Enhancing logistics processes using an operations management system to service over 20,000 stores in real-time

Nottingham Trent University
64 Collaboration for improving the wellbeing and safety of customers, employees and students

Japan Aerospace Exploration Agency (JAXA)
66 Using orbit determination technology to support unravel
the mysteries of the solar system, earth, and the origins of life

The International Gymnastics Federation (FIG)

Changing the world of sports with judging support system

The International Gymnastics Federation (FIG), overseeing gymnastics and related competitions internationally, is working with Fujitsu on the implementation of a gymnastics judging support system that uses 3D sensing and AI technology. It is extremely difficult to provide accurate scores during gymnastics competitions, which involve rapid movements and complex skills. This technology is expected to be applied to other types of sporting competitions in the future. FIG is collaborating with Fujitsu with the goal of using digital technology to spark a sports-driven industrial revolution, and bring happiness to people.

> *Fujitsu is a company that can turn the incredible into reality. Indeed, I believe this type of approach is vital for companies to grow and prosper. It is truly a pleasure to engage with a company focused on achieving a dream, rather than being preoccupied with short-term profits.*
>
> *Morinari Watanabe*
> *President*
> *The International Gymnastics Federation*

Developing a judging support system, for use in gymnastics competitions, a practical reality for 2020

In October 2017, the International Gymnastics Federation (FIG) announced that it would partner with Fujitsu to develop a practical judging support system for gymnastics competitions.

The trigger of this new initiative was a golf swing diagnostic tool created by Fujitsu. Morinari Watanabe, former Secretary General of the Japan Gymnastics Association and current president of FIG, recalls, "When I first saw the golf swing tool, I immediately felt that it could be used for scoring in gymnastics competitions."

The difficulty of determining scores in gymnastics competitions gave impetus to this idea. As gymnasts are constantly creating new and sophisticated techniques, it is not easy for judges to accurately assess their skills. The conventional method requires judges to write on scoring sheets by hand while performances are in progress. When inaccurate scores are made, the game may be extended and it also frustrates competitors and fans, therefore fair score is necessary. Watanabe continues, "Athletes must come first, and we have always sought to guard gymnasts against wrong decisions. Moreover, fair scores will increase confidence in gymnastics competitions and governance is also important for us as a sporting organization." This sense of urgency led to Watanabe's idea of using digital technology to support scoring.

Fujitsu's unique 3D laser sensors turn dreams into reality

Gymnastics is purely about the physical movements of the gymnasts, therefore it is not feasible to attach sensors to the gymnasts. Using motion-capture technologies, where markers are attached to the body was an idea; however, gymnasts felt uncomfortable with the markers attached, because it affected their performance or the marker may come off by the strenuous movement, so it was not realistic to use in competitions.

Meanwhile, Fujitsu has developed its own technology – based on 3D laser sensors – that capture gymnastics movements from a

distance. This technology makes it possible to digitalize movements during performances in real time without imposing a burden on the athletes. Originally, Fujitsu had developed the laser sensor technology for the automotive sector, using it to detect the movements of people around the car. Now, in the latest version of this technology, highly sensitive lasers that are capable of tracking around 2 million points per second are projected onto the athlete. The exact position and posture of the athlete's body can be tracked to the split second.

These sensors, used in combination with "skelton recognition software," a technology developed for medical rehabilitation, makes it possible to estimate the position of the human body in real time, as well as monitor the position of the limbs, the degree to which the joints are flexing, the number of twists, and other factors. Artificial Intelligence (AI) is then applied to match the performance results with a skills data dictionary that has been built using machine learning, allowing the athlete's techniques to be evaluated accurately.

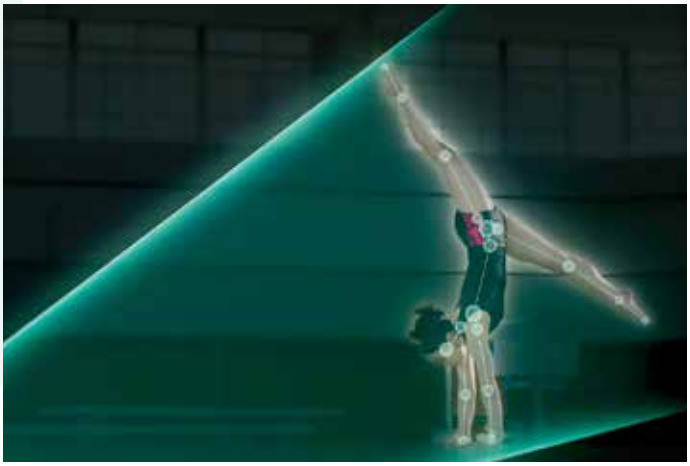
The new 3D sensing technology does not require markers or any other peripheral materials. The FIG and Fujitsu launched this co-creation project with the aim of creating a system that would allow the athlete to perform as usual and then, as soon as the performance was finished, the system instantly displays the name of the elements, degree of difficulty, performance points, and other variables on a monitor.

Watanabe holds high expectations, "If this system is perfected, inaccurate scores will become a thing of the past, and a long-standing dream of the sports world will come true."

Using digital technology to spark a sports-driven industrial revolution and bring happiness to people

The judging support system currently under development is for gymnastics, and applying it to other sports is clearly in the sights. Watanabe explains, "If we can practically apply the system to gymnastics, where performers use their entire bodies, then it stands to reason that we can apply it to other sports competitions as well. Many other sporting organizations have indicated that they would like us to make the system available for them as soon as possible." The sporting world is expecting that the technology can help to realize fair competitions by eliminating inaccurate scores, while also increasing enjoyment for viewers and bringing innovation to the area of athlete training. The 3D sensing data will facilitate more effective training, and help athletes develop new techniques as well as prevent injuries.

Furthermore, the technology is anticipated to be applied to other fields beyond sport. According to Watanabe, "The next target sector after sports is healthcare. The basic aim of sports is to enable people to become healthy, and technology can be used to support this process." The same techniques used for making sports more effective can also help to extend a person's healthy life expectancy – a major challenge in our aging society. Watanabe says



Capturing gymnast's movement by 3D laser sensors and skeletal position recognition technology

enthusiastically that "technology should be used to not only improve convenience but also bring happiness to people by enriching their lives and minds. By combining technology and sports, we can also contribute more broadly to humankind around the world. That would be a real sports-driven industrial revolution."

The journey to overcome a big challenge is never easy. "Many obstacles will appear down the road, and sometimes it is better to detour around an obstacle rather than attempt to climb over it. If we fail, it will be my responsibility, but if we succeed it will be attributable to the Fujitsu team. I want everyone to boldly forge ahead, unafraid of failure" says Watanabe, speaking passionately. "And I believe Fujitsu has the team to get the job done."

Customer Profile

The International Gymnastics Federation (FIG)

Address: Avenue de la Gare 12 A 1003 Lausanne (Switzerland)
Established: 1881 (as European Gymnastics Federation)
National member federations: 146 (as of 2019)
Website: http://www.gymnastics.sport/site/

Toray Industries, Inc.

Co-creation to open new frontiers, being inspired by quantum phenomena

While the performance of conventional general-purpose computers appears to be reaching its limits, interest in quantum computing technologies is increasing rapidly. However, quantum computing still has the challenge of overcoming the stability of the 'quantum bit' as well as increasing its scale. Digital Annealer is a unique computing architecture, inspired by quantum phenomena, which is able to rapidly solve combinational optimization problems on a practical level. Toray Industries, a materials and pharmaceuticals manufacturer, is working together with Fujitsu to develop commercial uses for Digital Annealer. The technology has the potential to transform the pharmaceutical industry and the principles of research and development.

> *With computing capabilities moving ahead in leaps and bounds, calculations that were once thought beyond reach have now become possible. We believe that the Digital Annealer and the co-creation initiative with Fujitsu will help us break through to the next level, where the winners are determined not by the scale and size but rather by the intelligence.*
>
> *Ryuji Tanimura, Ph.D.*
> *Senior Molecular Designer*
> *Head of Computer-Aided Drug Design*
> *Pharmaceutical Research Laboratories*
> *Toray Industries, Inc.*

Digital Annealer expected to solve complex optimization problems

The limit to increases in computer performance, as expressed in Moore's Law*1, is fast approaching. It is anticipated that quantum computing will provide the solution to this, becoming the next generation of computing architecture. However, few actual solutions are currently available. Fujitsu's Digital Annealer is one such solution, designed for solving combinatorial optimization problems by adopting a general purpose solution called the 'annealing' method. It brings advantages of quantum computer into the digital circuit. Fujitsu is already conducting joint research with a number of companies to discover groundbreaking ways of using the Digital Annealer in business, and Toray Industries (Toray) is one of partners.

The first theme of the joint research between Toray and Fujitsu was the optimization of molecular structures. They verified predictions of the most stable structures of proteins by using Digital Annealer. According to Dr. Ryuji Tanimura, Head of Computer-Aided Drug Design, Pharmaceutical Research Laboratories at Toray, "Proteins, which include enzymes, antibodies and receptors, form complex structures and experimentation to analyze them is extremely labor-intensive."

To determine the structure of a protein through experimentation, crystals with stable molecular structures must be created and analyzed with X-rays or other techniques. However, crystallizing and stabilizing proteins is a difficult process. Growing protein crystals is a time-consuming process. It can take anywhere from a few months to half a year, or even more in some cases and it is not uncommon to discover, even after investing all this time that the process has failed. Consequently, to overcome such lengthy intervals, researchers are looking to computation as a means of

*1 Moore's Law is a prediction that the number of elements in an integrated circuit would double every 18 months in Semiconductor industry
*2 A spot where branches from main chain of proteins
*3 The spatial arrangement of the atoms affording distinction between stereoisomers which can be interconverted by rotations about formally single bonds

predicting the optimal combinations of different, novel molecular arrangements, what is known technically as the side chain*2 conformation*3 of proteins.

Dr. Tanimura explains, "Combination algorithms capable of predicting optimal structures have been available before. The performance of conventional general-purpose computers has allowed us to use these to make predictions for small proteins, but as the combinations of the side chain conformation increase, it was hard to reach answers in practical time."

Toray looked to the Digital Annealer as a means of potentially overcoming this problem.

Previously impossible to find optimal solutions of large combinatorial problems becomes now possible

Two main steps were taken to enable the Digital Annealer to predict the most stable structures for side chain conformation of proteins. First, the known optimal combinations of side chain conformations for structures of small proteins were compared with the optimal combination solutions for the same proteins provided by the Digital Annealer, to confirm that they matched. Next, the Digital Annealer was used to predict the structures of large proteins that previously were unable to be realistically computed.

From September 2018, Digital Annealer specialists from Fujitsu, and researchers with knowledge of protein simulations from Fujitsu Laboratories, worked together for around three months to predict the structure. The side chain structures of large proteins would be tons of combinations. For instance, the possible combinations would be 10 to the power of 100 when identifying proteins which have100 side chains with 10 different conformations. The goal of this research is to reach the most stable structures among the large numbers of identified possible structures in just a few minutes.

Reflecting on the project, Dr. Tanimura comments, "We already had the algorithm formulas for computation, and an interface for transferring them to the Digital Annealer, so we progressed easily to the implementation phase." The answer for the known optimal combinations was verified, and the problem of the large proteins, which a general-purpose computer failed to solve after three to four hours of computation, was solved in about 20 seconds by Digital Annealer.

Dr. Tanimura emphasized the most important outcome was that, "We were able to arrive at answers which were out of reach using the conventional way." The significant progress made through this project gave the research team confidence in using Digital Annealer as a means of designing proteins with desirable characteristics.

Designing a desired protein entails the ability to change its properties, structures, and functions. This ability also aids in the design of molecules able to bind easily with proteins and becomes a powerful tool in drug discovery.

A shift to 'in silico' is changing the rules of the market competition

Illustration of protein structure

This co-creation project between Toray and Fujitsu provided confidence in the ability of the Digital Annealer to design proteins, so the development of a design program for predicting desired protein structures is being considered as the next step. Meanwhile, Toray and Fujitsu are currently planning their next joint research project to conduct trials in the area of new materials, which accounts for a large share of Toray's sales. The two companies have also begun to investigate the formulation of new algorithms to use the Digital Annealer for simulating the development of polymers and other materials.

Digital Annealer used in this project had 1,024 bits connectivity, and will evolve into a second generation with 8,192 bits, which will expand the scope of its application. It is also expected to be able to solve more complex problems.

Dr. Tanimura explains his vision, "In the past, drug candidates were evaluated randomly, with verification through animal testing at the end. There can be up to a million possibilities. By narrowing numbers of evaluating methods down through the computation as much as possible, we hope to reduce the number of possibilities down to 1,000 or even 100." This represents a shift from in vivo (animal experiments) through to in vitro (test tube experiments) and now to in silico (computer experiments).

This shift changes the principles of research and development of new medicine competition. "If we can improve the precision of in silico, it will become a contest of intelligence rather than scale and size. That is the world that I wish to see," concludes Dr. Tanimura enthusiastically. Fujitsu and Toray have launched a co-creation initiative that will open frontiers and bring us to the next level.

Customer Profile

Toray Industries, Inc.

Address: Nihonbashi Mitsui Tower, 1-1, Nihonbashi-Muromachi 2-chome, Chuo-ku, Tokyo
Established: January 1926
Employees: 45,762 (as of March 31, 2018, including affiliated companies)
Website: https://www.toray.com/

The New South Wales Office of Environment and Heritage

Uses AI to process thousands of drone image and helped to find and monitor hard-to-reach threatened species

Locating and monitoring threatened plants and animals can be difficult in the rugged and vast Australian landscape. Fujitsu and the Saving our Species program worked with drone specialist, Carbonbix, to dispatch a drone capable of taking five photos a second. Pictures were analysed using Fujitsu Advanced Image Recognition software to detect threatened plants.

> *This technology could change the way we find and monitor threatened species, saving us both time and money.*
>
> *Tania Pettitt*
> *Partnership Manager*
> *Saving our Species program*
> *NSW Office of Environment and Heritage*

Tracking threatened species in a smarter, more cost effective way

A flagship threatened species conservation program, Save our Species (SoS) is an element of the New South Wales (NWS) Government's Environment portfolio. As part of this, $100 million, over five years (2016 – 2021), has been committed to help secure the future of NSW threatened plants and animals. SoS combines best-practice science and research, with practical on-ground actions that directly benefit threatened species and the land they inhabit. SoS is tasked first and foremost with protecting the natural environment. In Australia's rugged countryside, that can be a challenge. Even something as simple as monitoring the survival of a threatened plant species can involve helicopter flights costing thousands of dollars, or a perilous hike up a mountainside.

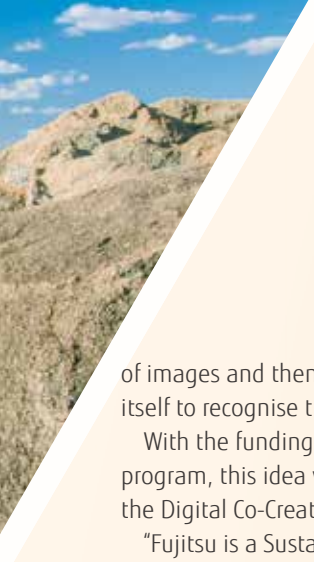
More than 1,800 plant and animal species in Australia are threatened or endangered, and almost 1,000 of these are found in NSW. The Saving our Species program is therefore always on the lookout for smart ways to improve its ability to both detect and protect threatened species and eliminate invasive ones, such as the prickly pear.

"Mount Dangar, in the Goulburn River National Park, is the only place in the world where the small, rare tree Acacia dangarensis and the daisy Senecio linearifolius var. dangarensis grow," explains Tania Pettitt, Partnership Manager, Saving our Species. "Usually, monitoring these threatened species would entail a full day on foot with no guarantee of surveying the whole area, or paying up to $10k per helicopter trip."

Fujitsu and NSW Government had a long-standing sustainability partnership. Fujitsu had been part of the SoS working group to develop the NABERS*[1] Energy for Data Centre ratings, a world-first validation of Data Centre Energy Efficiency claims. As well as being part of the working group, Fujitsu had been an early pioneer of the rating system, with the first data centre rated to the standard in Australia and the first complete portfolio rating.

Fujitsu came to the Saving our Species team with a radical suggestion: use drones to survey the territory, geo-tag thousands

*1 NABERS (which stands for the National Australian Built Environment Rating System) can be used to measure a building's energy efficiency, carbon emissions, as well as the water consumed, the waste produced and compare it to similar buildings



of images and then feed them into an AI platform that can teach itself to recognise the plants in question.

With the funding provided by Fujitsu's internal incubator program, this idea was made possible through the management of the Digital Co-Creation team.

"Fujitsu is a Sustainability Advantage member, meaning it is committed to a green ethos. When it suggested using drones, we thought the Hunter Valley would be the ideal location for a pilot of the technology," says Pettitt. "It offers a cost-effective way to monitor both flora and fauna much more quickly and accurately."

Autonomous drones combined with AI seamlessly detects threatened plants and identifies the pest plants

Fujitsu partnered with Australian drone company Carbonix to identify an appropriate drone: one with a three-metre wingspan that can take off and land vertically, and can glide at speeds up to 100km/hr. The attached 5kg hyperspectral video camera can take up to five photos per second and enables canopy penetration for the specific targeting of vegetation.

5,000 images were captured over two days, with detailed maps pinpointing plant locations. Fujitsu's high-performance AI computing was then used to analyse site photography to detect threatened plants, while the introduction of pest plants were identified for eradication. GPS coordinates were then given to rangers to validate all findings.

"We all went up – Fujitsu engineers and Carbonix pilots – to the site and spent two days with the drone in the air, which supplied images directly to the Fujitsu hardware with its AI algorithm that could seamlessly detect the tree and the daisy, once we had tagged a few examples," continues Pettitt. "It was a massive win for us because we had no idea whether they would be there."

"Following a prolonged hot and dry summer, we feared the daisy population had perished," adds Lucas Grenadier, Senior Team Leader, Ecosystems and Threatened Species, NSW SoS. "So this exercise gives us a baseline of the existing population and a method to track it remotely over time."

A radical suggestion is now award-winning innovation

The Fujitsu Digital Owl solution provides an efficient, cost-effective and accurate way to carry out surveys of threatened plants and animals. "The project gives SoS the knowledge it needs to preserve these unique species and undertake key actions like collect seed and cuttings, weed control, and fence off plants that might otherwise be eaten by feral goats."

The solution was funded by Fujitsu's incubator program which enables staff ideas to develop into fully invested projects. The successful project was awarded the Smart Technology award at the ARN Innovation Awards 2018; and the partnership was recognised at the CitySwitch Awards which recognise sustainability excellence.

"This technology could change the way we find and monitor threatened species, saving us both time and money. The AI

technology that Fujitsu has developed makes analysing thousands of images far more efficient," comments Pettit. "This technology has the potential to have multiple applications beyond locating remote plant species, as Digital Owl is an effective way to conduct surveys. The Saving our Species team are now excited to survey using Digital Owl to locate other species."

"We are at the frontline of an existential battle where climate change is having a radical impact on native flora and fauna," concludes Grenadier. "Having new tools such as Fujitsu Digital Owl gives us more than a fighting chance of protecting key plants and animals for future generations."

Customer Profile

The New South Wales Office of Environment and Heritage

Address: Level 14, 59-61 Goulburn Street, Sydney (Australia)
Founded: 2011
Website: https://www.environment.nsw.gov.au/

Mitsui Sumitomo Insurance Company, Limited

Transforming customer touchpoints – Chatbot technology introduced as part of companywide digitalization

Many companies, including financial institutions, have introduced chatbot technology as a measure to address labor shortages. However, this technology has rarely led to a decline in the actual volume of inquiries received by a support team. Mitsui Sumitomo Insurance Company has adopted CHORDSHIP, Fujitsu's artificial intelligence (AI) chatbot, to complement its online service desk. Not only has CHORDSHIP reduced the volume of inquiries, but it has also become an effective way of communicating with new customers and is a catalyst for driving digitalization.

> *Introducing chatbot technology has enabled us to devote more time to providing our customers with financial services. Automating the responses to common inquiries has been particularly effective.*
>
> *Takayoshi Iwamae*
> *Assistant General Manager, Contact Center Planning Department*
> *Mitsui Sumitomo Insurance Company, Limited*

Across all industries, the shift to digitalized customer touchpoints is accelerating. This is especially true in the financial services sector, where the various players – banks, insurance companies, securities firms, and credit card companies – are promoting digitalization to become more competitive. Mitsui Sumitomo Insurance, a major non-life insurance company, is no exception, and in recent years, it has assertively promoted IT investments centered on digitalization.

Mitsui Sumitomo Insurance has introduced chatbots for three of its products that customers can apply for online: Net de Hoken@ Travel (overseas travel insurance), 1-Day Insurance (automobile driver insurance available in 24-hour units), and Customer Web Service (a service for policyholders). It has adopted CHORDSHIP, Fujitsu's AI chatbot technology, as the platform underpinning these services.

Realized after-hours response and automation of routine tasks in just a few months

Staff handle inquiries for these three offerings via the company's online service desk daily from 9:00 to 17:00 except for the year-end/New Year holiday period (the Customer Web Service offering is supported only from Monday to Friday). According to Masashi Nomura, Section Manager, Marketing & Sales Promotion Section, Contact Center Planning Department, Mitsui Sumitomo Insurance, "Due to the web-friendly services, many customers were keen to access them in the evenings. Dealing with inquiries after hours was a big challenge." The company's online service desk handles calls for three services at two locations–Tokyo and Kobe. Although they maintained an average response rate above 90%, the service desk did not have any extra capacity, and productivity improvements were also a big challenge.

Explaining the reason for the chatbot technology introduction, Takayoshi Iwamae recalls, "We decided that introducing AI chatbot technology would increase the service hours, and also be highly effective in automating responses to routine inquiries."

The chatbot implementation project commenced in June 2018,

and the system was fully operational just a few months later. Mitsui Sumitomo Insurance were already using an AI-based operator support system provided by a different provider, but Iwamae adds, "The terminology used by customers when inquiring via the chatbot differed from that used by the operator support system, so we were unable to make the transition without changes." The company then focused its efforts on designing appropriate conversational scenarios.

According to Haruka Ishibashi from the Marketing & Sales Promotion Section, Contact Center Planning Department, "We originally had around 300 FAQs, and we added 100 new ones after some trial and error." Following further experimentation with Fujitsu, the company was able to improve the chatbot's rate of correct responses within a short period of time. Chikako Naruse, another team member, continues, "We worked hard to bring together the perspectives of developers, customers, and service operators. We reached our objective in the shortest possible timeframe by working together as a team."

Accessible means of customer engagement – even for handling sensitive inquiries

The CHORDSHIP chatbot system consists of a synonym dictionary and scripts, and works in conjunction with content management systems and other knowledge bases.

Ishibashi explains, "With our existing FAQs, customers could not easily find the correct answers unless they were very proactive. However, thanks to the natural language search used by the chatbot, the process has now become relatively simple. Storing various interactions also enables us to enhance the chatbot FAQs themselves." Indeed, the resolution rate has already reached 70-80%.

Iwamae continues, "In the case of Net de Hoken@Travel, the chatbot assists customers to navigate to the quotation screen. This helps reduce the volume of inquiries, which we thought would be difficult to achieve using chatbot technology." It turns out that in December 2018 the chatbot system received 8,800 inquiries, of which half were handled outside of staffed telephone support hours. In addition, despite an increase in the volume of policies issued, the number of incoming telephone calls decreased, and this highlights the effectiveness of the chatbot technology.

Nomura emphasizes the extent of the chatbot's success, "We predicted that most of the inquiries will be the ones that are easy to ask, but it turned out that many inquirers write the specific disease name and ask whether they could be offered the insurance. Interestingly, many customers found it easier to ask questions to the chatbot than when speaking to a human telephone operator." Introducing the chatbot technology has also led to contact with new customers. Ishibashi concludes, "We are increasingly making contact with new customers who had never called us in the past."

In the next fiscal year, Mitsui Sumitomo Insurance plans to roll out chatbot services for customers other than those of its online service desk. As Iwamae states, the company regards CHORDSHIP as "an integral part of its efforts to promote companywide digitalization."

Navigation of insurance premium quotation by chatbot

Automatic inquiry response by digital agent

Customer Profile

Mitsui Sumitomo Insurance Company, Limited

Address: 9, Kanda-Surugadai 3-chome, Chiyoda-ku, Tokyo
Established: 1918
Employees: 14,572
Website: https://www.ms-ins.com/english/

FlexLink AB

Automate time-consuming and monotonous admin tasks by RPA making two key processes faster and more accurate

FlexLink was reliant on a huge number of mundane and repetitive admin tasks performed by highly skilled engineers. They wanted to explore the possibility of automating these manual tasks to speed up processes and reduce errors. The company identified two key processes, part name changes and supplier reporting, to form the basis of an RPA pilot. Fujitsu's RPA has realized to reduce the time of part name change process from 20 minutes to five minutes, and generate the supplier reports in 15 seconds which took two hours to create previously.

> *Each part name change took us 20 minutes to complete manually – Fujitsu RPA does it within five. That means we can deliver products more quickly to our customers and provide better service.*
>
> *Per Siesing*
> *Product Development Manager*
> *FlexLink*

Automating monotonous tasks and let employees focus on higher value objectives

FlexLink depends on numerous administration-intensive business functions in the realms of planning, logistics, HR, payroll, and product development. The issue was that these low complexity, monotonous tasks were being carried out by a highly skilled workforce. The company wanted to introduce a smarter way of handling repetitive, but critical processes.

"Our employees are largely well-qualified engineers so to burden them with maintaining our part name database or supplier reports is not ideal," explains Per Siesing, Product Development Manager, FlexLink.

"We knew there must be a way of automating these tasks and freeing up our employees to focus on higher value objectives."

For example, FlexLink had one worker dedicated full-time to managing and confirming part descriptions across multiple sources, including SOLIDWORKS CAD software and Microsoft Office. It chose this process as the pilot for its automation project – the next step was finding the right technology and the right partner.

"It was a chance meeting between our COO and Fujitsu at a networking event that sparked our interest in Robotic Process Automation (RPA), which seemed like the ideal solution," adds Siesing. "We then evaluated the market and decided that, based on our initial impressions and the fact that it had a dedicated RPA Center of Excellence in Copenhagen, Fujitsu was the right partner for the job."

RPA to the rescue avoiding the risk of human error

RPA uses software to emulate the way FlexLink employees work to deliver the automation of repetitive and mundane rule-based tasks without disrupting business operations. Having identified the part name process as the first pilot, Fujitsu and FlexLink began by mapping each step of the process and translating these into something that a program can understand. As functionality was developed and tested, a series of workshops then followed to

present the work.

"It was a collaborative, step-by-step approach that took six months to complete. It was perhaps a little too ambitious for our first project because it connected to so many applications and software, which made it tricky to roll out," continues Siesing. "However, it now enables product updates for thousands of catalog items and ensures the replacement of article names in all affected applications, as well as assuring that each name change is updated in the applications and CAD drawings."

After beginning the first pilot, FlexLink was keen to add RPA to a second, simpler process: supplier monthly reporting, which extracts and inputs data from PDFs, timesheets, email, and Excel. Because this process was less complex, Fujitsu was able to complete the development within two months.

"Fujitsu created a robot that picks up reports, creates mail, and distributes reports on the right day, with the right content, to the right recipient," says Siesing. "It avoids the risk of human error, where we might accidentally send the wrong report or enter incorrect numbers."

Fast, efficient, accurate process to deliver products more quickly and provide better service

These two initial pilots have shown FlexLink that RPA can play a major role in its operations, especially as the amount of admin continues to increase. By automating repetitive tasks, it not only frees up internal resources but it also removes the potential for mistakes.

"It is quicker, more accurate and removes the burden of monotonous work. To make sure our product names are aligned across all applications and databases is thousands of hours of work – all of which can now be done without human intervention," comments Siesing.

"Each part name change took us 20 minutes to complete manually – Fujitsu RPA does it within five. That means we can deliver products more quickly to our customers and provide better service."

Furthermore, for the supplier reporting process, the time required has fallen from two hours to just 15 seconds, saving even more valuable time. Moreover, both RPA pilots guarantee consistency of data across all applications so users and customers can rely on accurate information.

"Fujitsu has provided us with a structured model for taking on RPA projects. We have been impressed by its professionalism and the RPA knowledge available at its Center of Excellence. It all added up to a smooth experience," concludes Siesing. "We now have high hopes that we can introduce RPA solutions more widely within the business – for example, our warehousing and distribution involves lots of manual interactions, which we could automate."

Customer Profile

FlexLink AB

Address: Byfogdegatan 11, Gothenburg (Sweden)
Established: 1980
Employees: 1,116
Website: https://www.flexlink.com/en/home/

Mitsubishi Estate Co., Ltd.

Applying blockchain to facilitate cross-company data usage Launched consortium to find new insights

Mitsubishi Estate launched its OMY Data Utilization Project in May 2018 after conducting a field trial in Tokyo's Otemachi–Marunouchi–Yurakucho (OMY) district. For this project, the company adopted Fujitsu's Virtuora DX, a data distribution and utilization service platform based on blockchain technology. The platform allows data to be shared in a secure environment, to facilitate data exchange between companies and to gain insights, which benefits to urban development initiatives for innovations.

> *To become a company capable of transforming itself in response to changes in urban environments, we must collaborate with those in different industries to accelerate open innovation and generate new businesses. There are many things that we need to learn regarding ICT, and we expect Fujitsu, a company with strengths in this area, to teach us.*
>
> *Hiroshi Sano*
> *General Manager, Open Innovation Promotion Office*
> *Area Brand Management Department*
> *Mitsubishi Estate Co., Ltd.*

Using the OMY district as an 'open innovation field' to promote urban development

By implementing attractive urban development projects, Mitsubishi Estate aims to contribute to society, while also redeveloping Tokyo's Marunouchi area, where its head office is located.

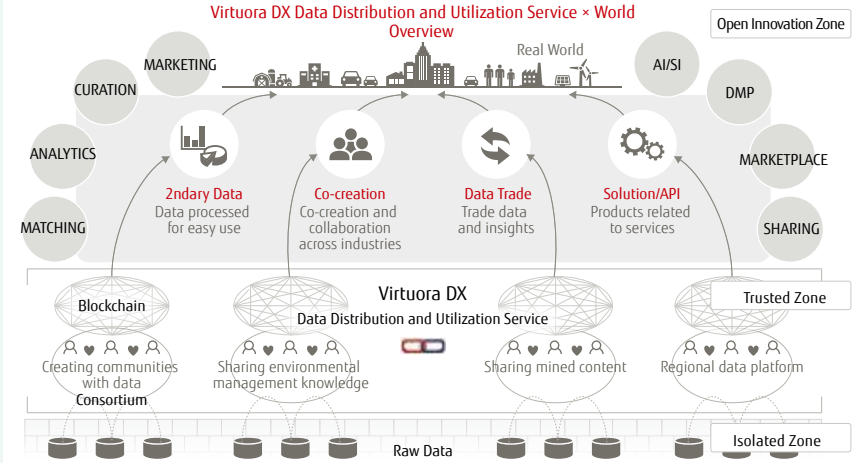
Hiroshi Sano, General Manager of Open Innovation Promotion Office explains, "Since the redevelopment of the Marunouchi Building in 2002, we have promoted the renewal in the Marunouchi area. We want it to become a district that is not only business-oriented, but also one that people are keen to visit." He adds that his company's business approach has evolved and now focuses on "creating urban environments that support modern lifestyles including shopping and sightseeing opportunities".

After quickly noticing the changing needs toward this area, Mitsubishi Estate launched the field trial called 'Marunouchi UrbanTech Voyager' initiative in the OMY district in Tokyo in 2018. Seeking to transform OMY into a business and innovation hub, the company has established various facilities to promote interaction of people and companies across industries. Its aim is to transform the area into an open innovation field.

To transform the OMY area into the open innovation field, the cutting-edge technology was required. Sano says, "We are actively working to incorporate the latest ICT solutions into our products and services." Hiroyuki Okuyama, Senior Manager at Mitsubishi Estate's Open Innovation Promotion Office, explains, "In the Marunouchi UrbanTech Voyager initiative, we identified three areas of focus: urban-development-friendly artificial intelligence (AI), IoT, and robotics. Together with our partners, we are now forging ahead with a proof of concept (PoC) aimed at resolving various societal issues."

Using blockchain to make data sharing easy and to facilitate innovative collaborations

The OMY Data Utilization Project was launched in May 2018 as part of the Marunouchi UrbanTech Voyager initiative. The aim of this project is to use cross-company data from multiple industries to uncover new urban renewal ideas. At its inception, four entities were involved in the project. Mitsubishi Estate provided building's power data and sales data of commercial facility regarding the OMY district. Softbank Corp., a leading mobile phone company and telecommunications service provider, supplied data on human movement behavior which Softbank Group Corporation holds. The University of Tokyo's Ohsawa Laboratory contributed its expertise related to analyzing the data collected. And Fujitsu offered an environment for sharing the data securely. Aiming of forming a data-matching consortium as well as sharing and utilizing real data, the project identified three focal points which are energization of shops and commercial facilities, revitalization of tourism, and visualization and modeling of human movement behavior. The consortium then explored the possibility of data interchanges across multiple organizations. The information used in the PoC was actual historical data provided by the consortium members, with the data anonymized (personally identifiable information removed) prior to it being shared.



Data Distribution and Utilization Concept Enabled by Virtuora DX

In addition, the project used Fujitsu's Virtuora DX, based on blockchain technology, as a cloud-based service platform to distribute and use data securely. This enables to share information within the consortium members by incorporating mechanisms developed by the University of Tokyo's Ohsawa Laboratory called a Data Jacket,*1 generally encouraging data usage of different fields by sharing a summary of the information about the data and KeyGraph,*2 visualizing the connections between data. These mechanisms help easily conceive new ideas through data usage. Virtuora DX supports promote open innovation and enlarge consortium with exchanging insights and ideas.

Using cross-company and cross-industry data to co-create new businesses

The OMY Data Utilization Project started from the four project founders, and the number of the memberships finally enlarged to 12. Data Jacket information obtained by this project was shared among consortium members. During the PoC, some participants found it difficult to share data with other companies. Okuyama recalls, "It's easy to assume that companies can readily exchange data among themselves. However, it proved to be difficult to analyze the raw data provided by each company. This was caused by differences in data granularity and data acquisition intervals. By enabling the data providers and data users to talk directly with each other, the participants gained insight into the contextual background and were able to use the data more effectively."

Sano concludes, "To become a company capable of transforming itself in response to changes in urban environments, we must collaborate with those in different industries to accelerate open innovation and generate new businesses. There are many things that we need to learn regarding ICT, and we expect Fujitsu, a company with strengths in this area, to teach us." Transcending the barriers between companies and industries, the consortium will continue sharing and using data to create new services and business models.

*1 Data Jacket is devised by Ohsawa Laboratory, the University of Tokyo, 2013
*2 KeyGraph is proposed by Professor Yukio Ohsawa of the University of Tokyo, 1998

Customer Profile

Mitsubishi Estate Co., Ltd.

Address: Otemachi Park Building, 1–1, Otemachi 1-chome, Chiyoda-ku, Tokyo
Established: 1937
Employees: 806 (parent company);
8,856 (consolidated group) (as of March 31, 2018)
Website: http://www.mec.co.jp/index_e.html

Beam Suntory, Inc.

Reducing potential risk of error by tracking production of barrels of bourbon

Jim Beam® was monitoring the production, storage and distribution of hundreds of thousands of barrels using a process heavily reliant on paperwork, leaving it exposed to error. The company wanted to find a more efficient, transparent and accurate way of keeping track of inventory. The company deployed GlobeRanger iMotion IoT Edgeware Platform, which connects sensors and IoT devices to gain rich data on production, storage and distribution of Jim Beam's® critical assets. Through a series of automation and software development, its barrels are now RFID-tagged and tracked through every stage of production which has also enables the possibility of consumer connectivity deeper into the liquid maturing lifecycle.

> *It was important that we had full IoT capability, the ability to integrate with our system of record, and a partner with true global reach, which Fujitsu GlobeRanger delivers.*
>
> *Nick Moberg*
> *Senior Manager of Platform Solutions*
> *Beam Suntory*

Introducing precise production tracking from time-consuming paperwork

As the world's third largest premium spirits company, Beam Suntory has unparalleled expertise in whisky, including world leadership in Bourbon and Japanese whisky, and strength across many key categories including tequila, vodka, cognac, rum, and cordials. Produced in Kentucky, Jim Beam® is one of the best-selling brands of Bourbon in the world. Since 1795, eight generations of the Beam family have been involved in whisky production.

Managing the production of hundreds of thousands of Bourbon across multiple warehouses and distilleries is a challenge. Each barrel, weighing more than 500lbs, is produced in Jim Beam's® Kentucky distilleries every year, and they all must be tracked from new oak, to filling, to aging, until barrel liquid dump.Traditionally, the warehouse teams would use paper forms to track the production and movement of the barrels, and then record those in their system of record. However, this paper process was time-consuming and cumbersome.

"As you can imagine, if a barrel is losing liquid, we need to be aware and somehow mark the barrel; if a cask is matured, it needs to follow the appropriate dump order," explains Nick Moberg, Senior Manager of Platform Solutions at Beam Suntory. "We looked at a number of track and trace solutions, including barcode, however after careful consideration, we decided RFID tagging would be the best route for us."

Jim Beam® consulted with friends within the industry and other industries. After spending two years analyzing the market, the company chose GlobeRanger iMotion IoT Edgeware Platform as the software backbone of the new platform.

"It was important that we had full IoT capability, the ability to integrate with our system of record, and a partner with true global reach, which Fujitsu GlobeRanger delivers," adds Moberg. "In addition, our parent company Suntory has worked with Fujitsu for many years so there was already a good cultural fit. The iMotion solution was also cost-competitive and came highly recommended

by other vendors."

Realizing seamless, automated IoT monitoring through data connectivity

The GlobeRanger iMotion IoT Edgeware Platform enables IoT device and data connectivity and management, for sensors and other devices and has proven its stability, flexibility and ease of use over more than a decade of enterprise installations in the defense and commercial sectors.

New oak barrels arrive at each Kentucky site, are filled and an RFID tag is fixed and validated by GlobeRanger. If the tag is damaged, the line is stopped and an audio alert is signaled for manual intervention. If valid, the barrel is rotated and sent to the fill room where a supervisor creates a barrel fill form in the system, detailing the plant, material, start date, and quantity. The fill order is integrated with the GlobeRanger system, which auto-populates the batch information.

"We created a three-stage project encompassing the commissioning, tagging and movement of each individual barrel. RFID antennae are embedded throughout the fill area, and handheld scanners are used in the warehouses so that we have total visibility of inventory at every step of the liquid maturation process," continues Moberg. "It provides a digital trail that allows for the automatic movement of liquid between plants, warehouses and trucks."

Accurate and transparent tracking is producing benefits

For Moberg and his team, the transparency of the process is the chief benefit. Every detail of the production process is mapped and available via a single pane of glass so that wastage is eliminated, and each barrel location is identifiable near real-time.

"When you are dealing with hundreds of thousands of items, things will have the potential to be misplaced, however, now we have the who, what, where and how regarding every barrel that rolls off the line so we can track down errors and answer questions effectively," says Moberg. "Trying to do that with paperwork and manual intervention was incredibly difficult."

This has the knock-on effect of making the lives of supervisors much easier. Less time is spent filling in paper forms and all assets can be tracked at the touch of a button while errors can be prevented from taking place. When you are handling a barrel with liquid that has matured for several years, this digital accountability is vital.

"If a mistake is made while dumping, we stand to lose valuable liquid assets, which is why this system removes the possibility of error," comments Moberg. "It provides a complete, automated overview for all our production via one interface supplied by GlobeRanger iMotion."

Beam Suntory has been impressed with Fujitsu's commitment to co-creation and the collaborative way in which it approached the project. It is now looking at the next step in its IoT digital

transformation journey, wherein the 'liquid lifecycle' becomes clearer to the consumer.

"We like to tell the brand story that showcases the art, science and craft behind the production of our market-leading Bourbon, and we want to tie that story to each individual bottle," concludes Moberg. "It is an industrial IoT solution that not only keeps track of production but can also help us bring extra life to our brand."

Customer Profile

Beam Suntory, Inc.

Address: 222 W Merchandise Mart Plaza, Suite 1600 Chicago, IL (United States)
Established: 1795
Website: https://www.beamsuntory.com/

The Shizuoka Bank, Ltd.

Banking channel innovation realizing new community-based financial services

As part of its 13th Mid-term Business Plan, the Shizuoka Bank set 'the reform of sales operations using retail channels and IT infrastructure' as one of its core strategies. The Shizuoka Bank chose Fujitsu's FrontSHIP, a front-end services platform to deliver location-free and omni-channel services. As the first step in this process, the Shizuoka Bank trialed various FrontSHIP functions, including the recommendation of financial products most suited to individual customer requirements and the online applications of banking services.

> *There is an urgent need for banks to establish front-end channels capable of open innovation including collaboration with other industries. To meet this need, we expect Fujitsu will deliver a specialized front-end services platform for the finance industry which has high compatibility with our existing systems, and can keep up with new global trends while supporting local needs.*
>
> *Hidehito Iio*
> *Director and Senior Executive Officer*
> *The Shizuoka Bank, Ltd.*

Using the latest technology for front-end channels to reform sales operation aligned with the digital market

With its base in Shizuoka Prefecture, southwest of Tokyo, the Shizuoka Bank, Ltd. operates from 173 locations within the prefecture, 30 locations in other prefectures, and 5 locations overseas (208 locations in total, as at September 2018). In addition to handling a wide range of financial products, the bank is currently investing in Fintech endeavors and participating in cross-industry collaborations. The Shizuoka Bank announced its 13th Mid-term Business Plan, as a three-year plan covering fiscal years 2017 through to 2019. One of the core strategies laid out in the plan was 'the reform of sales operations using retail channels and IT infrastructure'. The strategy seeks to innovate sales processes such as 'location-free operation', enabling applications and contracts anytime on-the-spot; 'self-service', for in-branch deposits, withdraws, utility and tax payment operations; and 'sales support', to disseminate sales information to customers via smartphones and social media to collect, accumulate and analyze customer feedback.

Commenting on the background to the bank's efforts to transform its sales operations, Hidehito Iio, Director and Senior Executive Officer, the Shizuoka Bank, says, "The importance of physical branches for local banks will remain unchanged, but with the progress of digital, there has been a dramatic increase in the entry of non-bank entities using Fintech services. There is an urgent need for banks to upgrade front-end channels through developing internet banking capable of handling open innovation including collaboration with other industries."

The Shizuoka Bank is promoting process transformation for both face-to-face and non-face-to-face channels through driving automation, paperless, and seal-less of transactions and promoting channel transformation, which is omni-channels to

deliver the same services from both face-to-face and non-face-to-face channels.

Providing attractive financial services by taking initiatives of digitalization

To transform both its face-to-face and non-face-to-face channels in parallel, the Shizuoka Bank adopted Fujitsu's FrontSHIP front-end services platform for the finance industry. FrontSHIP supports the creation of new contact points with customers and provides an improved customer experience through digital channels.

"The deciding factor to adopt FrontSHIP was its ability to match the security level of the previous internet banking system we were operating," recalls Yoshinori Kobayashi, the Shizuoka Bank's General Manager, IT Planning Group, Corporate Planning Department (formerly). Elaborating further, Nobuhiro Yayabe, Deputy General Manager, IT Planning Group, adds, "Another reason that we chose FrontSHIP was its high degree of compatibility with the existing internal systems we were running. The exceptional technical capabilities of Fujitsu were also very appealing to us."

In October 2018, the bank took its first step in using FrontSHIP by implementing its 'One to One' recommendations and applications for various online services. These involve analyzing a customer's requirements and the trends in their financial transactions and then matching the results with the bank's products and services that would be the best fit for the customer. Yayabe comments that, when the 'One to One' recommendation function was implemented, "We focused on improving convenience for each and every customer, while the system was controlled to be in line with laws on financial products sales."

Working toward a shared front-end services platform

Banking services that would otherwise need a visit to a branch could now be accessed at anytime, anywhere via their smartphones or other internet-connected devices. The Shizuoka Bank built their financial platform as a first step to realize this channel transformation.

By hosting its front-end services platform for the finance industry in the cloud, Iio comments, "Rather than the Shizuoka Bank building and operating a highly scalable front-end services platform on its own, we want it to become a cloud service that enables us to actively collaborate with external stakeholders according to its usage and cost." He adds, "With the banking business model changing dramatically, I have high expectations that FrontSHIP will become a key system for the future, that the use of cloud services will enable sharing of the underlying internet-based front-end services functionality, which will promote healthy competition as each bank implements its own financial services within that platform."

By implementing a system that can keep up with new trends, such as Fintech and cross-industry collaborations, the Shizuoka Bank is developing new retail channels and services. In this way, the bank aims to continue providing the best services fit to local needs in support of its fundamental corporate philosophy, 'to broaden dreams and prosperity within our community'.

The device screen of the Shizuoka Bank application

Customer Profile

The Shizuoka Bank, Ltd.

Address: 10, Gofukucho 1-chome, Aoi-ku, Shizuoka-shi, Shizuoka
Founded: March 1, 1943
Employees: 2,857 (as at July 31, 2018)
Website: https://www.shizuokabank.co.jp/english/index.html

Siam Commercial Bank

Co-creation with Siam Commercial Bank delivers cashless self-checkout for The Mall

Prompted by the Thai government's drive toward a cashless society, Siam Commercial Bank (SCB) and The Mall Group (TMG), a major upscale retailer based in Bangkok, turned to Fujitsu for an automated, flexible and cashless point-of-sale solution. Up and running since September 2017, the new system is boosting customer satisfaction and streamlining operations for both retailer and bank. Its success paves the way to expanding the system and co-creating more new digital services.

> *We hope to continue working with Fujitsu to make the cashless society a reality in our country.*
>
> *Srihannath Lamsam*
> *EVP of Payments Product Development and Solutions Division*
> *Siam Commercial Bank*

Digital transformation of the retail experience benefits shopper, merchant and bank

For consumer and merchant alike, checkout has always been the most troublesome aspect of the retail experience. Shoppers wait in long lines while customers ahead fumble for exact change. Cashiers must handle the cash tendered and give change that the retailer needs to prepare each day. Meanwhile, so many staff are tied up on checkout that too few are on the floor to assist customers. And at the end of the day, an armored car must take all that cash to the bank where it has to be counted again. For all concerned, the checkout process is a hassle.

New cashless technologies, like PIN-verified credit cards and smartphone-based QR codes, open the door to innovations that speed up transactions and free up staff. But making them work requires the cooperation of multiple players: government regulators, banks, merchants, technology providers... and customers.

Recognizing its achievements in cashless self-checkout applications in Japan and elsewhere, TMG and SCB turned to Fujitsu for a solution.

Bringing together multiple partners for a solution "Made in Thailand"

Only a few years ago, this project might have been impossible. Central bank regulations were too restrictive and customers were not yet ready. But in recent years the Thai government's "national e-payment agenda" led to the introduction of PromptPay, a new e-payment infrastructure across all banks in the Southeast Asian nation. Along with the credit- and debit-card transactions common in similar systems, PromptPay goes a step further to include QR code functionality – which makes it possible to pay directly from a smartphone.

As this new era dawned, SCB, one of Thailand's most progressive banks, was determined to lead the way. But to prove the concept SCB needed an equally progressive retail partner with lots of smartphone- and card-bearing customers, plus a technology provider with just the right expertise. TMG, Thailand's leading

operator of Gourmet supermarkets (with an average of 2million transactions per month) was the obvious choice on the retail side. After a careful selection process, both SCB and TMG agreed that Fujitsu offered the best technology. And so a three-way process of co-creation began in early 2017.

A paramount KPI for the project was a superior Thai-language interface, given Thailand's unique script and intricate culture of politeness. Accustomed to similar language challenges in Japan, Fujitsu readily agreed that the software had to be locally developed. And to keep costs down, so did the hardware. The result is a solution entirely "Made in Thailand."

At the same time, Thailand being one of the world's major tourist destinations, the system had to be flexible enough to meet the language needs and payment preferences of a diverse clientele.

Plus, a range of other functions were required, such as validating parking passes and factoring in membership and coupon discounts. In fact, this functionality was seen as a critical feature from launch, with self-checkout discounts as the lure to get shoppers to try it.

What's more, the new solution had to be compatible with TMG's existing store system.

How do you get shoppers to try something they've never seen before?

TMG's Bangkok Gourmet supermarkets – favored by young, up-scale, tech-savvy and time-stressed shoppers – was the perfect place to launch an innovation completely new to Thailand. Many TMG shoppers have both credit cards and smartphones, along with the knowhow to master unfamiliar apps.

Even so, the trio of co-creators knew they had to do everything possible to gain acceptance from customers. First of all, the external design had to be friendly and welcoming. Second, user instructions had to be intuitive and easy-to-understand in the local language. And third, the twin lures of faster checkout and deep discounts were seen as essential.

To stimulate trial at launch, TMG presented early adopters with an offer too good to refuse: spend 500 baht and get 100 baht back.

As expected at launch, staff had to be on hand to show shoppers how to use the system. But as people learned how to use the system the need for such "interventions" gradually tailed off.

Digital transformation accelerates Thailand's progress toward a cashless society

Since its initial launch in September 2017 at TMG's flagship Gourmet supermarket in Bangkok, the co-created cashless checkout system has performed with a high level of reliability, and TMG is now in the process of rolling it out across the company's locations nationwide.

Chairat Petchdakul, VP of Supermarket Merchandising notes that, "It is contributing to improving our customers' shopping experience. By co-creating for the Gourmet market with SCB and Fujitsu, we

were able to achieve something that we could not have achieved alone. It makes us very happy when we see customers using the cashless, self-checkout. Among the many vendors available to us, Fujitsu was the only one who could achieve these things by our required delivery date."

TMG is now moving to extend system functionality by offering a wider range of language and payment options. To serve Chinese visitors, who typically spend heavily on items to take home, the system now accepts WeChat Alipay, China's most popular payment method. And plans are afoot to offer more global cashless payment options, such as PayPal.

Today, TMG outlets typically feature 10 human cashiers alongside two self-checkout machines. But in future the company expects that ratio will be reversed. And both TMG and SCB expect the trend to spread as TMG's pioneering system has drawn widespread attention in Thai business circles. For Thailand's bankers and government officials alike, this is an encouraging sign that the nation is progressing steadily toward a cashless society.

SCB is equally pleased with the result. Srihannath Lamsam, EVP of the bank's Payments Product Development and Solutions Division, said, "We owe the success of this co-creation project to Fujitsu's know-how and its many years of experience in Thailand. We hope to continue working with Fujitsu to make the cashless society a reality in our country."

Customer Profile

Siam Commercial Bank

Address: 9 Ratchadapisek Rd., Jatujak, Bangkok (Thailand)
Founded: 1904
Website: https://www.scb.co.th/en/personal-banking.html

SEVEN-ELEVEN JAPAN CO., LTD.

Enhancing logistics processes using an operations management system to service over 20,000 stores in real-time

Retail giant Seven-Eleven Japan has overhauled its operations management system to ensure safe, secure, and punctual shipment of goods from its partner distribution centers to its franchise stores. Real-time operations information management ensures safe and secure distribution management. It also has numerous benefits including increased fuel efficiency, reduced ecological footprint, streamlined operations, and a greater ability to respond in times of crisis.

> *Under the slogan 'Close and convenient,' store layouts are constantly changing, and this requires distribution changes. This means that systems also have to change. We always expect Fujitsu to keep up with these changes and we look forward to their proposals for the optimum solution in each case.*
>
> *Hiroyuki Harajima*
> *General Manager*
> *SEVEN-ELEVEN JAPAN CO., LTD.*

Safe, secure, punctual product distribution to over 20,000 stores nationwide

In January 2018, Seven-Eleven Japan became the first retailer in Japan to achieve a store count in excess of 20,000. 7-Eleven's main objective is to provide goods and finely-tuned services to cater to local preferences, and by doing so, make its stores an indispensable "close and convenient" part of local communities.

To maintain the flavor and quality of each and every one of its products, the company has distribution centers for the four food-temperature categories such as chilled, warm, frozen, and room temperature, and uses its market concentration strategy which stores are located in clusters, with each cluster being supported by a distribution center to distribute collectively to the region. There are 156 partner distribution centers in Japan (as at the end of February 2018), with 5,900 delivery vehicles and around 13,000 drivers that deliver goods to each store daily.

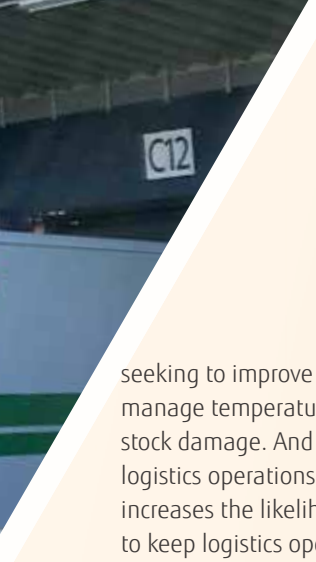
Hiroyuki Harajima, General Manager, Seven-Eleven Japan, emphasizes, "Our mission is to deliver safe and secure products, safely and securely to our franchise stores."

Seven-Eleven Japan began deploying in-vehicle devices and an operations management system from very early on.

Harajima describes the need for the operations management system as follows, "Our company has been developing infrastructure based on our supply commitments. It may be possible for one person to manage 2,000 stores based purely on his or her innate ability, but that definitely won't work with 20,000 stores. To provide the same level of service to all franchises, you need suitable mechanisms in place. This is why we use systems to manage the logistics framework and so enable stable supply and distribution."

Deploying Fujitsu's operations management system for further enhanced quality of logistics operations

Harajima lists the following reasons for Seven-Eleven Japan



seeking to improve the quality of its logistics operations, "First, to manage temperature and vibration - in other words, to minimize stock damage. And second, to implement efficient, sensible logistics operations. If an item has to transit via several stores, this increases the likelihood of damage, and that incurs a cost. It is vital to keep logistics operations simple."

Fujitsu's operations management system ensures this level of logistics quality, a point that led Seven-Eleven Japan to first deploy the system in 2006. Later, when the company conducted a system overhaul in 2012, the new solution proposed by Fujitsu was also deployed at each partner distribution center.

The new system uses DTS-D1D, a networked in-vehicle station with a high-performance drive recorder, to support driving in real-time. The system also uses cloud-based network driving support which provides real-time status and therefore contributes to a higher quality of logistics operations.

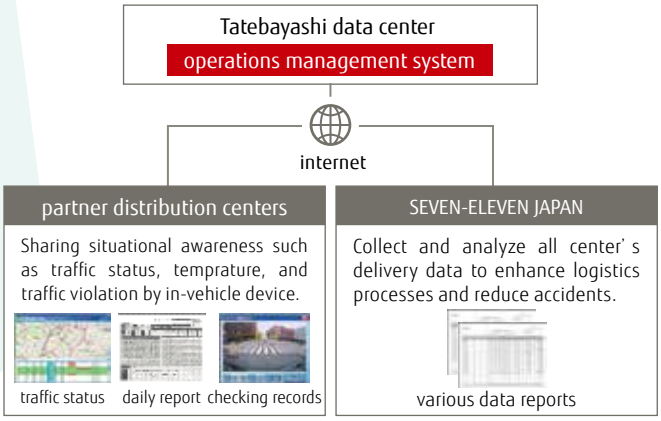
HI-LINE Co., Ltd. provides distribution services to around 7,000 7-Eleven stores from Hiroshima in the west of Japan through to Kanagawa and Tokyo districts in the east. Akira Hanafusa, Manager of the Chilled Rice-based Foods partner delivery center at Neyagawa, describes the advantages of the new system, "In the past, we could only ever pinpoint the location of a delivery vehicle through radio contact. So when a driver became lost en route and called us for directions, it was hard to relay a set of instructions. With the current system, however, we can identify a driver's location in near real-time. And now we can even accurately determine a van's refrigeration temperature remotely from our office."

Toshio Hagane, Deputy Manager of HI-LINE's partner distribution center at Neyagawa, credits the new system with improving work efficiency for van drivers, "In the past, we needed to insert a memory card into the in-vehicle station, and, as soon as the driver returned to the center, they'd remove the memory card and print out the driving report at the office. The new system is accepted very well by the van drivers because they don't have to wait around anymore."

Keeping essential infrastructure running for residents, and caring for the environment

As one of seven retail organizations selected as a designated public institution under the Disaster Countermeasures Basic Act of Japan, Seven-Eleven Japan plays an important role in disaster and recovery situations, together with Seven & i Holdings and Ito-Yokado. The current operations management system is capable of sharing traffic conditions in real-time via the cloud between Seven-Eleven Japan and the companies that operate the delivery centers, so this can also be useful for rapid consultation and decision-making during an emergency. In fact, the system played an active role in February 2018 when heavy snow storms in the Hokuriku region caused major disruption to transport and distribution.

According to Harajima, "Despite heavy snowfalls, Seven-Eleven



Outline of operations management system

Japan maintained communications between Head Office, delivery centers and van drivers, making us the only company that continued delivering goods every day to most of our stores except where traffic limitations did not allow us to deliver. We were able to achieve this only because of our real-time operations management system. People used to think of convenience stores as lifestyle infrastructure stores, but nowadays they have become a lifeline. And you could say that a cloud-based operations management system is essential for ensuring logistics operations in an emergency situation."

It is anticipated that Fujitsu's operations management system will lead not only to optimum decision-making when disasters strike but also to consideration for the environment. Harajima concludes, "As we have around 5,900 delivery vehicles in Japan, we pay constant attention to carbon emissions, due to the direct link with environmental issues. Further streamlining of vehicle loading capacity and distribution distances to densely clustered stores, and our pursuit of optimal efficiency leads to improved fuel efficiency and, by extension, less impact on the environment. In line with our slogan "Close and convenient," we change the selling space in stores on a daily basis, and we modify our distribution practices as well. This means that systems also have to change. We always rely on Fujitsu to keep up with these advances and look forward to their future proposals for providing the best solutions."

Customer Profile

SEVEN-ELEVEN JAPAN CO., LTD.

Address: 8-8, Nibancho, Chiyoda-ku, Tokyo
Established: November 20, 1973
Employees: 8,886 (as of February, 2018)
Website: https://www.sej.co.jp/company/en.html

Nottingham Trent University

Collaboration for improving the wellbeing and safety of customers, employees and students

Nottingham Trent University (NTU) wants to enhance its curriculum and research, attract students and ensure they graduate with the skills required to be successful in modern employment, whilst also making a positive societal impact. NTU and Fujitsu decided to collaborate and co-create across a wide range of projects, including smart cities, workplace wellbeing and digital campuses. We invested in BuddyConnect as the first partnership project to help wellbeing of employees.

> *The FUJITSU Digital Transformation Center has a well-oiled process to draw out our joint expertise towards a common goal. BuddyConnect is a great example of a wellbeing-focused project we wanted to accelerate our partnership.*
>
> *Jonny Crawley*
> *Strategic Partnership Manager*
> *Nottingham Trent University*

Signing a partnership to explore collaboration projects

NTU is committed to partnering with leading organizations to effect change for the better. It believes that businesses and universities have much to teach each other and can harness their individual strengths to make a positive impact. It has partnered with Fujitsu in a Strategic Relationship Agreement, which will explore collaboration projects, including those centered around improving the wellbeing and safety of customers, employees and students.

"Fujitsu is a great partner because it cuts across multiple sectors, industries and technologies. It has a strong focus on 'co-creation', which mirrors NTU's approach to problem-solving," explains Jonny Crawley, Strategic Partnership Manager, NTU. "We can learn from the business challenges faced by Fujitsu, its customers and supply chain, and use these lessons to inform our curriculum and research, a vital part of the university's ambition."

The partnership will focus on three areas: identifying innovative R&D opportunities; collaborating on business planning; and developing skills and employability. In order to take a tangible first step working together, the two organizations held a workshop to tease out commonalities, which produced a number of appealing projects.

"It is easy to become paralysed by choice at this early stage, so we wanted to begin with a smaller scale, more specific application related to wellbeing," adds Crawley. "Fujitsu is focused on human-centric technology that makes life easier and people happier, so when it introduced us to an early version of its workplace mobile app, BuddyConnect, it seemed to be the ideal starting point for our collaboration."

Andy Seferta, Head of Ecosystem and Analyst Engagement, Fujitsu states, "Our Ecosystem approach recognizes the outcomes, combined value and positive benefits we can bring to the society by working with partners, academia and customers. I am already excited by the strategic collaboration, mutual strengths, matching cultures and wider potential of our relationship that will benefit a

wide range of people, including customers, employees and students."

Workplace support in an intuitive application

BuddyConnect is an intuitive app that supports people with autism. It helps employees plan and manage the anxiety challenges autism may present in the workplace. BuddyConnect is a unique source of support, it puts in place an effective support and guidance infrastructure through easy-to-access information, and by connecting those with autism with additional support.

"Fujitsu had developed a 'minimum viable product' with BuddyConnect so we immediately wanted to see where NTU could add value," continues Crawley. "The Human Experience Design process in the FUJITSU Digital Transformation Center (DTC), helped bring to life our opportunity to improve people's wellbeing. We looked at infusing our social science expertise to assess user behavior, adding gamification elements as well as monitoring eye-gaze and posture. The next step is to collaborate to build analytics on top using machine learning. It demonstrates how our skill-sets can complement each other."

The result is an intuitive app that helps support mental health and autism in the workplace. Key to BuddyConnect is a colour-coded wellbeing tracker, allowing users to record how they're feeling: green for great, amber for not-so-great and red for when users feel overwhelmed.

Each option triggers an action depending on the situation, from a quick chat with a designated buddy over the app's instant messenger service, to putting in a call to a dedicated Employee Support Line.

Future functionality includes a day planner to keep track of users' to-do list and deadlines, and an interactive campus map showing where essential facilities are.

Co-creation in action delivering wellbeing with a human centric approach

With a roadmap in place to make the app more feature-rich and intelligent, NTU and Fujitsu are ready to trial it with neuro-diverse users. In total, 1,100 people are taking part, providing a wealth of feedback to further fine tune the app's functionality.

"The DTC has a well-oiled process to draw out our joint expertise towards a common goal. BuddyConnect is a great example of that," says Crawley. "It is exactly the type of wellbeing focused project we wanted to accelerate our partnership."

However, BuddyConnect is merely the first step in NTU's digital transformation journey, including retail analysis with a major UK supermarket and a suicide prevention initiative.

"The value of Fujitsu comes from its expertise and human-centric approach, but also its sheer size. With 14,000 UK and Ireland employees, it gives us the breadth of knowledge and experience in a one-stop-shop, which is proving a hit with students," concludes Crawley. "Fujitsu helps keep us fresh, attract new students and

gives students vital exposure to real-life industry experiences, while we can give Fujitsu access to global challenges at the forefront of higher education."

Customer Profile

Nottingham Trent University

Address: 50 Shakespeare St, Nottingham (UK)
Established: 1843
Website: https://www.ntu.ac.uk/

Illustration Akihiro Ikeshita

Japan Aerospace Exploration Agency (JAXA)

Using orbit determination technology to support unravel the mysteries of the solar system, earth, and the origins of life

Since the Halley's Comet exploration project in 1985, the Japan Aerospace Exploration Agency has adopted Fujitsu's orbit determination technology in all domestic solar system exploration projects that have been undertaken in Japan. Although determining a probe's orbit in deep space beyond the Earth is extremely difficult, the orbit determination group of the Institute of Space and Astronautical Science is working alongside Fujitsu in orbit determinations in ongoing missions to ensure their success.

> *We have started R&D on the Martian Moons eXploration (MMX) program seeking to launch spacecraft in the first half of the 2020s. This is a more challenging project than Hayabusa2, so more accurate orbit determination will be important. We will continue improving the technique of orbit determination.*
>
> *Dr. Makoto Yoshikawa*
> *Associate Professor, Department of Spacecraft Engineering*
> *Institute of Space and Astronautical Science*
> *Japan Aerospace Exploration Agency*

JAXA's Institute of Space and Astronautical Science: continues to venture into new frontiers

Japan Aerospace Exploration Agency (JAXA) was established in 2003 as a result of the integration of the Institute of Space and Astronautical Science (ISAS), the National Aerospace Laboratory of Japan (NAL) and the National Space Development Agency of Japan (NASDA). Projects that they conduct cover a vast spectrum of fields, including the use of space environments, contributions with satellites and probes, space science research, solar system exploration research, and astronautical technology research.

"The Hayabusa2 asteroid probe is observing an asteroid called Ryugu in order to clarify the origin and evolution of the solar system and raw-material substances of life forms. The probe has successfully touched down on the surface of Ryugu in February 2019," explains Dr. Makoto Yoshikawa, Associate Professor at ISAS, JAXA, and Mission Manager of Hayabusa2 project. In 2018, he was selected for 'Nature's 10' as one of ten people worldwide who have had a significant impact on the scientific community chosen by the science journal Nature.

Dr. Yoshikawa conducts research at ISAS to determine the orbits of artificial satellites and probes. He explains, "Orbit determination is to estimate where a satellite or a probe is and what its speed is at a specific time. The location and speed of a satellite or a probe are calculated through radio-wave communication with an antenna on the Earth. The orbit determination group estimates the current location of a probe and the orbit design group figures out the best way to move that probe based on the estimation results."

Fujitsu supports in the challenging field of orbit determination

Dr. Yoshikawa explained the difficulty of determining a solar system probe's orbit. "A large factor contributing to the difficulty is the great distance. Compared to a satellite near the Earth, the

distance between a solar system probe and the Earth is far greater, which causes changes in speed to be small when measured with radio waves. This is why estimation is difficult. In addition, a longer distance results in weaker radio waves and more noise. Poorer data quality results in less precise orbit determination." Other factors contributing to difficulty in orbit determination include tiny forces, such as solar radiation pressure, and fluctuations of the output of thrusters and ion engines that serve as the propulsion system of a probe.

Fujitsu is an active player in the field of orbit determination. It has been responsible for the development and operation of orbit determination systems in all of Japan's solar system exploration projects for more than 30 years – from the 1985 Halley's Comet exploration project (Sakigake and Suisei deep-space probes) to present. Dr. Yoshikawa adds, "Fujitsu has been helping us with orbit determination in deep space past the Moon in particular. In Japan, it is only Fujitsu and us that conduct orbit determination in deep space."

Responsible for determining solar system probes' orbits as a project team member

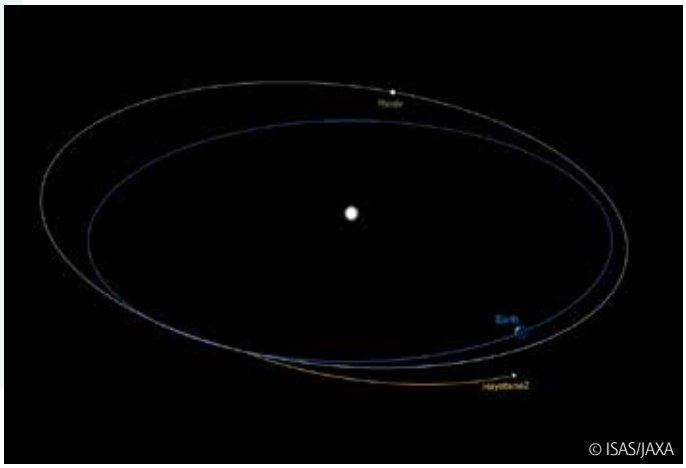
The orbit determination systems that Fujitsu provides calculate the locations of probes precisely based on data of probes that ground stations have tracked with radio waves and in some cases data of target celestial objects that those probes have observed. However, delivering systems is not the only job. Dr. Yoshikawa explains Fujitsu's role, "Since deep space exploration involves many new challenges, the software created initially is often not applicable without modification. When calculations that an orbit determination system performs are a bit off, we have a discussion with Fujitsu to modify the method. And Fujitsu and we make improvements by enhancing the system and modifying operations. Fujitsu has been participating in projects while fulfilling its responsibility as a member of the orbit determination team, not a distant, external partner company."

Difficult situations are commonplace in orbit determination for a solar system probe. Dr. Yoshikawa recalls, "When a problem occurred in the Nozomi Mars exploration project, Fujitsu's technology saved us. Fujitsu adopted the method of processing the weak radio waves that are too poor in quality to use under normal circumstances and extracting data usable for orbit determination in order to operate the probe. That was a very difficult job but nevertheless Fujitsu accomplished it."

Hayabusa2 was launched in 2014 to explore the Ryugu asteroid. It is the successor to the first Hayabusa asteroid probe, which was launched in 2003. Fujitsu is involved as a key member of the Hayabusa2 orbit determination team.

Evolving through experience for higher precision in orbit determination accuracy

Dr. Yoshikawa emphasizes that experience is crucial in orbit determination. "Although Japan has launched many satellites, the number of probes that went to or past the Moon is only around 10. Various predictions made on the Earth often turn out completely incorrect in space. When encountering trouble or an unexpected situation, we have to analyze it in preparation for similar circumstances. Experience is of vital importance for growth." Drawing on their vast experience, the orbit determination group and Fujitsu continue to improve the accuracy of orbit determination.



The orbit of Hayaubsa2, going away from the orbit of the Earth after the Earth swing-by

As of the end of 2018, ISAS is operating the Akatsuki, IKAROS, Hayabusa2, and MIO solar system probes. The orbit determination group and Fujitsu will continue to determine the orbits of these probes in operation now.

Dr. Yoshikawa expressed a vision of the future, saying, "In addition, research and development on the Martian Moons eXploration (MMX) project has been commenced for launching a probe in the first half of the 2020s. This project is even more difficult than Hayabusa2 and more precise orbit determination is crucial." Going forward, Fujitsu will support Japan's projects for solar system exploration with its orbit determination technologies.

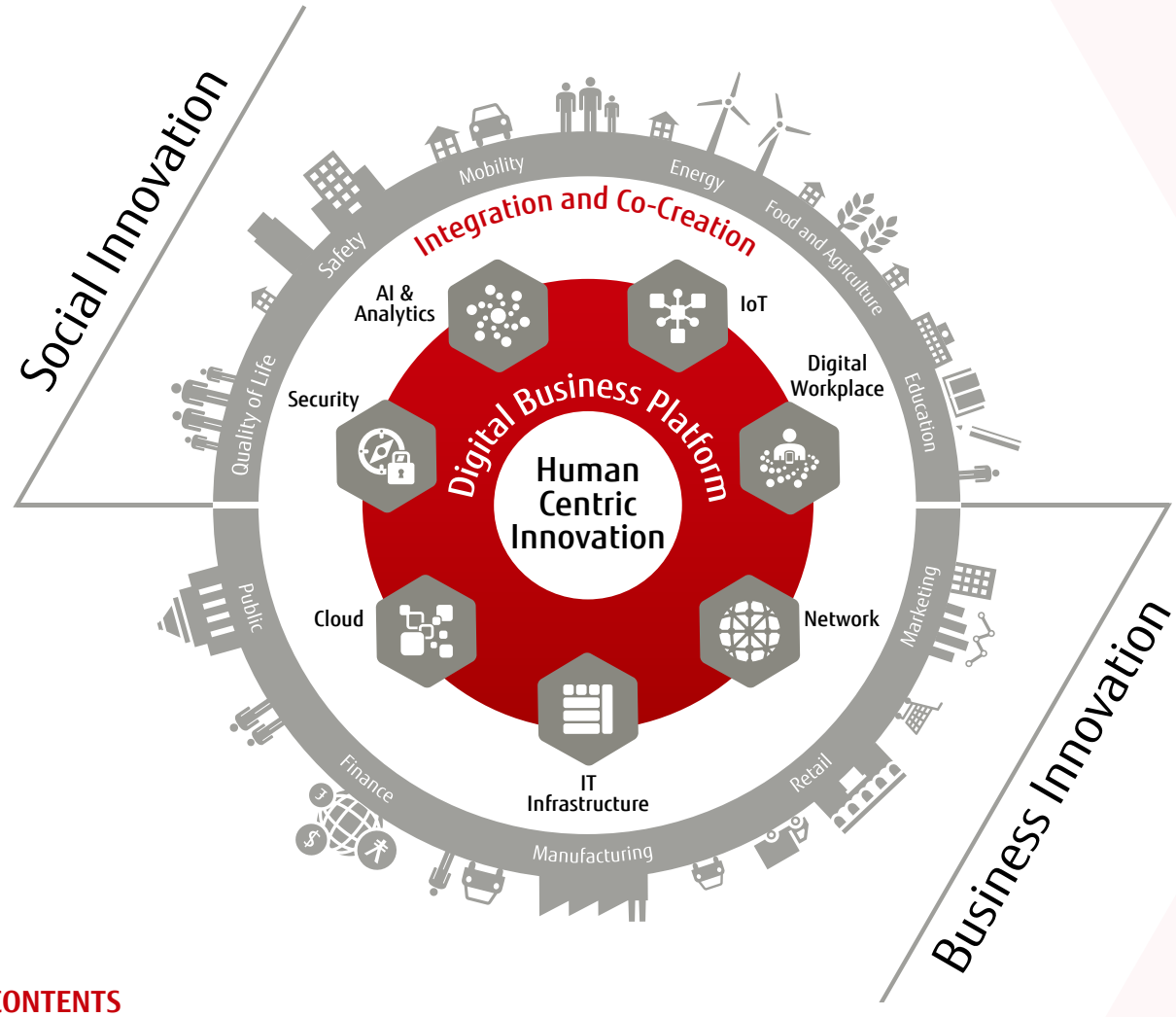
Customer Profile

Japan Aerospace Exploration Agency (JAXA)

Address: 7-44-1, Jindaiji Higashimachi, Chofu, Tokyo
Established: 2003
Employees : 1,526 (as of July 1, 2018)
Website: http://global.jaxa.jp/

Fujitsu's technology and services, the building blocks of a trusted future

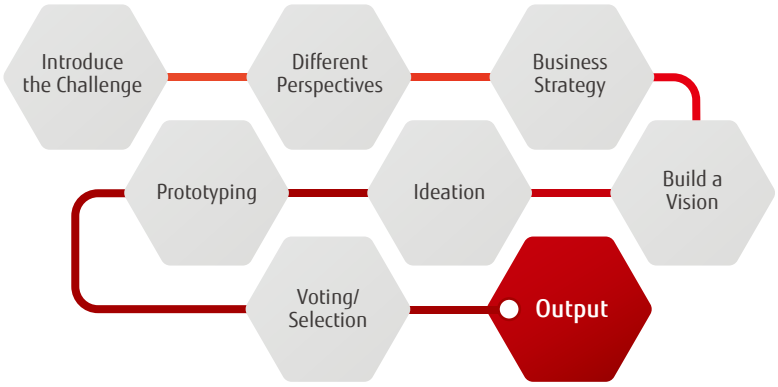
Enterprises today have the joint challenge of driving digitalization of core business to improve efficiency and productivity and the creation of new digital business for future growth.
Fujitsu has a broad range of digital technologies and services to support businesses in these joint objectives and to manage them as a coherent whole. We provide digital technologies such as AI, IoT, security and blockchain as services on MetaArc, our multi-cloud based digital business platform. We also provide integration services and we deliver co-creation programs to drive business and social innovation. With our digital technology and services, Fujitsu helps you throughout your digital transformation and in your journey towards the future.



CONTENTS

70 Application Services & Integration
72 IoT
73 Network
74 AI & Analytics
76 Digital Workplace
77 Hybrid IT & Multi-Cloud
78 IT Infrastructure
80 Security

Co-creation



The key to digital transformation lies in bringing together diverse thinking from business and technology to support our customers' unique digital transformation. We have established **Digital Transformation Centers (DTC)** in major cities around the world, complemented by mobile DTCs to provide venues where we can apply the **Fujitsu Human Centric Experience Design (FUJITSU HXD)** methodology, which helps harness the power of human creativity.
In the DTCs we bring experts together from business and technology to address a specific business challenge being faced by our customer organization. Using a unique form of 'design thinking' developed for a digital transformation environment – Fujitsu HXD – we are able to create innovative concepts faster in a collaborative and dynamic mix of knowledge, creativity, ideation and concept development.
Pre-formed digital inspiration cards are used to fast track the ideation process. These inspirations are the product of our work with a diverse range of customers and industries. As the ideas flow they're captured on paper and quickly digitized to add to the development of specific solutions. Large digital screens track the trajectory of thought, so participants can keep track of ideas and re-arrange them to inspire new outcomes. This tried and tested approach has been developed in Japan and is designed to allow the rapid development of proofs-of-concepts which can be tested, modified, and turned into proofs-of-business to deliver tangible outcomes.

Transform your business with Fujitsu Digital Business Solutions

Focused on business transformation, Fujitsu Digital Business Solutions (DBS) enables customers to create and nurture new business opportunities. Our DBS practice is a digital transformation engine for customers to become more competitive by optimizing processes for greater efficiency, productivity and profit.
Fujitsu DBS transformation experts can help customers every step of the way – from an initial idea through to full implementation into full-scale production.
Main business solutions are:
- Account Based Ticketing with ACT (cf. Transport Solutions pag.71)
- Asset Tracking, Building Information Modeling (BIM) with Globe Ranger (cf. IoT Solutions pag.72)
- Quality Control in Manufacturing, Infrastructure Inspection with FAIR (cf. AI Solutions pag.74)
- Combinatorial Optimization with Digital Annealer (cf. pag.75)

DBS Centers of Excellence focus on proving new business ideas and developing these into proof of business concepts. Our game-changing approach is agile to ensure that innovation delivers its promise – it can create unprecedented improvements to your top and bottom lines, with up to 80 percent uplift in terms of revenue and increases, or time saved.

Artificial Intelligence (AI)

With specialist Centers of Excellence (CoE) in North America and Europe, Fujitsu delivers AI-based solutions for customers focused on high-ROI business benefits across all sectors – from retail, to legal, to defense. In retail, Fujitsu's European CoE has developed a new solution that cuts self-service checkout fraud by using AI to cross-check scanned items, with the potential to save retailers billions of Dollars annually. In manufacturing, Fujitsu's Advanced Image Recognition system (FAIR) improves the efficiency of quality control by up to 80%.

Industrialized Automation

Robotic Process Automation (RPA) processes massive volumes of repetitive tasks without errors, in a fraction of the time it would take a human to perform. Available 24 hours a day, it relieves humans from repetitive tasks and frees them to focus on higher value-add. According to Fujitsu's experts at its RPA CoE, enterprises can save between 12% and 16% on operating budgets just by removing the barriers that are currently holding RPA deployments back from scaling out. The Fujitsu Industrialized Automation Operating Model helps customers more easily reap the massive potential benefits of this disruptive technology.

Blockchain

Blockchain and digital ledgers are moving beyond the hype to genuine use cases in enterprises and government. Fujitsu – spearheaded by its Blockchain Innovation Center - is enabling this forward momentum with a pragmatic emphasis on optimizing processes, blockchain-as-a-service platforms and proof of business rapid-prototyping frameworks. The new FujitsuFlow suite of blockchain-as-a-service offerings includes Fujitsu InvoiceFlow which eliminates the very real issue of accidental data error and the increasing problem of invoice fraud. Other offerings in the suite will be launched throughout 2019.

Analytics

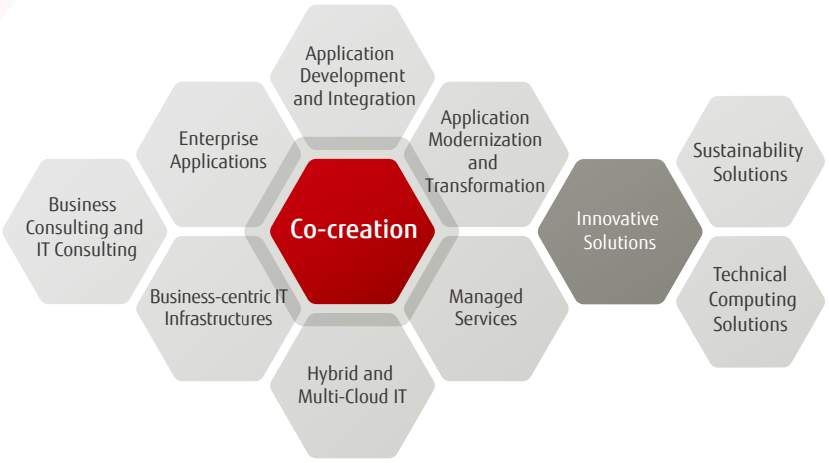
At its Advanced Analytics Center, Fujitsu has developed the Sholark suite of analytics and AI offerings for healthcare, defense and legal and compliance. Gartner estimates the average legal department lawyer spends 25% – 40% of their time on work that doesn't need legal training. Sholark processes large volumes of structured, semi-structured and unstructured data in real time, utilizing semantic intelligence to find connections and deliver meaningful insights to support decision making.

Application Services & Integration

At Fujitsu, we take an innovation-led approach to connecting applications & technologies helping organizations become intelligent enterprises. This approach enables our customers to reinvent themselves making use of emerging technologies while transforming with speed and agility to meet business needs.

Connected Applications, Solutions and IT Infrastructure

Fujitsu's Business, Application and IT Infrastructure consultants work with organizations to achieve excellent customer experience, operational effectiveness and business performance. We take an end-to-end view from the Application to the IT Infrastructure including operational aspects to provide a complete solution.



Business Consulting and IT Consulting

We advise on the best current and emerging technology to help customers achieve their business objectives.

Enterprise Applications

Scalable services for leading software applications, covering core business functions.

- SAP Services
- Oracle Services
- ServiceNow
- Microsoft
- Intelligent Enterprise Services

Application Development and Integration

Our experience in dealing with complex multi-vendor environments and emerging trends/technologies ensures that projects are well managed and within budget.

Application Modernization and Transformation

To enable customers to easily migrate or modernize legacy applications and reap the benefits of cloud services, minimizing risk and cost and providing flexibility.

Sustainability Solutions

Fujitsu helps your organization optimize the efficiency of its ICT equipment and data centers, saving you money and reducing greenhouse gas. Our Enterprise Sustainability Solutions align your sustainability objectives with your business goals for sustainable growth.

Business-centric IT Infrastructures

Utilizing latest server, storage, networking and software technologies we build agile IT infrastructures running your applications with maximum efficiency. With integrated systems we reduce time and risk of IT infrastructure innovation projects. These facilitate the adoption of software-defined hyper-converged and hybrid IT architectures driving agility to the next level.

Hybrid and Multi-cloud IT

With the cloud you can leverage your own IT capabilities allowing you to shift IT resources from maintenance to digital business initiatives. Fujitsu helps you to find the right balance between on-premises IT with cloud IT creating hybrid IT models. We help you to source various cloud services without losing control.

Managed Services

Ensures IT systems are operational with improved flexibility, efficiency and performance at a reduced cost.

Technical Computing Solutions

Fujitsu provides the enabling technologies and services to meet the research, development, and analysis needs of its customers in aerospace, meteorology, astronomy, healthcare and industrial projects. Fujitsu has also teamed up with numerous prominent research agencies to design bespoke solutions for the most varied and challenging technical computing applications.

Retail

Fujitsu's Connected Retail solutions are focused on enabling retailers to:
- Deliver richer customer experiences
- Achieve Operation Excellence
- Enable easy order everywhere
- Offer frictionless checkout

We have more than 50 years of experience delivering solutions that include high-performance best-of-breed hardware, mobile and self-service solutions, and end-to-end retail business applications and multi-vendor lifecycle support services.

Manufacturing

With decades of experience working with manufacturers, we have the expertise to ensure that manufacturing processes are digitally transformed and optimized in an agile and cost-effective way.
Fujitsu enables you to leverage the convergence of IT and operational technology (OT), helping to improve your manufacturing efficiency, increase productivity, reduce costs, and improve the supply chain transparency.

Service Providers

Being a leading managed service provider ourselves puts us in a prime position to understand the pain points of the different types of service providers.
We can de-risk the service integrator journey with our excellent data center products, solutions and attached services as well as innovative cloud-like sourcing models.

Automotive

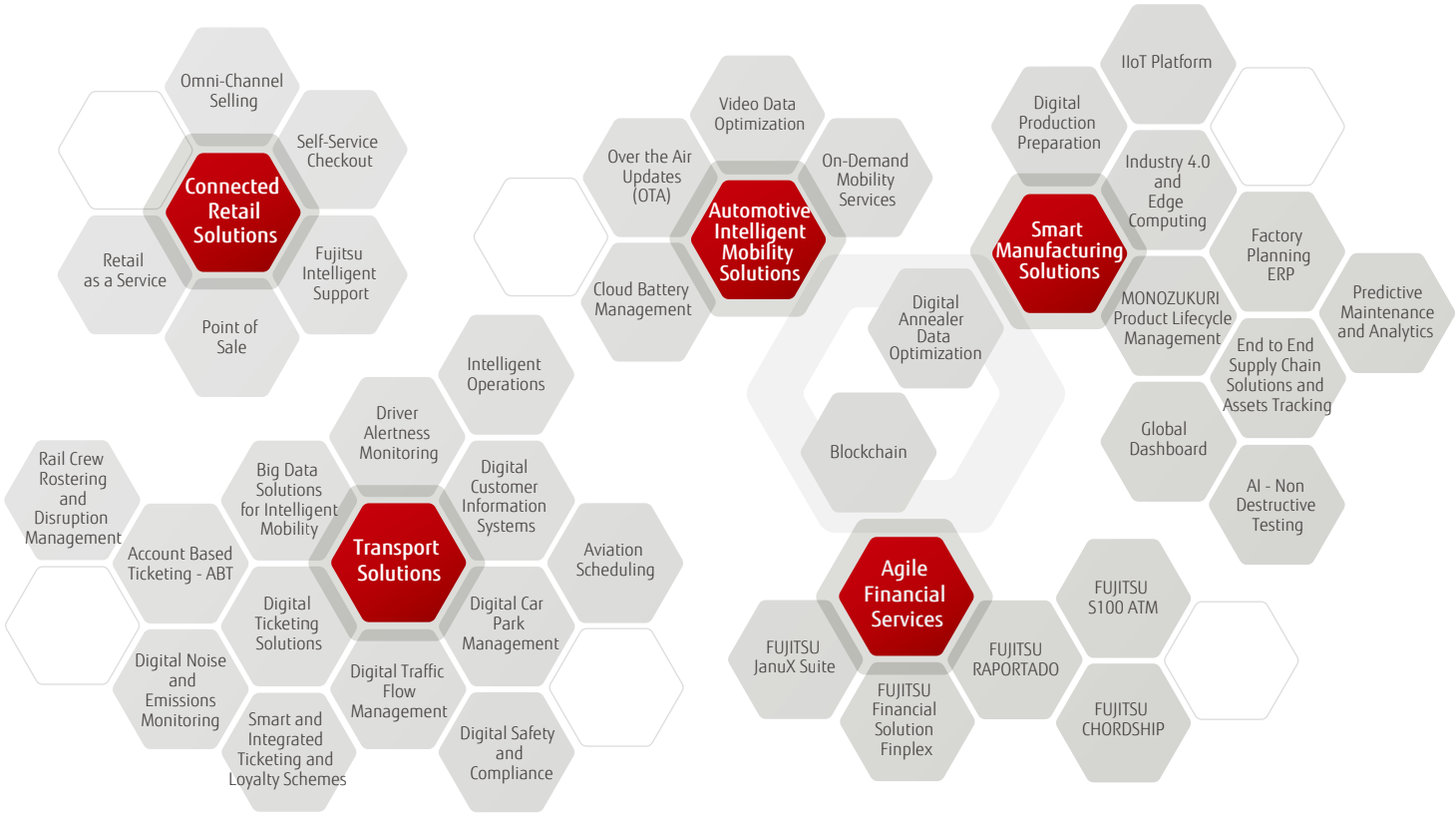
We have over 35 years of experience working with world-leading vehicle manufacturers. With our automotive-specific portfolio, we deliver intelligent mobility solutions, IT solutions for sales and after-sales service, research and development, production, and logistics. Our innovative service offering can enable you to boost your efficiency and improve your global operations.

Financial Services

At Fujitsu, we have worked together with financial services organizations over 45 years, exchanging perspectives, vision, and co-creating solutions and services in a highly innovative manner to support banks and insurers changing to data and technology driven agile organizations with a strong customer focus.

Transport

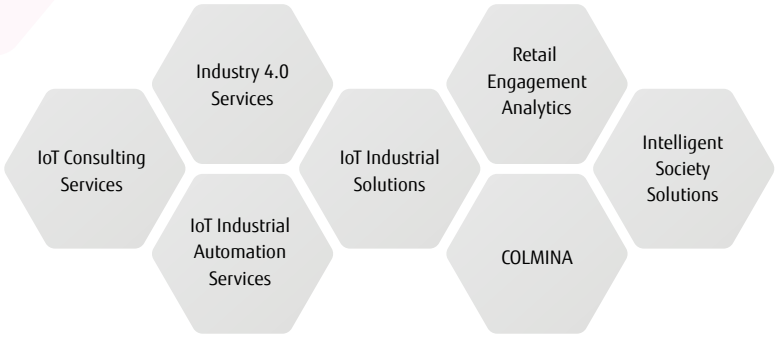
Fujitsu helps transport operators provide Mobility as a Service initiatives including Smart Ticketing, laying the foundation for more personalised transport services that build both customer loyalty and efficiency in service delivery.
From improved employee engagement and optimized collaboration by connecting teams across functions, to increasing operational efficiency and building new business models, Fujitsu is helping transport operators innovate and evolve.



IoT

Internet of Things (IoT) is a key driver of digital transformation and business innovation. Hyperconnectivity is enabling people, information and things to come together in unique ways that are fundamentally changing business and society. Fujitsu helps organizations to become hyperconnected businesses and take full advantage of this shift.

Connecting people, information and things for an hyperconnected business



IoT Consulting Services

Fujitsu's long and comprehensive global experience means we have been able to develop expertise across a number of industries. For customers exploring how to transform their business using IoT, we work with them to co-create solutions specifically for their needs. To support our co-creation approach we have invested globally to build out our design thinking capabilities, digital transformation spaces and industry consulting teams.

Industry 4.0 Services

Manufacturers have pioneered the use of sensors and data-based monitoring, but today's advanced networking, real-time controls and machine intelligence are taking the sector to a new level of sophistication and productivity. It is becoming a hyperconnected industry.

IoT Industrial Automation Services

Key to successful IoT deployments is being able to manage devices and sensors both centrally and at the edge. Fujitsu has access to a vast range of sensors to meet the needs of many use cases. In edge computing Fujitsu has its **GlobeRanger iMotion** platform and **Intelliedge** gateway and appliances. M2M solutions, including those supporting LPWAN allow us to offer global IoT connectivity. But having access to the data is only part of the story, Fujitsu can provide real-time visualization, HMI/SCADA, energy management, fault detection, manufacturing intelligence, and a suite of analytics solutions for operational excellence. These capabilities deliver significant cost reductions in design, build, deployment, and maintenance for a wide variety of applications. As an established IoT Systems Integrator, we use these services to support the rapid creation of IoT solutions that deliver real business value.

IoT Industrial Solutions

Fujitsu provides a range of connected service solutions for a wide array of applications in multiple industries; these provide advanced visualization and control; rapid archiving and retrieval; in-depth data analysis; data mobility; IIoT/cloud integration and more. Example solutions include remote asset monitoring, global asset tracking, connected field force, situational awareness and intelligent building services built around the IoT Automation Services. All these are provided as fully E2E Managed IoT Solutions.

Retail Engagement Analytics

Fujitsu's Retail Engagement Analytics (REA 2.0) puts real-time operation - al information at retailers' fingertips. Using RFID and IoT technologies to capture, monitor and analyze real-time in-store customer behavior, REA allows retailers to effectively manage everything from staff allocation and store layout to product placement and checkout queue traffic levels.

Fujitsu Manufacturing Industry Solution COLMINA

It links data on the location of people and products, on factory equipment, and all systems and know-how throughout the manufacturing process, as well as data among companies in the supply chain.

Intelligent Society Solutions

Aimed at addressing various social challenges in food, agriculture, health & medical care, transportation, education and energy, Fujitsu continuously creates new value through innovative ICT.

- FUJITSU Intelligent Society Solution Akisai
- FUJITSU Intelligent Society Solution SPATIOWL
- FUJITSU Intelligent Society Solution RFID and Sensor Solution

Network

Connectivity is fundamental to digital transformation and the network is a business critical component of any modern organization. Fujitsu's Software-Defined Connectivity solutions put the network at the heart of the business. The solutions can connect clients anywhere, offer automation and orchestration with proactive monitoring to ensure the business stays connected.

Value-added services based on trusted virtual and physical networks

Fujitsu managed network services enables customer realization of:

Business transformation through:
- Improved service provision
- Fast value realisation

Customer intimacy by:
- Better customer understanding
- Maximizing the customer experience

Operational excellence via:
- Employee empowerment
- Autonomous operation

Product leadership:
- Intelligence in product / service
- Co-creation of innovation value

Managed Network Services
(Managed WAN, LAN, Wi-Fi, SD-WAN and Virtual Edge)

Whether your organization's future direction is IoT, digitalization, Big Data, Hybrid IT, Artificial Intelligence, or the virtualization of assets - Fujitsu not only has the capability to deliver a true end-to-end offering to enable these important transformations, we can also provide the critical infrastructure and services that will be its lifeblood.
We have the expertise to help you better understand analytics, management needs, and the impact of digitalization to ensure yours is a world-leading transformation.

Network Infrastructure Services

Today Fujitsu is providing new cutting edge technologies to enable organizations to achieve a competitive advantage. Fujitsu's Virtuora offers service providers and networking organizations the ability to provide software based - service chaining capabilities, end-to-end operational automation, service orchestration and programmability.
Fujitsu's Virtuora is providing the glue to connect and utilize new software based networking, optical infrastructure and virtualized networking into a compelling capability.

Network Software

Fujitsu provides network service management software that enables operation and management and quality assurance for next-generation networks, using technologies like Software Defined Networking (SDN), Network Function Virtualization (NFV), Microservices among others.

Network Products

Fujitsu supplies a comprehensive range of network products, including communications systems for carriers and network devices for enterprises. The former constitutes the backbone of our ICT-driven society, such as core networks, metro networks, and access networks. The latter is used to integrate internal networks within enterprises.

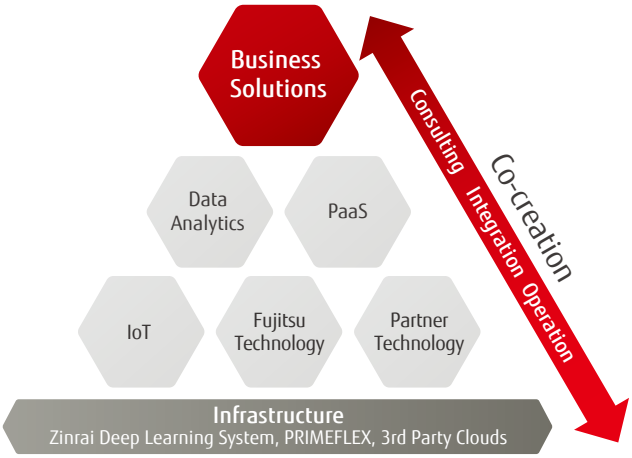
AI & Analytics

Today, a powerful new digital technology is emerging - Artificial Intelligence (AI).

Fujitsu Intelligence Technology

At Fujitsu, people remain central to our vision, with AI solutions centered firmly on empowering workers and citizens, creating value and supporting the work they do.
Fujitsu Intelligence Technology is growing Fujitsu's global AI business for global customers.

By establishing this critical location outside Japan, Fujitsu will respond with agility to international standards and demands, seizing upon the needs of its global customers and driving forward the development of new solutions.
The Zinrai framework of AI solutions provides a human-centric approach to the co-creation of services and solutions. It utilizes 'best of breed' global technologies that have been developed and deployed to meet ever-growing customer challenges. By combining the strength of Zinrai AI development with carefully selected partner capabilities, we are able to deliver optimal AI supported solutions that overcome the challenges our customers face.



Zinrai AI Consulting and Services

Human Centric Experience Design (HXD), Fujitsu's approach to Design Thinking, helps clearly identify the business opportunity. Combined with our business consulting tools and assets, Fujitsu can determine how the solution will deliver business value to your organization, targeting cost efficiency and revenue growth.

Analytics Services

Fujitsu provides a range of use cases matched to your requirements which can be deployed on premise, cloud or hybrid and all supported by our SMART Analytics Services.

AI Business Solutions powered by Zinrai

Fujitsu Zinrai human-centric solutions can be used either via the cloud or on-premise and can provide complete support over the lifecycle of a customer's AI journey - from consulting and co-creation through to deployment and operation.

- AI Predictive Maintenance
- AI Quality Control
- AI Social Infrastructure Maintenance
- AI Customer Flow Analysis

Transforming your industry with AI Business Solutions

- In the business world, AI is radically transforming many industries. With its ability to identify patterns and detect anomalies in mountains of digital information, Fujitsu's Sholark suite of offerings is adding a new dimension, and once trained, it's tireless in processing many standard tasks. And in retail, Fujitsu has developed a new self-service checkout fraud prevention solution that can save the retail sector billions of dollars annually.
- In manufacturing, the Fujitsu Advanced Image Recognition system (FAIR) leverages AI to improve quality control processes. It can detect tiny flaws invisible to the human eye reliably, 24/7, without the human error often associated with this kind of mundane work. Fujitsu is working with its manufacturing customers to deploy FAIR, achieving efficiency improvements in quality control of up to 80%.

Utilities Network optimization Cyber attacks detection	**Transport** Self-driving Traffic intelligence	**Logistics** Vehicle routing Car dispatching	**Finance** Consumer engagement Regulation and security
Manufacturing Equipment failure prediction Quality control	**Healthcare** Diagnosis support Drug discovery assist	**Retail** Customer flow analysis Demand forecasting	**Public Sector** City monitoring Citizen services

Zinrai Deep Learning System

Fujitsu provides an on-premises experience of Zinrai AI with this integrated Deep Learning platform to accelerate self-learning process, enabling organizations to automate operations and identify new avenues of business. Understanding the extreme acceleration needs required in deep learning workloads, Fujitsu offers a domain specific, massively parallel architecture with optimal precision called Deep Learning Unit (DLU). The DLU achieves 10 times more performance per watt than traditional processing units in the market.

The world's first quantum-inspired technology

Digital Annealer

FUJITSU Quantum-Inspired Computing Digital Annealer is the world's first quantum-inspired technology delivering performance generations ahead of classical computing solutions, overcoming the challenges of the evolving quantum computing systems. This revolutionizing technology can solve real world, large-scale combinatorial optimization problems today like portfolio risk optimization fool-proof from financial crisis, factory optimization, new drug discovery and many more.
Providing up to 10,000 times faster performance than commercial solvers running on traditional computers, this disruptive technology not only massively optimizes organizations business processes but also enables them to create a competitive advantage in their field.

- Up to 10,000 times faster than industry standard compute*
- Performance 12 Moore's Generations Ahead
- Avoid the complexity and energy costs of advanced cooling solutions

* This figure is based on solving a typical combinatory optimization problem in software using the algorithm implemented in the hardware running on a Xeon family processor.

Optimize and innovate with Digital Annealer solution:

Finance
Portfolio risk optimization
Credit risk assessment
ATM cash replenishment

Logistics
Traffic route optimization
Parallel fleet routing

Automotive/Manufacturing
Car design optimization
Robot welding optimization
Job shop rescheduling
Warehouse route optimization

Bio and Material science
Drug discovery
New material development
Protein folding

Utilities
Network optimization 5G roll out

End to end solution approach:

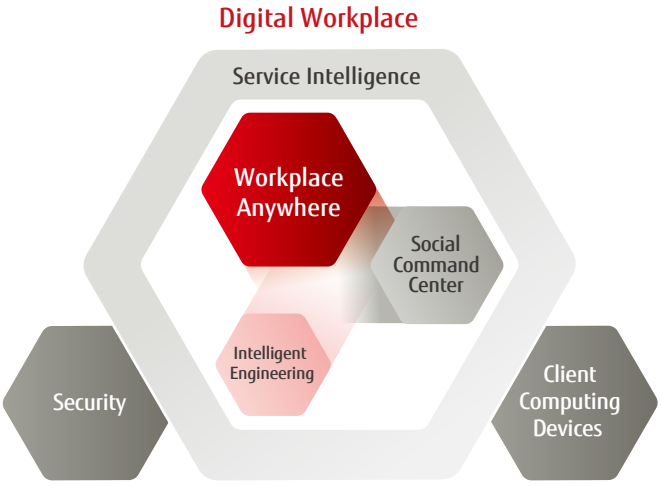
	Use cases				
Solution	Logistics / Last Mile Planning	Portfolio / Cash Management	Network Investment	Shift / Robotic Scheduling	Molecular Comparison
	Algorithms				
Procedure	Graph Coloring	Knapsack	Minimum K-Cut Partitioning	Graph Similarity	
Infrastructure / Services	Services Layer	1QBit Middleware	Digital Annealer		
	Level -1/2/3		Cloud Service		
	UI Portal		On-Premises Services		
	Q&A		Technical Service		

Consulting Integration Operation Co-creation

Combinatorial optimization problems faced in actual business

Digital Workplace

Unleash the potential of your people to connect, collaborate, and innovate. Completely supported by intelligent services.



Empowering your people

Fujitsu's Digital Workplace Services increases productivity and transforms your workplace by enabling people to excel in their jobs - empowering them to deliver more value, wherever they are.

The business outcomes are:

Everything is connected: From people and devices, to data to applications; everything in the workplace can be connected to transform your workforce and drive productivity. This means employees are unleashed, accessing the data they need anywhere, any time and any place on the right applications.

Employees are empowered: Simple help options and easy to use hardware, software and applications in consumer products have led people to expect the same in their workplaces. Meeting – and exceeding – those expectations will improve their experience and boost collaboration across your ecosystem to strengthen relationships and help retain talent.

Creative intelligence is prominent: New tools and technologies empower all employees to deliver innovation, more value and growth to their organization and also enjoy a more purposeful role.

To realize the full benefits of a Digital Workplace we help you focus on delivering the right employee experience and transforming the way people work. A workplace assessment helps you map out the vision, benefits and roadmap to accelerate your move to a digital workplace. Colleague journey mapping and colleague experience design ensure, your employees needs and requirements help improve productivity and employee engagement. Our approach to New Ways of Working then goes further by helping you explore the capabilities of your new digital workplace to do things you were unable to do previously. This is all underpinned by change and adoption consulting to help you fully recognize the benefits of the organizational and technology improvements. Wherever you are in your journey we can help you realize the value and drive the business outcomes you desire.

Workplace Anywhere

A unified suite of technologies delivered as a managed service to create a consistent, personalized and contextual user experience at scale. We securely combine Cloud, Virtual and Managed Workplace Services to enable you to get the right blend for your organization and transform the way you work.

Intelligent Engineering

Fujitsu's Intelligent Engineering moves IT Support to a more proactive and preventative approach. It combines in-depth analytics, predictive technology and our own insight to keep your business running 24/7.

Social Command Center

The Social Command Center, Fujitsu's Next Generation Service Desk, delivers a 24/7 personalized support service, so users are empowered to help themselves however and whenever they choose.

Client Computing Devices

Fujitsu offers a complete range of environmentally conscious products and uses environmentally friendly technologies and processes throughout the entire product lifecycle.

- Notebooks and Tablets
- Desktops
- Workstations
- Thin Clients
- Smart Devices
- Peripheral Devices

Hybrid IT & Multi-Cloud

Fujitsu Hybrid IT & Multi-Cloud services blend private, public and managed cloud with existing or on-premises IT, to drive business agility, efficiency, innovation and growth. All of this is delivered for you flexibly by Fujitsu and our partner ecosystem ensuring that your transformational Hybrid IT & Multi-Cloud environment delivers maximum value for your organization.

Your perfect balance of Multi-Cloud and traditional technologies

As a leading Hybrid IT and Multi-Cloud provider, we have the global expertise to build your perfect balance of cloud-based services, enabling you to modernize your existing business, innovate new digital applications and build the immersive and personalized experiences of tomorrow. We understand cloud requirements and maturity vary greatly – so we offer tailored solutions, designed specifically for you, whilst ensuring legacy, multi-cloud and cutting-edge technologies are seamlessly connected and integrated across your organization.

How can Hybrid IT & Multi-Cloud benefit your business?

Agility and efficiency:

- Respond to change & demand with scalable services
- Significantly reduce operational and IT running costs
- Drive greater return from existing IT investments

Growth and customer experience:

- Transform and optimize applications in the cloud
- Create new differentiated cloud-native applications
- Unlock valuable insights from existing and new data

Digital innovation and speed:

- Anytime, anywhere access to leading SaaS-based applications & productivity tools
- Exploit cutting-edge application development capabilities
- Leverage breakthrough technologies at scale, including AI, Blockchain & Quantum-inspired IT

Co-creating cloud success: our leading services and partner ecosystem

Fujitsu has global strategic partnerships with the leading private and hyper scale cloud providers, offering customers an extensive multi-cloud and digital innovation portfolio to accelerate transformation on all levels. We offer end-to-end services for Amazon Web Services, Microsoft Azure, Oracle, SAP, VMware and more and have the expertise to deliver migration, management, integration and optimization at scale:

Public & Private Cloud Services

End-to-end services for major enterprise cloud technologies, including:

- Fujitsu Managed Private Cloud & VMware Cloud on AWS
- Amazon Web Services
- Microsoft Azure
- SAP & SAP on Azure
- Oracle Cloud

vmware PARTNER ENTERPRISE SOLUTION PROVIDER

aws partner network Advanced Consulting Partner

Gold Microsoft Partner Azure Expert MSP

SAP Global Partner

ORACLE Platinum Partner Cloud Premier EMEA Oracle Cloud Managed Service Provider

Transformation Services

Migrate to agile hybrid IT & multi-cloud environments that enable you to unlock value which traditional data centers cannot match. Modernize & transform your applications in the cloud - and develop new, differentiated cloud-native applications and services.

Integration Services

Integrate multi-cloud and on-premise services with enterprise grade applications for corporate users, suppliers and end customers. Automate processes and services for business agility. Co-create digital business innovation with **Fujitsu RunMyProcess**.

Managed Services & Orchestration

Adopt and combine the best mix of cloud technologies that provide the most value for you and your digitalization journey – with flexible management and optimization across your ecosystem of platforms, technologies, services and suppliers.

Data Services

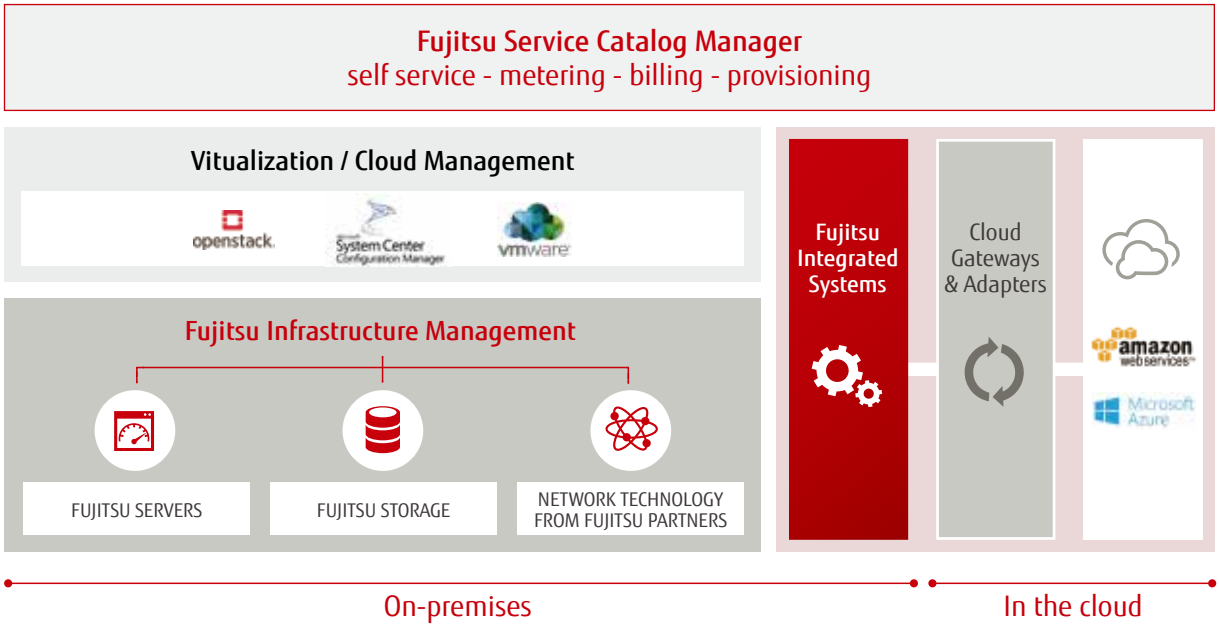
Drive greater value and insights from your data across multiple cloud and traditional sources, with powerful analytics. Ensure security, compliance and loss-prevention are entirely and continuously managed across your hybrid data landscape.

IT Infrastructure

Digitalization drives transformation of data center IT towards new dimensions of fast and flexible scalability. By integrating our own and our partners' innovative technologies into complete IT solutions Fujitsu supports its customers to master the IT Infrastructure challenges of a digital economy.

Paving the way to software-defined and Hybrid IT

Digitalization continuously creates new data sources contributing to an exponential data growth. This requires new IT architectures which can scale flexibly at an instant. Software-defined data center (SDDC) concepts following an end-to-end virtualization approach are able to fulfill even extreme scalability demands. Pre-defined and integrated converged and hyper-converged infrastructures could establish themselves to accelerate the adoption of SDDCs. They also make it easier to shift workloads into the cloud by providing the technical foundation to connect on-premises IT with the cloud. Such Hybrid IT constructions enable data center managers to re-allocate internal resources from maintenance and operations to digitalization projects which create direct business value. Fujitsu delivers the right IT infrastructure technologies, solutions and services supporting customers on their journey to a software-defined, (hyper) converged and hybrid IT with end-to-end operational control.



The IT infrastructure that powers digital transformation

Digital transformation is rapidly changing the needs of all business areas. One of the key challenges organizations face is defining how to use the right mix of cloud based services and infrastructure technologies to deliver both new digital solutions and to modernize their existing infrastructures. To be able to support customers in this transformation journey, Fujitsu offers a broad range of servers, mainframe and storage systems, necessary infrastructure and data center management software products as well as predefined Integrated Systems to facilitate the setup of an IT infrastructure and its operation.

Enterprise Service Catalog Manager

Fujitsu's Enterprise Service Catalog Manager (ESCM) is a self-service portal to centrally manage service delivery, life-cycle operations and user access for all IT services in a hybrid IT environment. IT organizations can introduce new services quickly, keep control of service usage, and report and charge service consumption. Business users have access through an intuitive self-service portal on which they can easily find and consume services that are managed on- or off-premises.

Integrated Systems

PRIMEFLEX® is a family of pre-defined, pre-integrated and pre-tested combinations of data center components. PRIMEFLEX includes general purpose and purpose-built systems, traditional converged and hyper-converged systems, factory-installed ready-to-run systems and reference architectures which can be easily adjusted to customer-specific requirements.

Servers

Fujitsu provides a complete range of infrastructure platforms, from industry-standard PRIMERGY and mission-critical PRIMEQUEST systems, Fujitsu SPARC / UNIX servers, as well as BS2000 Mainframes. More importantly, Fujitsu will collaboratively find the best solution for each individual demand.

Storage

Fujitsu's ETERNUS storage portfolio balances storage capacity, performance and costs for the complete lifecycle of data - from production, business analytics and big data to backup and long-term archiving. It comprises all-flash, hybrid and software-defined primary storage systems as well backup to disk and tape solutions. Based on ETERNUS products, leading technology from our partners and comprehensive services from Fujitsu we deliver complete storage solutions.

Infrastructure Management

Fujitsu's Infrastructure Manager ISM enables organizations to have centralized control over the entire data center which includes servers, storage, networking, cloud management software as well as power and cooling using a single user interface. ISM is not just restricted to a single site but is also capable of distributed data center management facilitating the path to a software defined IT.
In addition the new ISM Essential is a standard version of ISM, providing converged infrastructure monitoring capabilities and server management free-of-charge.

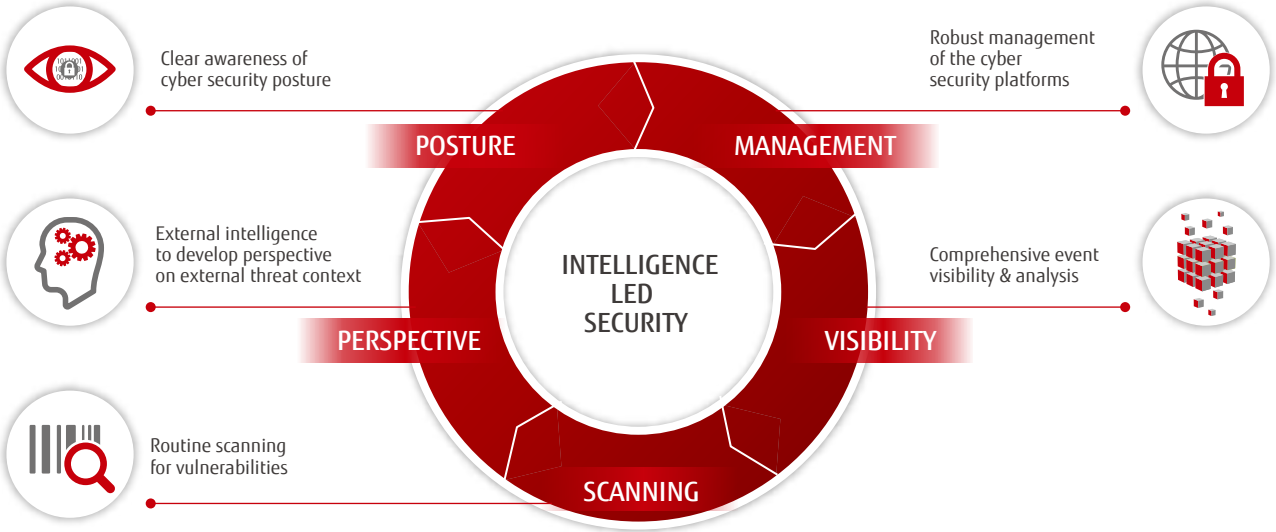
Security

Fujitsu helps organizations to manage their information security and continuity risks effectively, in line with their business strategy, providing flexibility in the way they work and enabling secure and resilient business.

Intelligence-led security

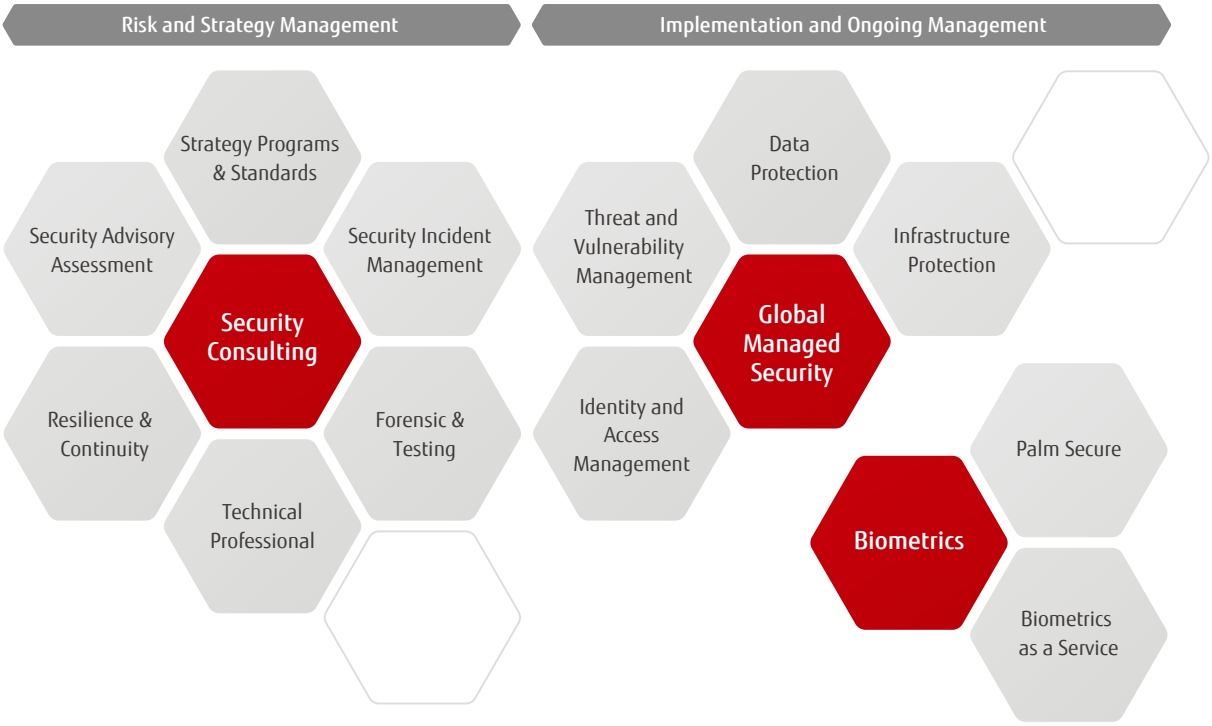
Fujitsu Cyber Security Services provide essential security capabilities to our clients, supporting their drive to protect information assets in the face of emerging strategic and operational business challenges. We are a critical component of our clients' approach to their regulatory and legislatory demands, assisting them in managing their information security risks flexibly and effectively.

As a global cyber security organization and service integrator, Fujitsu provides Cyber Managed Security and Consultancy Services across the full delivery lifecycle. We deliver our services based on our continuous learning from using industry-leading intelligence tools combined with the expertise and experience gained from years of security and service integration for some of the most sensitive customers.



Security Operations Centers

Fujitsu has its own intelligent Security Operations Centers. Our analysts and engineers have access to the Fujitsu Threat Intelligence toolset and platform based on many years of expertise and experience, with an attacker's mind's eye to think like a perpetrator and thwart their intentions. Fujitsu's SOC teams are constantly monitoring the threat landscape and security challenges.



Security Consulting

Using the Fujitsu Security Consulting Services, you benefit from independent information security consultant expertise and advice relating to your business, and the design, implementation and integration of security controls that you need to put this insight into action.

Global Managed Security Services

We use market leading cyber security products and expert professional services to support the assessment of risk, define requirements, provide technical and service design and architecture, as well as ensuring effective deployment and operation of the Managed Security Service. All our services give customers the 24x7x365 cover needed to protect their business.

Infrastructure protection

Fujitsu's infrastructure protection portfolio helps you safeguard your network and endpoint devices, and the data that travels around them. You can create specific risk profiles to suit your commercial requirements, enjoy full visibility of the devices connecting to your network, what their security status is, and how to manage them while they're active. Fujitsu's range of managed services helps you proactively prevent cyber-attacks, monitor network traffic for malicious content, block and analyze potential risks, and protect information as it is shared or stored.

Identity and Access Management

Fujitsu's Identity and Access Management and Privileged Access Management solutions help customers define and design the right controls to keep users, systems and customers protected whilst maintaining optimum operational efficiencies.

Data Protection

Fujitsu's Data Protection offerings help customers to manage the complexities of keeping data safe from all types of attacks and provide frameworks and automated policy enforcement even across cloud-based services to help mitigate the risk of sensitive data loss and help meet compliance requirements.

Threat and Vulnerability Management

Fujitsu provides intelligence-gathering offerings that are pivotal in helping customers stay ahead of threats. Fujitsu's Threat and Vulnerability Management solutions give clear visibility of the risks facing an organization allowing them to proactively enhance defences.

Biometrics

Fujitsu helps in selecting the best-suited biometric technology for your particular budget, environment, requirements and other criteria. **Fujitsu PalmSecure Palm Vein Pattern Recognition Technology** has been shown to be one of the most accurate biometric authentication solutions currently available on the market. Our **Biometrics as a Service** is designed specifically for mobile users, Fujitsu's cloud-based Biometrics as a Service platform enables secure, enterprise-grade mobile authentication using biometric technologies.

FUJITSU LIMITED

Shiodome City Center,
1-5-2 Higashi-Shimbashi
Minato-ku, Tokyo 105-7123, JAPAN
Tel. +81-3-6252-2220
https://www.fujitsu.com/global/

A Note Concerning Future Projections, Forecasts and Plans
This publication contains forward-looking statements in addition to statements of fact regarding the Fujitsu Group's past and current situation. These forward-looking statements are based on information available at the time of publication and thus contain uncertainties. Therefore, the actual results of future business activities and future events could differ from the forward-looking statements shown in this publication. Please be advised that the Fujitsu Group shall bear no responsibility for any of these differences.

Consideration for the Environment
- This report has been printed using waterless printing, which reduces the amount of harmful materials used and emitted.
- It is printed on FSC® Certified Paper as designated by the Forest Stewardship Council® in order to help preserve forestry resources.
- It uses vegetable oil inks that do not include volatile organic compounds.

July, 2019
Printed in Japan
FV0064-3