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Future Services & Societal Systems in Society 5.0

Held on Monday, November 7, 2016

Center for Research and Development Strategy
Japan Science and Technology Agency

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1. Introduction

As part of its Fifth Science and Technology Basic Plan (FY16 to FY20), announced in April 2016, the government of Japan aims to realize what it calls "Society 5.0," or "Super Smart Society." Society 5.0 provides a common societal infrastructure for prosperity based on an advanced service platform.

The anticipated continued progress of IT will provide individuals and society tremendous opportunities for innovation, growth, and prosperity through human-machine collaboration and co-creation; however, this same advancement is also presenting unprecedented ethical, legal, social, security, privacy and safety challenges that need to be addressed before the true benefit of these opportunities can be realized. This report discusses the following three subjects: (1) vision of a service society realized by IT, such as Reality 2.0, Wisdom Computing, and Cognitive Service System; (2) technology that will enable this vision; and (3) impacts associated with the vision and our readiness to accept it.

In concert with the International Society of Service Innovation Professionals (ISSIP), the Japan Science and Technology Agency (JST) held a one-day Discovery Summit with a number of world-class research faculty and industry and government leaders on November 7, 2016, in Tokyo, Japan, to explore both these opportunities and challenges. The speakers were well-known across scientific and technology communities as well as advocates for next-generation skillsets that will enable society to thrive within a smarter, wiser future.

2. Opening Remarks

Kazuo Iwano welcomed the attendees on Monday morning and noted that people had come from many countries around the world to hear distinguished speakers from Japan and the United States on the day's key subject: "Thinking About the Future Style of Services and Its Impact on Society." He noted that people in Japan are enthusiastic about artificial intelligence (AI) and the Internet of Things (IoT), though little attention has been paid to the relationship between these technologies (and the science behind them) and society. There needs to be expanded discussion about the ethical, legal, and social issues (ELSI) and how we can make a social impact through these technologies on societal organizations and structures. He encouraged attendees to collect ideas from the summit and its workshops, as well as to build new interpersonal connections amongst one another.

Following Iwano's opening address, Jim Spohrer of IBM spoke to the crowd about his first visit to Japan (in 2006), to give a talk on service science. He recalled presenting about how successful Japan had been in improving the quality of various products distributed across the globe, and how Japanese leadership exemplified the diligence needed to identify variances and defects in products, and how one of the main challenges of service science was to understand also the value in variance, such as in diversity and differences.

One of the main differences between 2006 and 2016, he stated, is that artificial intelligence is now the primary focus of the industry (citing a paper for Communications of the ACM about the challenges for service science that he co-authored with Henry Chesbrough of Berkeley). He believes that with cognitive computing and artificial intelligence we can realize the dreams of not just smarter but wiser service systems.

3. Keynote Speech

(1) Disrupting Unemployment, Dr. David Nordfors, Co-founder of i4j

Speaking during his first time in Japan, Dr. David Nordfors noted that he was very impressed by Tokyo's beauty upon arriving for the summit, comparing it to his hometown of Stockholm, "but even more beautiful." Nordfors founded an organization called i4j, focused on innovation for jobs and the future of work, together with Vint Cerf, an American known as the "father of the internet," who co-invented TCP/IP with Bob Kahn. Nordfors and Cerf (along with Max Senges) published a book in February 2016 called Disrupting Unemployment on which Nordfors' talk at the summit was based.

His speech sought to address questions such as: How will innovation create or destroy jobs? How will workplaces be organized in the future? What are the alternatives to employment? What does the future of education and well-being look like? He also stresses question about the future of wisdom, because we may actually risk the future without wisdom in the present.

Another co-founder of i4j, Sven Littorin, was also present. He was the Swedish Minister for Employment from 2006 to 2010, though he stated that he felt more like "the Minister for Unemployment," because he so frequently provided monetary assistance to those without jobs rather than being able to create jobs for them. In 2009, when General Motors announced that it would be selling its Saab unit, the Swedish Government held an emergency meeting to support job creation in the Västra Götaland region of Trollhättan, Sweden, to the tune of 542 million crowns. Littorin invented a model together with the Swedish Minister for Industry in which they took the severance money that GM had to give employees during the layoff, matched it with government money, and created an institute based on innovation, education, and social action that would benefit all of the workers, something that Nordfors called an "innovation ecosystem." Littorin followed a similar strategy in Lund when Sony Mobile bought Sony Ericsson and closed the local facility. Nordfors noted that Sweden gained a new innovation ecosystem with 2,000 engineers working for the Internet of Things in Lund, thanks to Sven.

Nordfors also introduced Curt Carlson, President of SRI International for 16 years, who took over the company on its brink of bankruptcy. Due to the sheer size of this research factory, Carlson decided that the best strategy for improvement was to kick start a complete culture change within the company. He used a multi-disciplinary approach to teach engineers and scientists how to think about the business, which seemed to work, since they eventually created Siri, the computer program that works as an intelligent personal assistant and knowledge navigator as part of Apple's iOS.

Nordfors also spoke about a people-centered economy—a topic on which he wrote a paper for the Kauffman Foundation's New Entrepreneurial Growth Agenda in 2016—where multiple individuals speak with one voice. He used i4j as an example of such an economy, as the organization is a network with hundreds of members with different ideas, all converging in lively online discussions. Nordfors says that, assuming all people can create value, we only need an economy that facilitates the expression and results from this value. The present labor market, however, is inefficient and not designed for an innovative or people-centered economy. Innovation for jobs is suggested as an essential additional component to the current state, because an ecosystem of entrepreneurial startup companies can disrupt unemployment and reduce misemployment. It is further hypothesized that innovation for jobs ecosystem can always contribute toward a people-centered economy that maximizes the value of people more successfully than an arbitrary task-centered economy, which only seeks to minimizes the cost of the task (i.e., what companies are doing today).

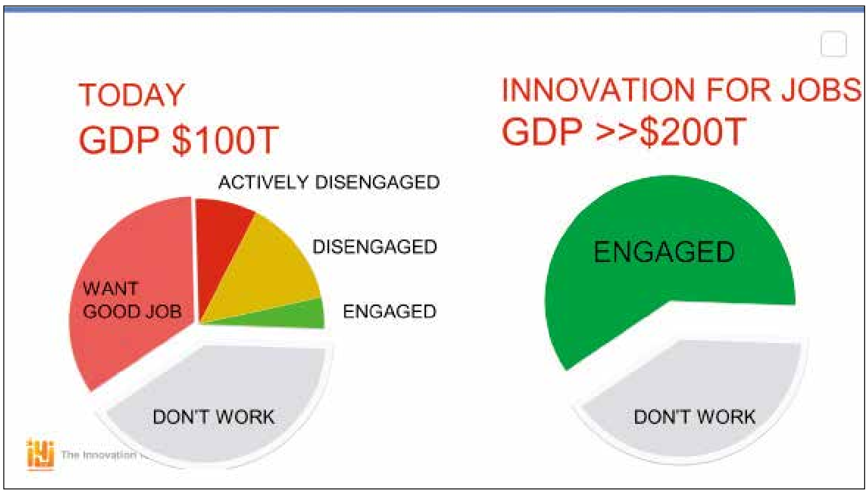
ECONOMY	TASK CENTERED	PEOPLE CENTERED
OBJECTIVE	LOWER COST OF TASKS	RAISE VALUE OF PEOPLE
INNOVATION	INNOVATION FOR SPENDING	INNOVATION FOR EARNING
STRATEGY	PAY LESS FOR LABOR SELL CHEAPER TO CUSTOMER	THE WORKER IS THE CUSTOMER AND THE CAPITAL
PUBLIC/PRIVATE INCENTIVES	NOT ALIGNED	ALIGNED

The Innovation for Jobs Ecosystem

Nordfors presents a simplified view of the economy, wherein “people need each other, and when people need each other more, the economy grows” and vice versa. Therefore, we need innovation that results in people needing each other more. Value happens, he says, when people see it, so we need innovation that makes people see more value in each other. In an innovation economy, raising the value of people is actually better business than lowering the cost of tasks.

So what, then, is a people-centered economy? In practice, it is an economy that reframes the labor market as a service market. Consider that earning a living is a need and, therefore, a job is a service for satisfying that need. The incumbent service for earning a living is called employment; however, what happens when customers are unhappy with a service? It results in a broken labor market where the incumbent service is not appreciated by its customers. Conversely, what if the service for earning a living is something that you want, and that fits your unique set of skills, talents, and passions, in which you work with an inspired team that does meaningful tasks and works with good customers? But how do you find this? How about, for example, a startup company is created that harnesses technology to find this ideal employment for you and takes a small fee for doing so. This, according to Nordfors, is very good business.

He then compares the task-centered economy of today with the people-centered economy described above, that includes startup companies that seek such offers. As noted, in a task-centered economy, the objective is to lower the cost of tasks (i.e., efficiency), wherein the spender is the customer in the task-centered economy. In the people-centered economy, the customer is the earner, so we have innovation for earning. In the current economy, Nordfors reminds us that we get lots of service offers to help us spend better, but we don’t get many service offers that seek to help us earn better. As such, to have an innovation economy that is in balance, we need to have as much innovation for earning as we have for spending. The strategy, then, in a task-centered economy is that you have workers and you have customers, and you want to pay less for the workers so you can sell cheaper to the customers.



Continuing this idea, in a people-centered economy, workers are going to also be customers because they are given the service of earning a living. Now the worker is also the customer but is also the capital. If I am serving a worker-customer who is interested in something and who has a talent and I know that they could get a better income with some added skills, I will offer them the course for free. I would buy a course, offer it to my worker-customer for free, and tell them that if they take the course and pass it, I can promise better income. Even though this is a great offer for my worker, I am also increasing the value of my capital, because if my worker-customers earn more and increase the value, then my commission grows and I earn more.

Now, let's look at a task-centered economy as well as its macro- and micro-economies and the alignment between them. Currently, companies want to reduce their workforce while at the same time and sell cheaper to customers. For governments, however, the worker and the customer are the same person, so they want their workers to earn more in order to spend more, thereby growing the economy. In a way, the task-centered economy gives private business an incentive to actually shrink the overall economy. In a people-centered economy, there is a greater alignment of priorities, as both the government and private businesses unanimously want people to earn more, which should open additional possibilities for merging labor and innovation policy. If entrepreneurs innovate better jobs for the unemployed and other undervalued workers, it is good labor policy to support such innovation.

Market size for a people-centered economy

Today, the world has 5 billion people of working age, 3 billion of whom are employed outside of the home. Of these 3 billion, it is safe to say that almost all of them want to have a good job that earns them a living from a meaningful work. However, only 1.3 billion are employed at jobs that actually earn them a living. Out of these 1.3 billion, only 200 million are engaged in their work. Double as mane, 400 million, are actively disengaged and dislike their job. The remaining 700 million are disengaged, they go to work every day to earn enough money to survive and then go home. This workforce creates a global market value of $100 trillion per year.

If the "innovation for jobs" ecosystem is activated, resulting in reliable matching systems for people and jobs, competition will emerge between companies that compete to offer people tailor-made jobs. In the end, then, we would have 3 billion people (or 3 billion customers for the service of earning a living) that all are working in jobs that are a good match for their skills, talents, and passions. They participate in good teams that work together and inspire each other, and they work with tasks they find meaningful for appreciative clients. The rhetorical question at the heart of Nordfors' example here is "How much more value would this workforce create than the current one, in which so many people are unhappy with their job situation?" He argues that the current economy actually contributes to destruction of value, either intentionally or unintentionally, among people who "act out" by lowering the quality of life for others.

Nordfors says that this positive shift (i.e., from a people-centered economy) would lead a workforce creating more than double as much value between each other, in other words at least a $100 trillion increase in GDP globally. If the commission for the tailored job (the service) is 20%, then the revenues would be $40 trillion. His slogan, then, is that "3 billion customers want a good job, but where are the entrepreneurs to offer them the service?"

Nordfors, along with Chally Grundwag and Nurit Yirmiya, submitted a National Science Foundation (NSF) proposal recently that has passed the first selection. Its primary concept is what the authors call "coolability," which refers to enhanced abilities within disabling conditions. A commonly used example for this concept would be someone on the autism spectrum disorder having other enhanced abilities, such as being extremely good at remembering detail. With this semantic innovation of coolability, Nordfors et al. believe that there is a significant market for unleashing these resources because people with autism spectrum disorder suffer from more than 50% unemployment, with those who are employed often earning very little and not being utilized to their maximum value of their enhanced abilities. The authors posit that if an innovative solution was developed that could solve enable these individuals to work without being hampered by their disability, it would be easier to raise them from $0 to $100,000/year than it would be to take someone on the commercial market (e.g., someone who is already an engineer) and raise them from $100,000 to $200,000/year. It should therefore be an attractive businesss opportunity for innovators to raise their value.

Using examples from their forthcoming, unpublished paper, Nordfors highlights three disorders: autism spectrum disorder, attention deficit hyperactivity disorder (ADHD), and dyslexia. He describes the difficulties of people living with these conditions (e.g., difficult social interaction, hyperactivity, difficulty reading) but then highlights their coolabilities and the careers that can fit within those traits. He stresses that this is a large untapped resource of millions of people who are willing to work but who, in the current task-centered economy, earn little to nothing in unfulfilling jobs. By using IT, AI, and other technologies, there is the potential to create an ecosystem that enhances and taps into the value of this enormous market.

In Nordfors et al.'s proposal to the NSF, the authors attempt to systematically map which coolabilities come with what disabilities. While this has been done, to a limited degree, for autism spectrum disorder, very little commensurate research has been done for other disabilities. Their proposal is for the development of a "coolability finder," that provides users access to a correlation database between coolabilities and disabilities in order to place the individual into a specific demographic. This same database can then be used by entrepreneurs who want to offer employment solutions to individuals in demographics that have skills that would add value to their business. In other words, employers can identify a special ability in which they see significant value, match and explore this ability in the database's demographic(s), and then work with the disabled individual to enhance both personal and corporate value. The entire system requires entrepreneurs seeking skills, "coolabled" people with profiles in the database, and then a matching system that connects entrepreneurs with the right coolabled customers who want to earn a living.

Nordfors et al. worked with President Pradeep Khosla at the University of California, San Diego, on the NSF proposal, as Khosla also sought to build an innovation ecosystem that aids in better connection within the community. The team is seeking to ultimately use San Diego as the pilot city for this innovation.

Summary

In reviewing these two economies' characteristics (both the positive and the negative), a few basic premises emerge. In a task-centered economy, market size is limited because people are encouraged to spend less; for example, this economy can't save more than GDP, because if the whole market is tapped then then nothing will cost anything and subsequently nobody will earn anything. This is similar to theories by economist Karl Marx, who predicted that automation would overtake all work and even the bourgeoisie (i.e., the class that Marx said "drives all innovation") would essentially put themselves out of work. He viewed this automation as a positive action for society because when people don't have to work they have more free time; ergo they would be happier and more likely to be good to one another. Nordfors, however, takes the contrary view to Marx and states that "people need to need each other" For example, if an economy is structured in such a way that people have no need to rely on one another, then why would people in that society be compelled to be kind to people that they don't know? A society requires that people can rely upon people they do not know or do not like. Contractual work and the labor market delivers that, by being each others contractors. The core concept of community is that people depend on each other.

A society happens when a cluster of people are bound by a network of personal commitments. It is a self-organizing, self-reinforcing network of commitments between individuals that shapes a common language for trust, ethics, law and practice in which each committed individual has a stake.

This common language is the basis for any economy, culture or society. Therefore, "everyone is a customer, nobody a worker" is a recipe for disaster, it will dissolve societies because the interpersonal commitments and thus the personal stakes evaporate. Joblessness and exclusion also threaten societies, for the same reason. But where "everyone is a customer and a worker," on the other hand, good societies evolve and prosper.

In the people-centered economy, there is no limit to growth, as people can become more valuable to each other on a continuous and increasing scale. The primary risk in this scenario, though, is inflation (i.e., if people earn more and more money, then they also need to create a commensurate level of additional value for each other; otherwise, you have inflation). The convergence, however, is not to a Marxist utopia but rather to continued stable exponential growth that keeps pace between value creation and quantitative inflation.

Another problem is that economics objectifies people. They are defined by their attributes, like gender, strength, health, skills, talents, education, professional experience, certifications, recommendations, nationality and so forth. They create value by operating on needs that also are defined by attributes. Their value is calculated in dollars. Economics does not measure the value of love and friendship, the contacts we call "Thou", which are the most important values in life, without which there would be no passion for raising families, leading to the continuation of our cultures, indeed our species. The difference between a "Thou" and an "It" is that it can not be exchanged or traded. "I can say 'Mr Painter, I have found another painter who will do a job more in my liking, so I am exchanging you'. I can not say 'My son, I have found another boy who performs better at school, so I am replacing you'." says Nordfors. In this example, the painter is an 'it', exchangeable, while the son is not. If the son is exchanged, he is treated like an object and becomes an "it".

Nordfors concludes his keynote speech that we need economics that can account for "thouness" so that we can create an economy where improving personal relationships is the meaning and relating to things and ideas, everything "it", provides the means. Today economists say "it is good that people raise families because it makes them earn and spend, driving the economy". Nordfors suggests we need economics that allows us to say, in mathematical language, "it is good that people work so that they can raise families". It makes a difference, because in the present economy, it is good if commuting distances increase, because it drives the creation of infrastructure and increases the GDP. But increased commuting distances will not improve personal relationships, it does not create more "Thouness" in the society.

He presents a simple illustration of a mathematical model for including "thou" in economics, suggesting that much of the counterintuitive results of contemporary economics, such as the GDP-driven incentive for increased commuting, will disappear.

Following Nordfors' presentation was a question and answer session. The exchanges have been edited for clarity.

Masahiro Kuroda:

Thank you very much. A very interesting presentation. I liked your framework of the market itself, but I would like to ask what you believe to be the role of government in policy.

David Nordfors:

Actually, we are going to have a meeting with i4j in Washington, DC, soon to discuss related ideas. One example of something that might be discussed is taking unemployment money and using that as a loan guarantee to match venture capital invested in companies like this, then you could see a venture capital market for innovation of jobs startups. If they succeed, the government actually doesn't need to spend any money, and if they fail, the private capital and government lose as much together, so it is an encouragement for private capital. These type of schemes work, but it is currently impossible to use any labor policy money for innovation. Even if engineers and companies say, "We want you to put more money into innovation because we can show that for every engineer we employ, we get 10 more jobs," which is a popular argument, it seems to fall on deaf ears. Labor economists don't really like the thought of using engineers as a basic unit for the labor market and that's understandable, but if you introduce the definition of a people-centered economy as I have done here, it's actually a safe bet, because then you have aligned incentives and no businessperson wants to do bad business. So, you just have to define the business that they invest in and find institutional private capital to match the government in order to keep pressure on the venture capitalists to stay on track when they seek investments.

Hiroto Yasuura:

You used GDP in your presentation, so will GDP still be a good indicator of the economy in the future?

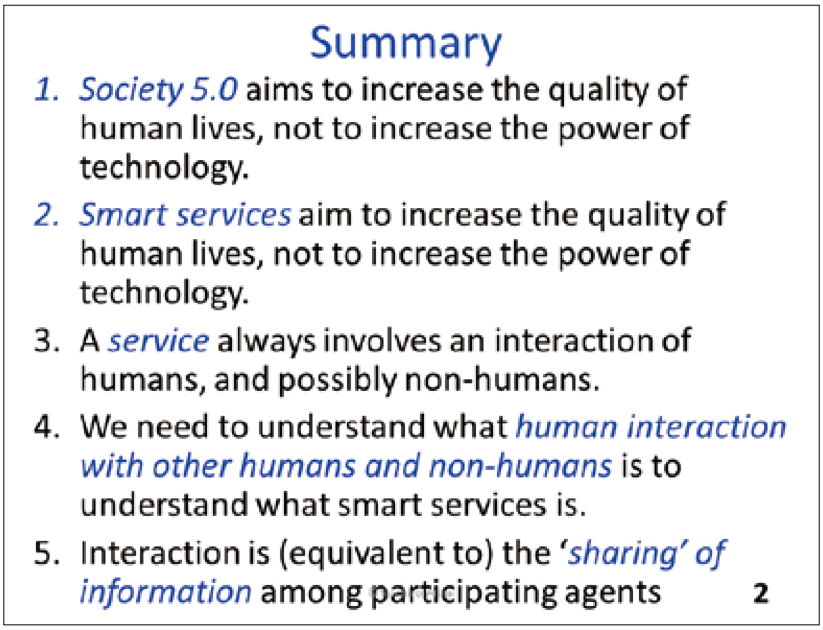
David Nordfors:

GDP is actually one of the good indicators, and reflects how much we spend on each other. But it is a failed indicator because it does not reveal anything about what it gives to us or our quality of life. It also does not take into consideration all the things that don't have a price; for example, good public healthcare. So, I think GDP was about as good as we could get in terms of my discussion. When Simon Kuznets introduced it first in 1937, he got the job from the U.S. Government to help avoid another Wall Street crash and depression. They didn't have any good indicators before that. And when he introduced it, he really warned people, he said, "Don't use this too much." But you know, when it is the only indicator you have and it works well, then everybody is going to optimize it. As such, we need to have more indicators. So, honestly, the problem with GDP is that it's too alone.

(2) What do We Need for Smart Service Society? Data Sharing, Organization, and Technology, Yuichiro Anzai, President, JSPS

The editor, not Yuichiro Anzai, is totally responsible for the quality of all the English trarslation except for the slides.

Professor Yuichiro Anzai, who works for Japan Society for the Promotion of Science (the largest research funding agency of Japanese government) spoke about the needs within a smart-service society, such as data sharing, organization, and technology, and also touched upon Society 5.0, and its aims to increase quality of life (rather than to increase only the power of technology), calling it the "fifth revolution" of mankind, following, for example, the agricultural and industrial revolutions, among others. He stated that a better understanding of human-human and human-nonhuman interaction is needed to fully develop smart services.



Smart services, he posits, also aims to increase the quality of human lives, not just to increase the power of technology, but that the "service" part is what still needs the most development. Some researchers are working on so-called service science or service engineering, wherein service always involves either a human-human interaction or human-nonhuman, such as with robotics. Almost any engineering systems involve human operators and human beings, and in that sense, human-machine interaction or human-environment interaction are evolving into the smart services space.

Anzai believes that "interaction" is the key word in understanding what smart services could be; however, interaction is a multi-layered concept, wherein human-human and human-machine/human-environment interaction include varied and evolving elements. He states that this type of research could fuel an agenda for next 10 to 20 years.

In his model, interaction is equivalent to the sharing of information among participating agents. This means that an interaction occurs and includes points of information-sharing among parties. Vice versa, if information sharing occurs then there must also be an interaction occurring.

6. We need to understand that information 'sharing' is physically impossible, and only possible by humans having their own goals, values, and inferential abilities for the society.
7. It is crucial to *design and develop communities, organizations, data-sharing frameworks, and technologies* that support participants of interactions to create their own goals, emotions, and knowledge, to acquire inferential abilities, and thus to 'share' information.
8. We need to understand that *data sharing* without incentives is not possible, and also that different people/areas have different incentives.

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Information sharing is not actually physically and, therefore, cannot be divided; as such, it is only possible by humans having their own goals, values, and inferential abilities for society. In other words, when humans share information with each other or with an autonomous robot, it is not a defined physical act of sharing (e.g., a physical object) because information cannot be divided by itself.

Anzai discussed how it is crucial to design and develop communities, organizations, data-sharing frameworks, and technologies that support participants of interactions to help them acquire inferential abilities (e.g., goals, emotions, and knowledge) in order to effectively share information. This suggests that people need a high level of these sophisticated inferential abilities in order to share information effectively either with other humans or non-human objects.

He also theorizes that data sharing without incentives is not possible, as data has a value; to complicate matters, different people and different research areas have different incentive requirements. Working for the Japan Society for the Promotion of Science, Anzai has seen firsthand how different fields, such as biology and physics, are very different in the sense of incentives for providing data to the public. Biology is very conservative due to the field being very competitive, and then physics is different from astronomy and mathematics and so on.

Anzai also shared with attendees illustrations such as a human-computer dialog system using Japanese language and facial expressions, the latter of which can be controlled and changed according to the content of the dialog and linguistic meanings. Though the illustrations were created 30 years ago, the concept of linking facial expressions with linguistic utterances and meanings, and being able to phase changes, is still a dynamic aspect of the dialog process (e.g., how users of the system can feel that they share information with that system [or with a person] and the computer). He also shared photos from the first exhibition in Japan, which occurred in 2000, for partner robots and human-robot interaction, developed by Norihiro Hagita, among others. These illustrate how humans can share information with robots; while they cannot do it physically, this research explores how they feel when they share information.

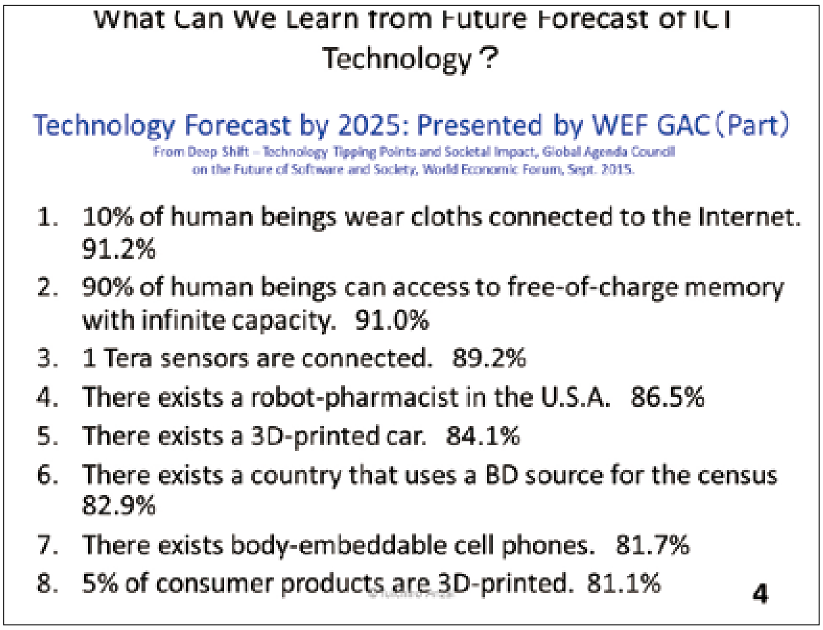
Also on display was a two-frame picture taken at ATR Laboratory in Kyoto, Japan, of early AI research, first showing two persons talking together as then one robot and one human talking to each other. The robot shown is primitive but autonomous and was created in 2004. Additionally, he shared a video borrowed from Norihiro Hagita showing a demonstration between a human and robot for the purposes of dialoging, wherein the human returns to a frequented supermarket and the robot remembers those occurrences; as such, the robot can talk to the human by recalling their mutual experiences and meetings from days, weeks, or even months ago.

Anzai also spoke to expanded uses of AI and information sharing between humans and robots by using examples such as a patient with dementia being assisted by a robot to help stand up from a wheelchair (i.e., a ubiquitous, empathetic interaction). Another example used was that "a book is just a book" until it is enhanced with AI, allowing a person to talk with the book out of social interest. He distinguishes emotional interaction from empathic interaction, in that an emotional interaction means that the parties can share emotional information with each other but their attention (i.e., empathy, intellect) is elsewhere.

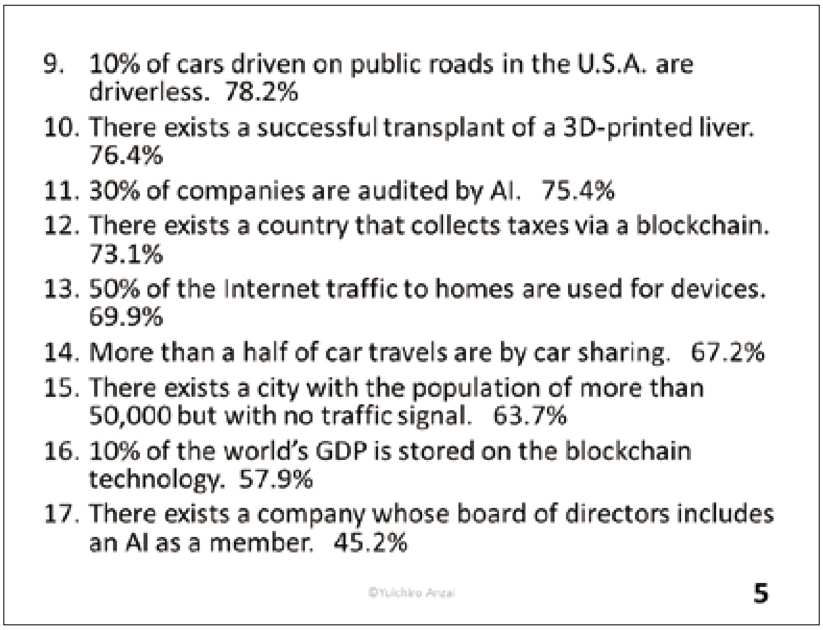
In Society 5.0 and Smart-Service society, however, researchers are talking about human society in which all people need to share information. He compares a scene from Manhattan, New York, and Kasumigaseki, Tokyo, to exemplify information-sharing problems domestically in Japan, supporting the images with an example of a divorced family in which responsibilities for home (the mother), work (father), and education (children) are separated in the new living situation. Anzai believes that this separation and resulting negative effects on information sharing are leading to a decrease in population among the younger generation.

As such, what kinds of AI-related technologies may be useful for supporting human interaction with other agents? First, social infrastructures for safety and comfortable work environments, as well as opportunities like mobility (e.g., automated vehicles for patients and elderly) and other enhancements for safe, smooth, and comfortable interaction.

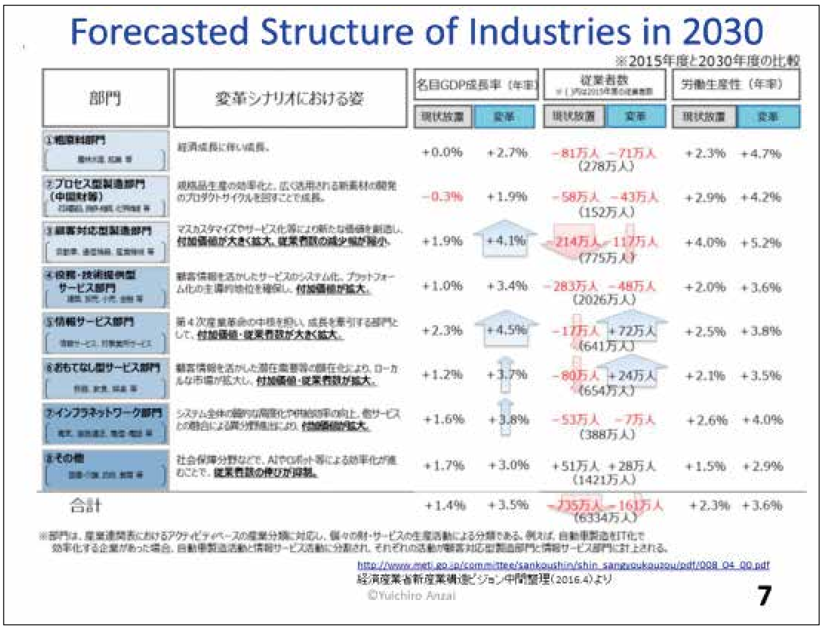
Second, technologies that enable humans to efficiently retrieve conceptual information from episodic documents such as long videos tapes and other meta would enhance interaction; and third, assistance in producing appropriate linguistic and non-linguistic messages at specific times in within unique contexts. Both of these suggestions are, however, not possible with current AI technology. On a more intrapersonal level, technologies that would enable people to manipulate multiple goals or views related to tasks, rather than the current limitations of the human mind, which prefers to recall one way of doing a task and is, in general, too rigid. Cognitive science has structured a research field called "theory of the mind" that could aid in constructing advanced theoretical models of technology that could help improve the human mind, such as being able to read or infer our actions, intentions, desires, goals, and knowledge. There is, however, a fine line to walk between creating the ideal artificial human mind and furthering that agenda as a whole, and balancing ethical, legal, and social issues.

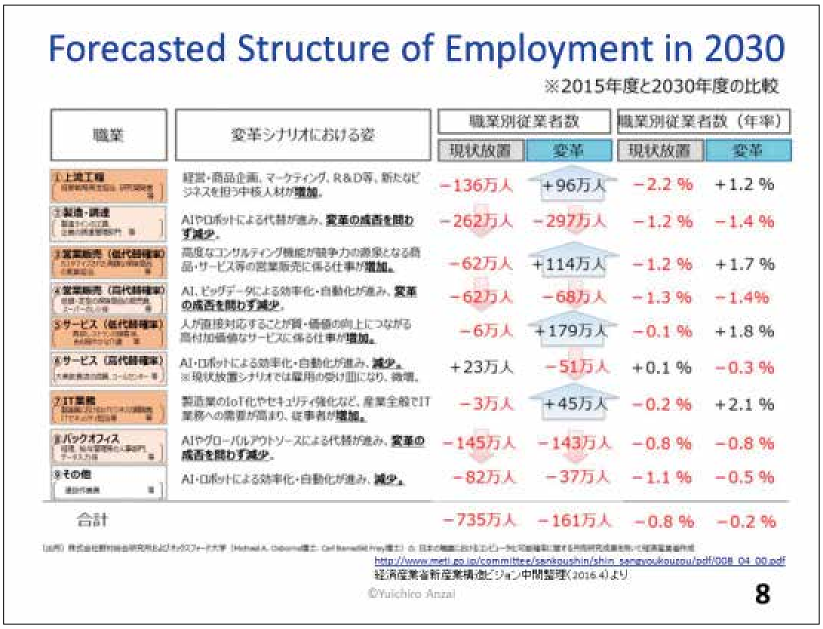


Following his discussion on the concepts of interaction and information-sharing, Anzai delves into future forecasts of ICT technology, using primarily a forecast through 2025 as an example, which was done the Global Agenda Council (GAC) for Software & Society at the World Economic Forum (WEF), or Davos Conference. The GAC for Software & Society group forecasted that by 2025, 10% of people will wear clothing items that are connected to the Internet and that 90% of human beings will be able to access free-of-charge memory via infinite capacity in the cloud, using 1-terabyte sensors as the standard for connection to the Internet and IoT. He then spoke to a colorful graphic for attendees, illustrating the proliferation of technologies such as driverless cars, 3-D printing, and large cities with no need for traffic signals (the latter of which the GAC forecast above predicted could occur with a 64% likelihood by 2025).

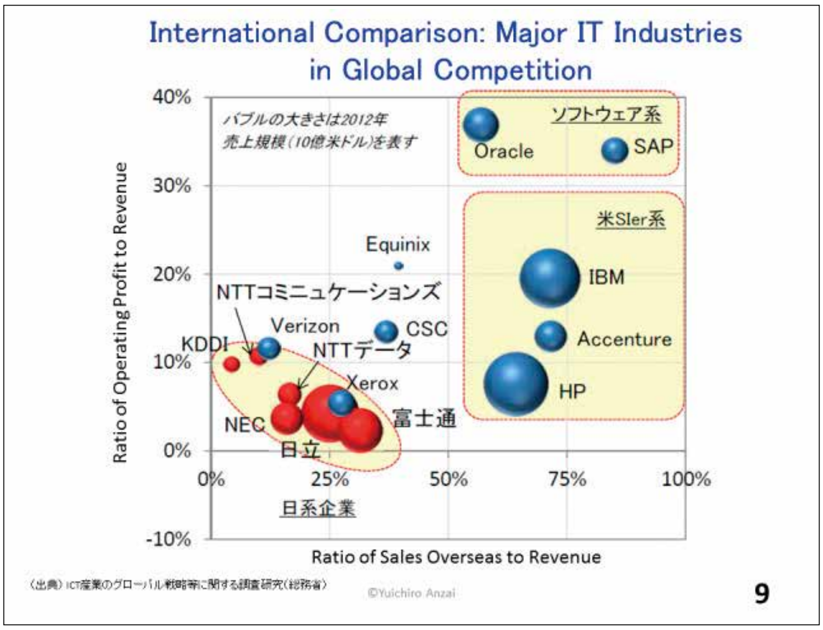


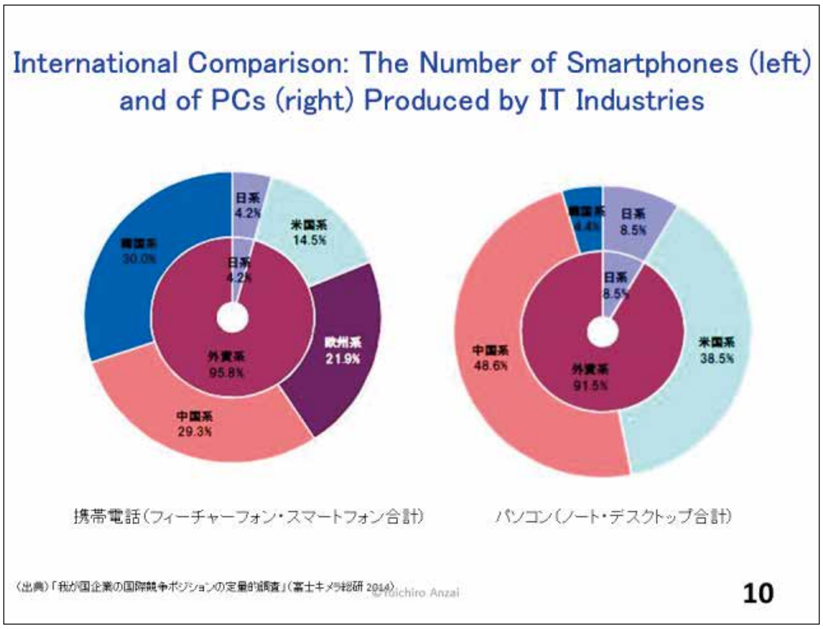
Anzai began to wrap up his presentation with a discussion of what we can learn from AI, BD, and IoT technologies, as well as their related past and present trends. For example, technology (at least in the near future) must align with human-computer interaction, algorithms, big data technology, data administration, security, and human resource development. He used examples from Google, GPU parallel architecture, and other recent research as examples.



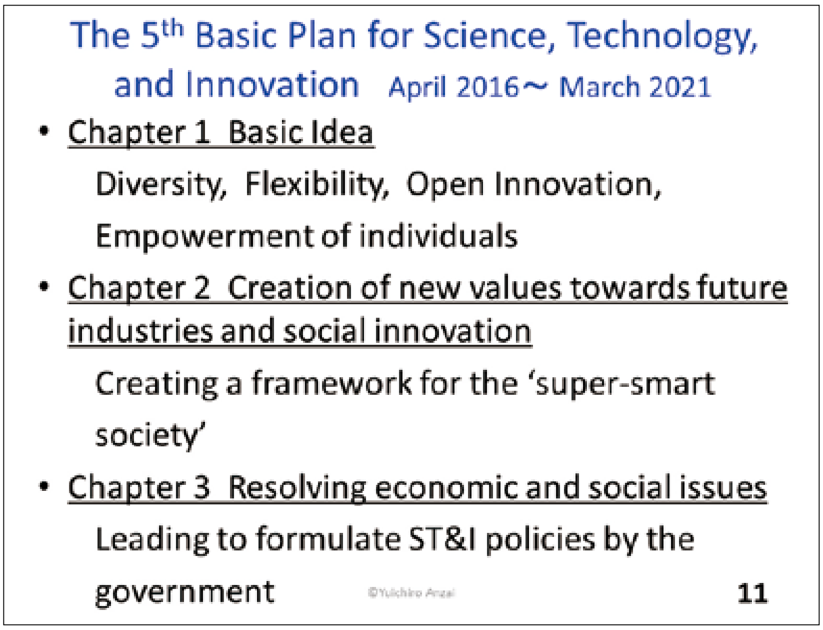


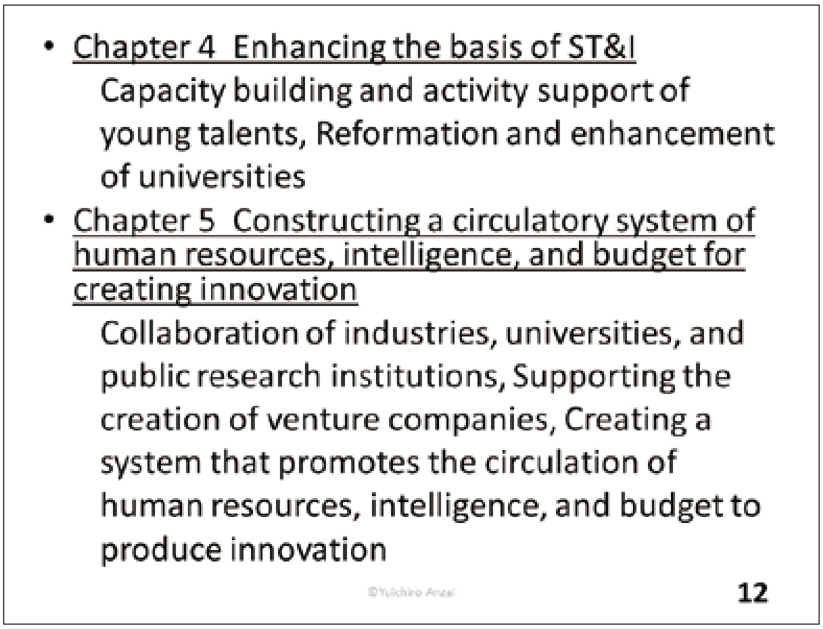
In Japan at least, according to Anzai, the structure of industries will change; in tandem, so will the structure of employment, job markets in general, thus creating a smart-service society. On the company level in Japan, Hitachi, NEC, Fujitsu, NTT Data, and NTT Communication may consider becoming more global, and will need to collaborate with scientists and researchers to help them forge the best path forward.





For PCs and devices such as smartphones, smart-service technology is likely to affect the next generation of devices and next-gen product innovation overall.





With regard to Society 5.0, Anzai asks how we can open up the prescribed agenda of diversity, flexibility, open innovation, and empowerment of individuals to include a culture shift within Japanese companies toward innovative culture. In this way, it would be a more comprehensive plan to reform the economy, the employment system, society, and education.

Crucial Domestic Issues

1. 【Reviving the Economy】 From 'goods' to 'knowledge'
2. 【Reforming the Employment System】 From 'life-time one-company employment' to flexible employment
3. 【Reforming the Society】 From the society with the 'triangular spiral' of Work (Father), Home (Mother), and Education (Children) to to the society of flexible balancing of individuals, families, and communities
4. 【Reforming the Education】 From the education that has supported the industrial society to the education for autonomy, diversity, and collaborativity
5. 【Society 5.0】 From the rigidly bound industrial society to the person-to-person-communication-based information society to the society with activity-based flexibly interconnected society (Diversity, Flexibility, Open Innovation, Smooth circulation, Promotion of Human-Oriented Science and Technology)
6. 【'Sharing' the Zeitgeist】

 13

Issues on R&D

1. 【Finding Goals in the Society】
2. 【Win-win's for University-Industry Relations】
3. 【Not sticking to already established technology】
4. 【Open Innovation】
5. 【Deregulation of rules and systems】

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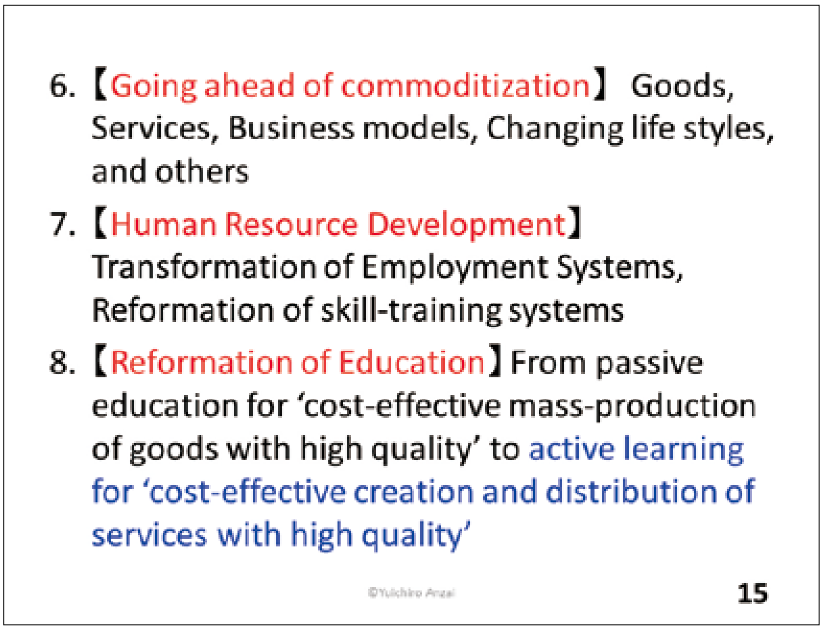
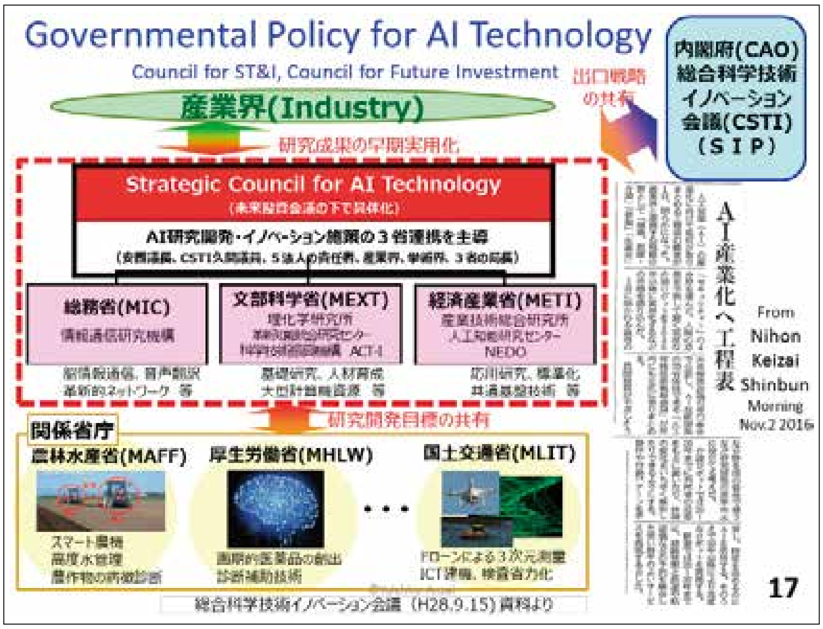


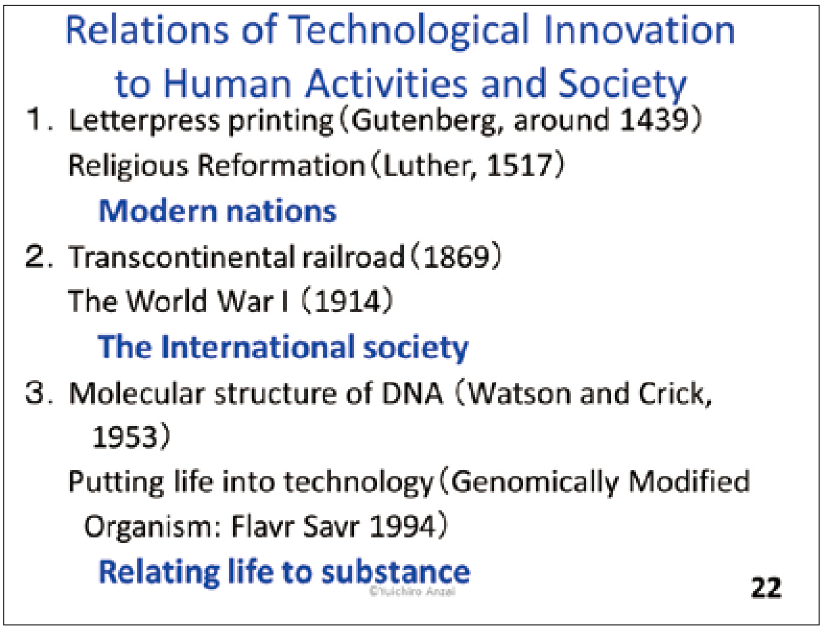
There are also issues related to R&D that Anzai believes should be included; for example, thinking outside of the confines of commoditization, as many devices and products in Japan get commoditized quickly, as has the information retrieval business, which resulted in the rise of AI has come out. While AI has not yet become commoditized, Anzai believes that we need to think deeply about how we rise above the current trend of strict commoditization. In thinking further about R&D toward a smart-service society and Society 5.0 (e.g., strategy, systems design and management, human resource development and management) companies as well as governmental organizations will likely need to add the position of Chief Digital Officer (CDO) who is not only responsible for technology itself but also for organizational and employment design and strategies based on digital technologies; in particular, data sharing.

Within the realm of human resource development, he stresses the importance of active learning—which is a departure from the current state of passive education—for cost-effective mass production of high-quality goods as well as the creation and distribution of high-quality services.



The problem for Japan currently, according to Anzai, is that even within just one company people cannot easily or freely share data, particularly in government. However, the country does have a significant governmental policy for AI technology.

Anzai began to wrap up his presentation by noting some key global and social issues at the background of a smart-service society, such as democracy and capitalism, income bipolarization, and real estate/housing. A sub-layer to these, however, are domestic issues such as work, home, family, and education, which (as noted in the divorced family scenario) becoming increasingly separated. How to form all of this together to make a new society is a priority for Japanese people. As such, human-human interaction and information sharing is not only important for innovation of technology (and, thereby, human-machine interaction), but also important for general societal change and the ushering in of a new era.



4. Digital packet communication technology (ARPA-Net) (1969)
- The rise of global enterprises (1970s～)
- Plaza Accord (1985)
- The Fall of the Berlin Wall (1989)
- Commercialization of the Internet (≒1995)
- Distribution of digital cell phones (≒1995)
- Collapsing of the after-the-war order of the international society (1990s)

The Global Society

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He stresses that technological innovation's relationship to human activities and society is strongly correlated, based on the former's historical timeline. For example, modern nations' acceptance of a global or international society only just began to be mainstream a couple of years ago, but its seed was planted during the 1960s and 1970s with the rise of global enterprise such as oil and manufacturing.

5. Penetration of the values of 'information'

Multi-regional society, ICT-based society (≒1995～)
- Booming up of the digital technology (Networks, Clouds, Sensors, Robotics, EER technologies, Gene manipulation technology, etc.)
- AI, Big data, IoT, Cyber-security
- Values of resources and data
- Transformation of industrial and employment structures
- Social instability by the combination of ICT with extreme activities (2000s), and capitalism (2008)

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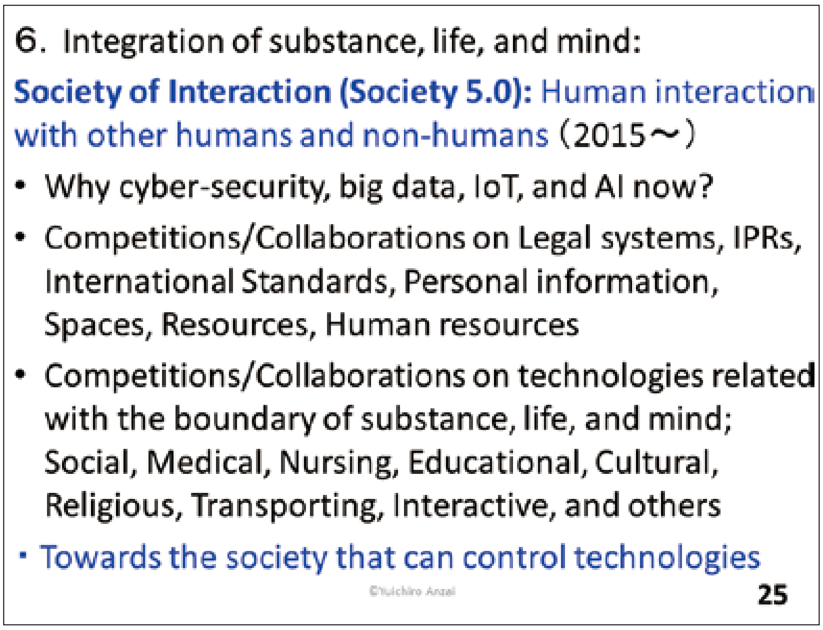
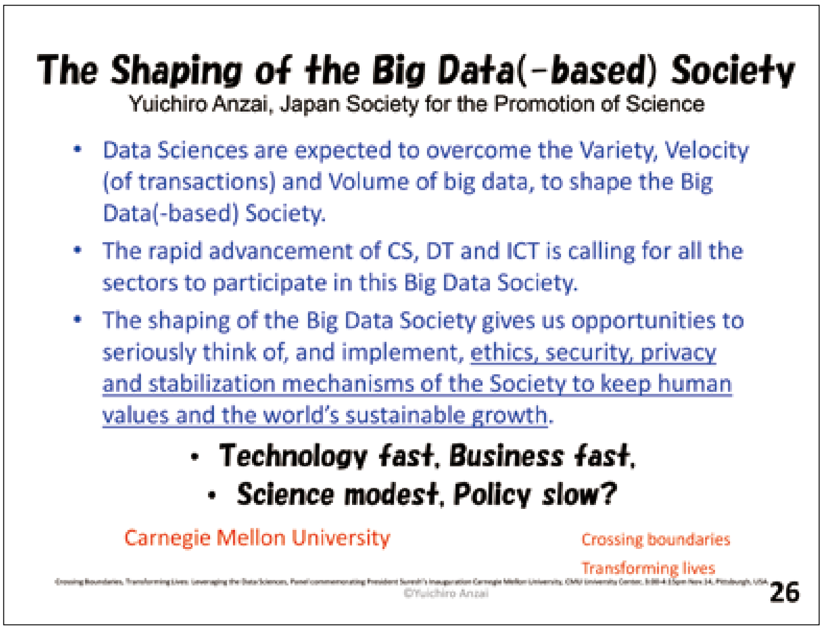


Multi-regional societies, such as China–EU and Britain–America–Russia, as well as an ICT-based society and a society of the future based on interaction, are at the forefront of the Society 5.0 agenda. Regardless of what types of societies are most likely to emerge, building up technology to support human interaction with other humans and with other non-humans will be key.



Before concluding, Anzai briefly refers to one of his previous talks at Carnegie Mellon University, which traced the shaping of the Big Data–based society. In this society, technology and business are fast-paced, science is modest, but policy does not share the same pace. Making policy speedy, and implementing ethics, security, privacy, and stabilization mechanisms in the society to retain human values and maintain sustainable growth is of utmost importance. Also of importance is how to combine and word around issues in the arena of home, work, and education.

4. Vision Session

Yassi Moghaddam:

During her premier visit to Japan, Yassi Moghaddam, Executive Director of International Society of Service Innovation Professionals, moderated the vision session of the summit, first reiterating the vision of Society 5.0, one of a "super-smart society that the government of Japan … is investing tremendously," with goals for 2020 and beyond. The impact of this investment is expected to touch every service sector and impact all citizens for the better, with heavy emphasis on technology (particularly AI, IoT, and other advanced technologies).

Echoing Kazuo Iwano's opening remarks for the summit, Moghaddam believes that technology alone will not create a super-smart society; rather, it will be the people in that society—who value each other—that will establish what she calls "this very intriguing model," which is why, in the vision of Society 5.0, there is the concept of smart-service system platform enabled by technology, but ultimately empowered by people who will work with others as well as with machines to co-create value together and co-elevate society (and its services). However, there are ethical, legal, and societal challenges in achieving Society 5.0, and one of the things that Moghaddam discusses is related to technological innovations and the legal and societal policy issues "guideposts" on the horizon, by which the future will be designed.

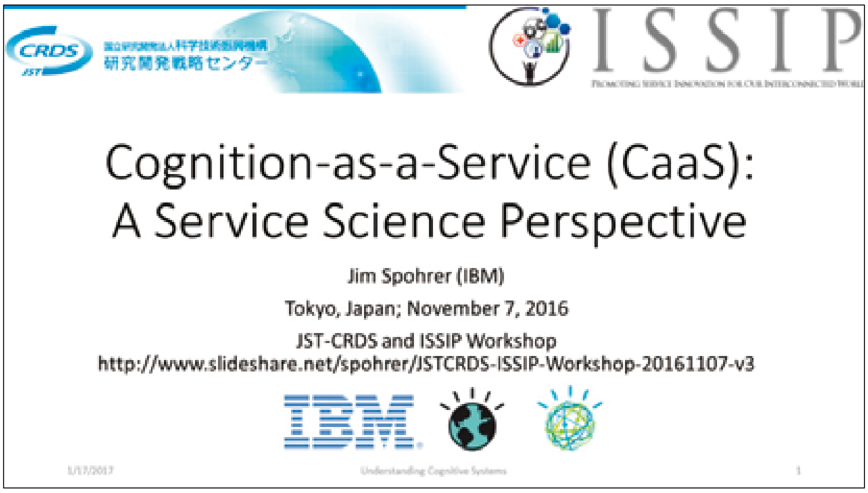
Moghaddam represents an organization called The International Society of Service Innovation Professionals (ISSIP, of which Iwano is a board member), an association that focuses on promoting smart-service systems and helping professionals to be more prepared and innovative for future jobs. She calls these people "T-shaped professionals," or those who are experts in at least one area (i.e., the stem of the T) but who also have the skills to go abroad (i.e., the top of the T). She states that her organization also includes and values emotional intelligence and empathy, and how, in the age of artificial intelligence, we can grow our humanity as well.

Before concluding, she highlights several goals of the day's summit, such as to produce a report that captures the tone and messages communicated throughout the program, as well as to publish a booklet through partner Business Expert Press and eventually a longer work through Cambridge Press. She then introduced the distinguished panelists such as Dr. Spohrer, Director of Understanding Cognitive Systems, who spoke at the summit about cognition as a service; Dr. Hiroto Yasuura, who spoke about the future of education; and Dr. Daniel McDuff, who shared his research on artificial emotional intelligence.

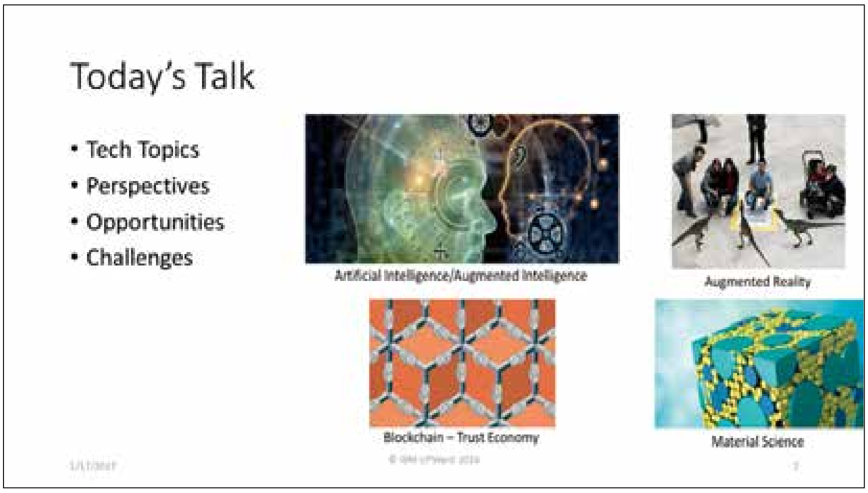
(1) Cognition as a Service: An Industry Perspective, Jim Spohrer, Director, Understanding Cognitive Systems, IBM Research

Dr. Spohrer began by stressing that his perspective at the summit is partly from his experience at IBM, partly from the perspective of the United States, partly from ISSIP, and heavily influenced by current research at the National Science Foundation (which has been a forerunner in research on smart service systems).

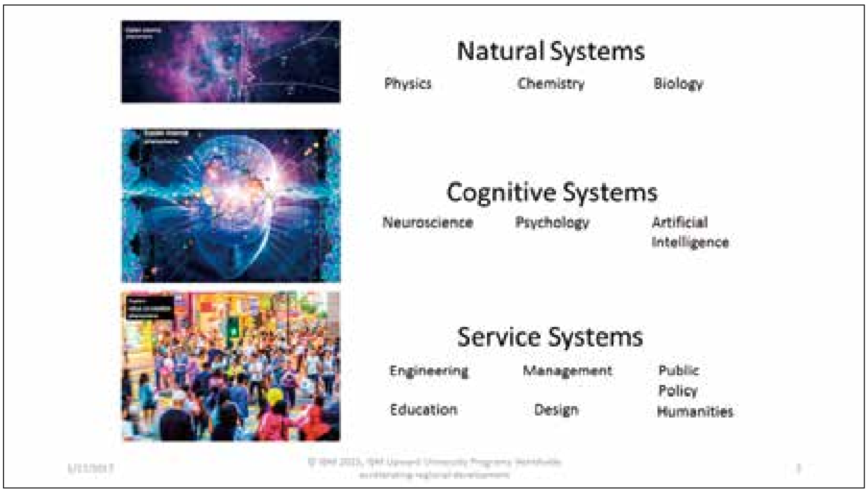
Spohrer believes that universities and industry in the US are working together better than ever to create smart-service systems, with the goal of moving away from GDP as the definitive measure of quality of life in the future.



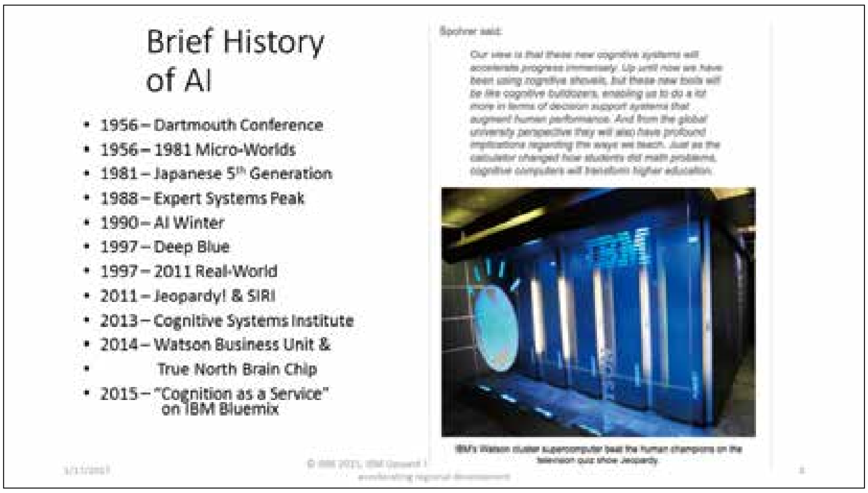
Spohrer's speech focused on technology topics such as cognitive computing and artificial intelligence, which he believes are strongly interlinked. Artificial intelligence focuses on smart machines and the cognitive science/intelligence augmentation comes into play because the goal is also to have smarter people, at which point he referenced the "T-shaped people" that Moghaddam described.



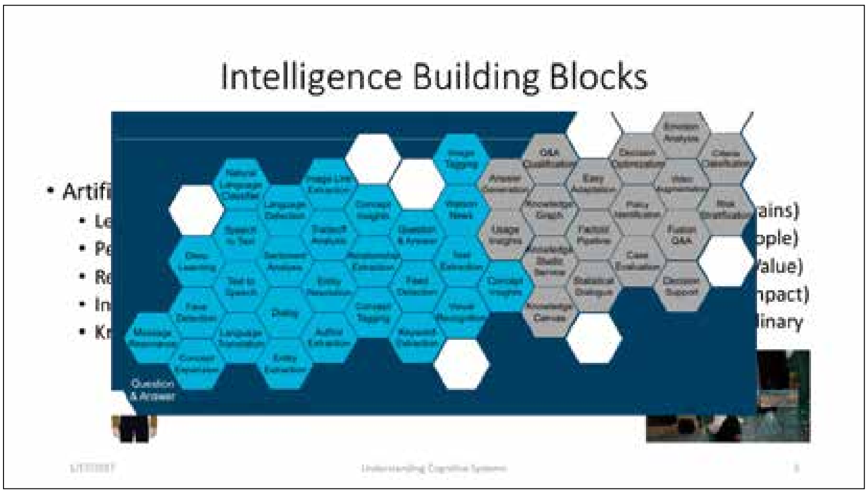
Augmented reality was the common theme that linked the different types of technology on which Spohrer focused during his time at the summit; for example, breakthroughs in blockchain for a trust economy, a crypto ledger that makes certain transactions auditable, and advances in material science. He stated that these four technologies are of great interest to IBM as well as other companies, as all four are predicted to influence the creation of entirely new industries over the next 10 years. In his focus on cognition as a service, he sees a wide variety of opportunities for value creation.



When visualizing the harmonization of science and the future of society, there are multiple components, such as the natural systems (e.g., physics, chemistry, biology), the cognitive systems (e.g., neurosciences, psychology, and artificial intelligence) and the service systems, which span engineering, management, public policy, education, design and the humanities. These three types of systems would benefit from a deeper level of scientific study as we move toward Society 5.0, with collaborative and overlapping efforts regarding smart service systems by industry and university players working together as well as behavioral scientists and economists working more closely with engineers and computer scientists. “Testbeds” will also be a key component to advance the scientific study of service systems, as there will need to be controlled places in which technology experiments can take place that have set policies and governance oversight. Paul Romer, Chief Economist of the World Bank, has called city-scale testbeds “Chartered Cities.” Entrepreneurs in California, USA have created a startup call “Blue Seed” to establish testbeds on ships anchored off the coasts of major metropolitan areas.

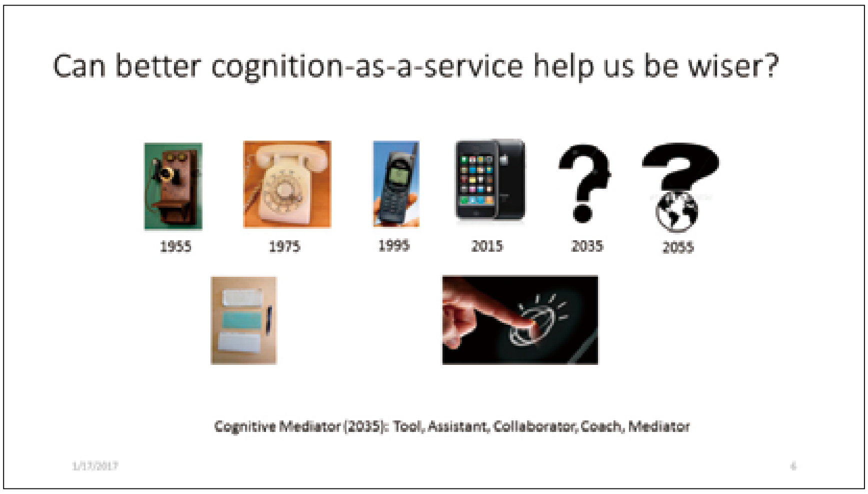


Spohrer provided attendees with a brief history of artificial intelligence, which has had ups (called “AI springs,” when everyone is excited about artificial intelligence, and investments flow more easily) and downs (when setbacks occur and people realize how complex and difficult AI is proving to be; funding also tends to dry up during these “lows”). Spohrer was born in 1956, the year that the Dartmouth Conference began discussing artificial intelligence, and was graduate student in AI during the 1980s at Yale University, so he has been connected to the industry (e.g., Verbex, machine learning, Apple, intelligent tutoring systems, and IBM, smart service systems) and passionate about AI for many decades.



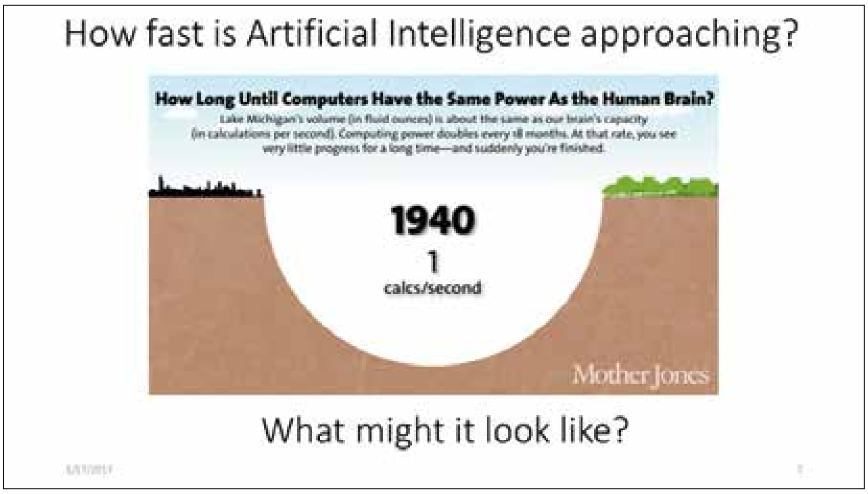
One of his premier graphics during the presentation was a structure of "intelligence building blocks," on which he and his colleagues at IBM collaborated to illustrate a new, next-generation, interdisciplinary cognitive curriculum that not only includes AI, but also learning perception, reasoning, interaction by conversation, and knowledge. This new curriculum includes augmented intelligence because it stresses the importance of studying the science of the brain as well as psychology and how cognitive systems can be designed to consider people as well as business values as well as the societal impact. IBM helped to establish the Partnership for AI to address ethical AI with Facebook, Google/DeepMinds, Microsoft, and other vendors.

IBM, which is transforming to a cognitive solutions and cloud platform company, has taken the Watson application program interfaces (APIs) and made them freely available to faculty and students around the world, enabling them to access next-generation computing capabilities. IBM established the Cognitive Systems Institute Group, and a weekly speaker series that shares best practices, including some talks on universities such as Dartmouth and their cognitive computing courses (see https://www.youtube.com/watch?v=UMZ_3cADWE0).

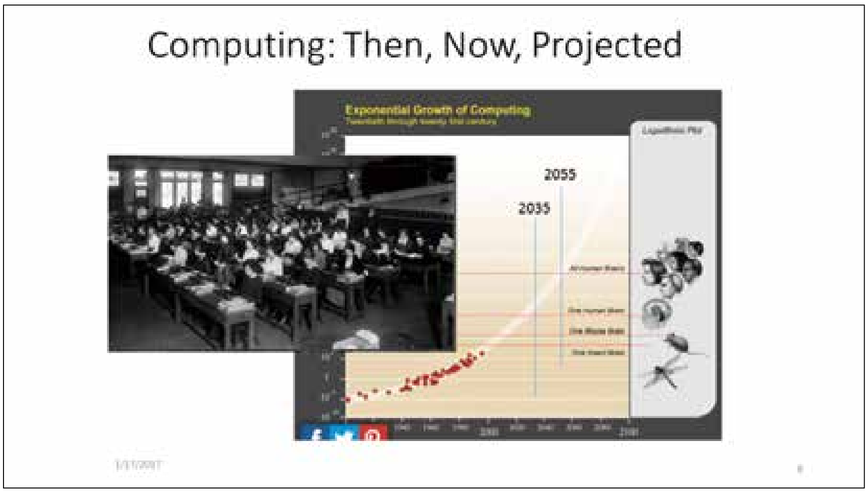


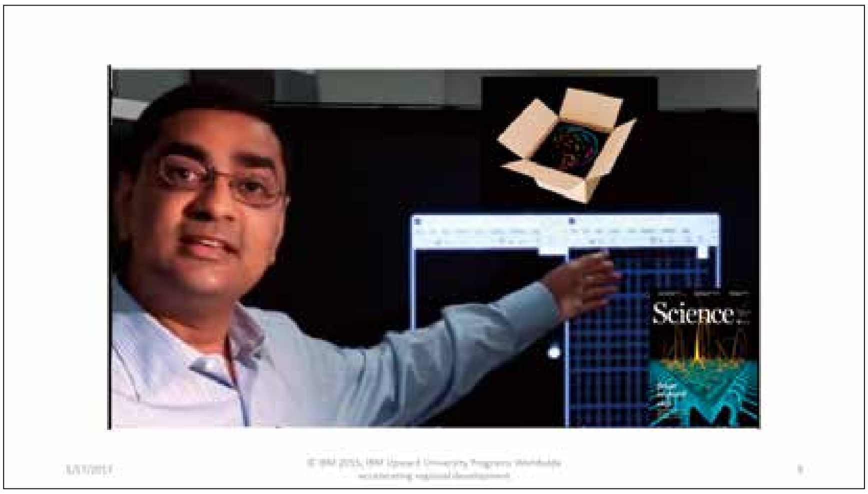
Spohrer uses his own personal analogy for technological advancement through the changing telephones he has had through childhood to the present, from a "party line" telephone made of wood in his rural childhood home in a farmhouse in the State of Maine to a rotary-dial phone in his dorm room at MIT in the 1970s, to his first cell phone in the 1990s in Silicon Valley and finally his current smartphone. He asked the attendees to imagine what phones will be like in 2035. And what about in 2055?

The building blocks today of which Spohrer speaks are quite powerful, and students who are willing to embrace these new technologies and innovate new solutions have tremendous opportunity that was not available to researchers and scientists even 30–40 years ago. For example, Spohrer mentored a high school student once who expressed his desire to "invent something great for the future," and then three months later announced that he won $20,000 at a "hackathon" for developing a startup idea that used advanced building blocks of IBM Watson (see http://www.mercurynews.com/2016/08/04/cupertino-teens-score-20000-for-24-hours-of-work/).

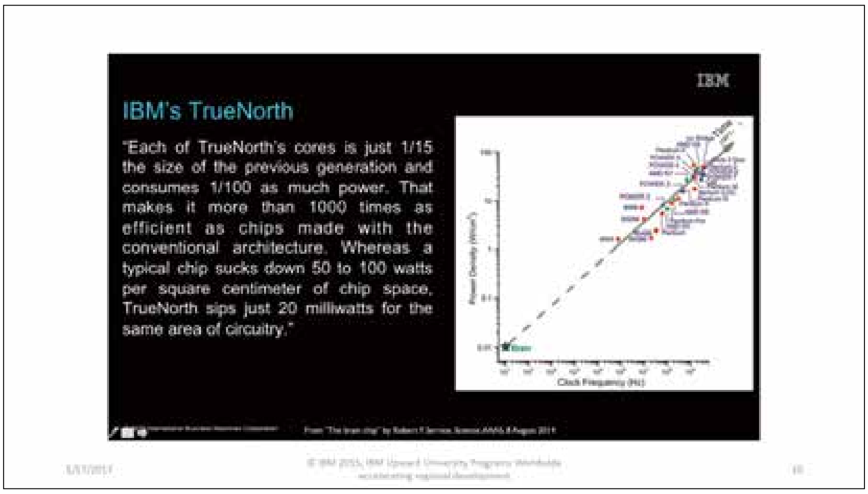


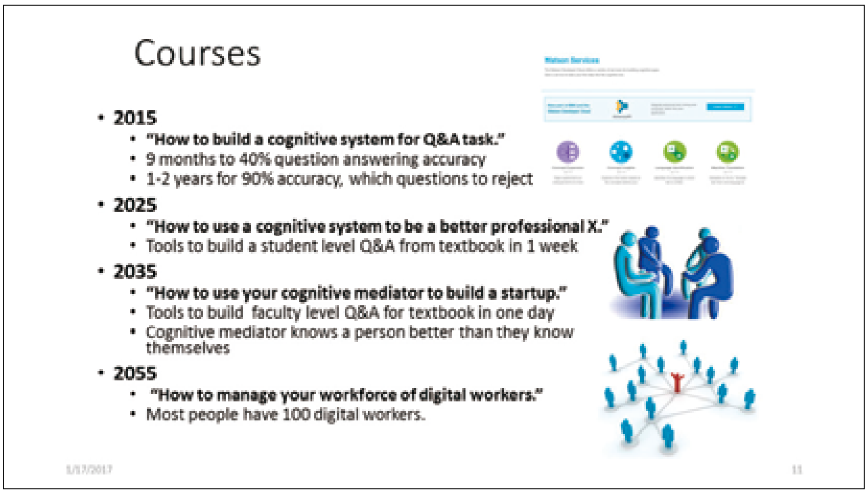
There are, however, challenges, such as the current lack of knowledge about how to think exponentially; for example, by 2025, we will have an Exascale (i.e., a computer capable of performing a billion billion calculations per second, or 10 followed by 18 zeroes, equal to a lower estimate of the human brain's computing capacity), though that theory only became plausible in 2015, and by 2035 an Exascale will only cost $1,000. Spohrer uses a chart to illustrate the curve of computing innovations and progression.





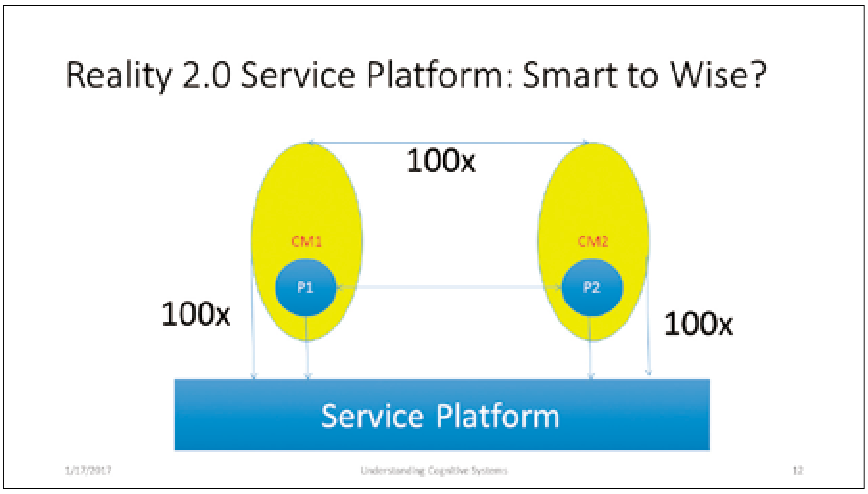
Spohrer also discusses a colleague at IBM Research – Almaden laboratory in San Jose, California, Dharmendra Modha, who invented the TrueNorth chip, which is a low-power chip they deemed "the brain chip." It actually uses less advanced silicon technology than other advanced chips because it has to be so low power. Modha first told the idea for the chip to Spohrer in 2008, describing it as "a chip that operates more like the human brain than conventional architectures." Then, on September 7th, 2014, after just six years from dreaming about the innovation, his chip was on the front cover of Science magazine (see http://science.sciencemag.org/content/345/6197/668).





What IBM foresees from making its Watson APIs available in the cloud, is that students and faculty will be able to build a Question Answering System (e.g., for a textbook), though he does state that it will be a challenging road, taking as long as two years to assemble the data and develop a reliable system. By 2025, though, he expects that it will only take two days to build a Question Answering System due to continuous advances.

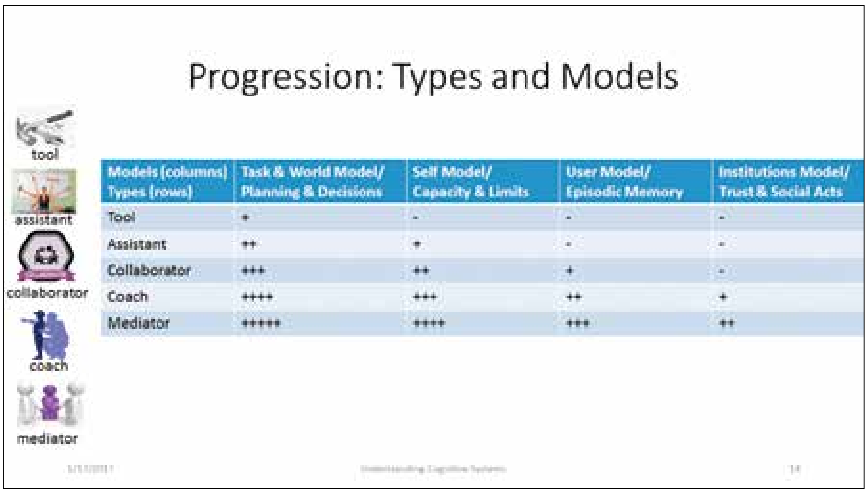
He references how Garry Kasparov was humbled when a computer beat him in chess and when Ken Jennings was humbled when a computer beat him on Jeopardy! to have the attendees imagine how a faculty will feel humble in 2025 when a computer can answer more questions accurately in the textbook than the faculty who wrote the book. By 2025, then, we would be teaching classes on how to build and work with “cognitive assistants” to be a better professional (e.g., doctors, lawyers), and by 2035, classes will be taught on how to use one’s “cognitive mediator” to build better startups. By 2055, companies might be learning how to manage their workforce of “digital cognitive workers,” which could be commonplace at that time.



The industry has been theorizing about this world of 2035 because the underlying prediction is that most people will have “cognitive mediators” by that time that know their people very well and that can communicate 100 times faster than people. For example, if Spohrer and a colleague are talking so many words per minute, their cognitive mediators would simultaneously be looking at hundreds of opportunities for the two individuals to collaborate and co-create value together. This ties into the people-centered economy that Nordfors was talking about, and the matching that will be possible to help each other and (i.e., “need each other more”), which will be facilitated by these cognitive mediators. (Note: Spohrer wrote a chapter in Nordfors’ new book, The Innovation For Jobs, about cognitive mediators as a way to innovate for jobs.)

The next part of his presentation presents challenges but also opportunities for moving forward on the technological innovation curve. He states: “The best way to predict the future is to inspire the next generation of students to build it better.” By 2035, Spohrer predicts that the following will be commonplace realities: self-driving cars, city-wide mandatory water recycling (as in Singapore already), local rather than overseas manufacturing due to robotics and 3-D printing and plasma recycling systems, “artificial leaf” energy that is broadly available, faster construction of building that include advanced materials for safety, energy, and healthier living, and a variety of smart information communication technology for telepresence visitors to arrive and depart. In addition, retail will be social and finance will be crowdfunded, thanks to a people-centered economy. He also predicts specific advancements in healthcare, such as robotic surgery and 3D printed organs, and education, to create the aforementioned “T-shaped people” who know how to work together to create startups across multiple disciplines. Education should inspire teams of T-shaped students to tackle problems that have not yet been solved. Spohrer says that “education will look much more like competitive, team-based sports.” Even government will work better by 2035, adopting principles of improve-weakest-link strategies as exemplified by the National Football League (NFL) Draft System in the

USA, in which the best college players are payed the most when they work for the teams that lost the most games in the previous year. This type of draft system for the flow of top talent increases "competitive parity," so it becomes more difficult to predict next year's winning team, and makes the NFL competition more enjoyable for fans rooting for their team to win. Spohrer predicts that game theory, mechanism design, and public policy will converge in smarter service systems of the future by 2035.

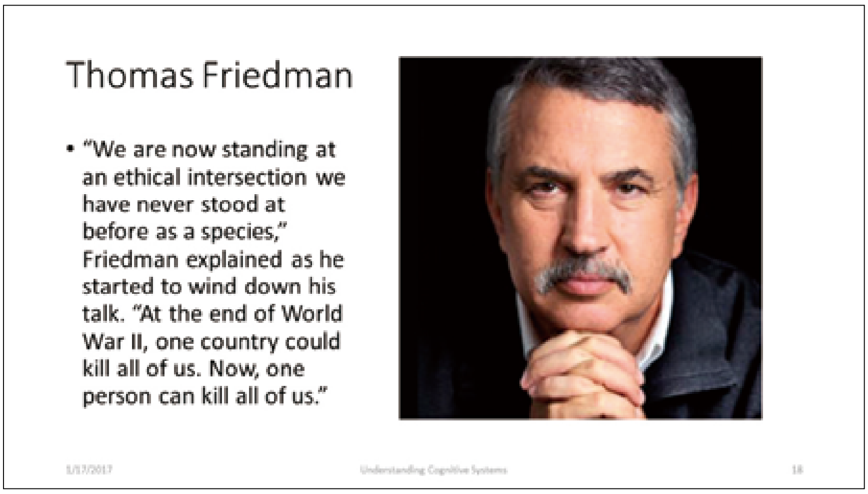


Models (columns) Types (rows)	Task & World Model/ Planning & Decisions	Self Model/ Capacity & Limits	User Model/ Episodic Memory	Institutions Model/ Trust & Social Acts
Tool	+	-	-	-
Assistant	++	+	-	-
Collaborator	+++	++	+	-
Coach	++++	+++	++	+
Mediator	+++++	++++	+++	++

At IBM in January 2016, CEO Ginni Rometty challenged employees to think about the cognitive systems that they need to do their jobs better. As a result, more than 2,000 projects were created, based on a provided investment budget for those projects that employees thought would be best. Some of the top projects garnered together more than $10 million of investment. Continuing on the theme of cognitive systems, Spohrer analyzed each of the top 500 cognitive systems and identified five types: (1) cognitive tool, (2) cognitive assistant, (3) cognitive collaborator, (4) cognitive coach, and (5) cognitive mediator. Within these five types are different models required for each, from simple world models of tasks to more complex social models of others to very complex models of institutions and laws of society.

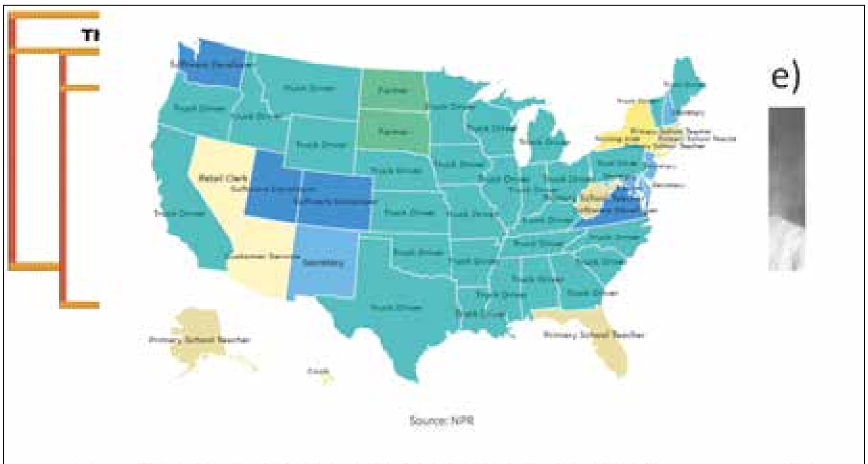
He also discussed the “10 million minutes of experience” that everyone goes through from babyhood to becoming an adult (i.e., that timeframe is considered “10 million minutes” or about 500,000 minutes per year for 20 years). To become an expert chess player or piano player requires 2 million minutes of experience, for example, but how did people gather this data?

At MIT, Roy Deb recorded the first three years of his child's life with high-quality cameras (videos and stills), capturing moments such as when his son first said the word "water" in the bathtub and every minute of experience up to that point. However, Deb has not yet released the data behind the experiment because his son is not 18 years old and he believes his son "owns" that data. As such, when his son turns 18, he will decide if he is willing to sign it over for science. Spohrer uses this example because software and machine learning systems will essentially "ingest" our human experience; it will "digest" the past and transform it into data that we hope can help shape the future.



Spohrer quotes Thomas Friedman from his talk at the World of Watson in Las Vegas just before this current summit as saying: "We are now standing at an ethical intersection we have never stood at before as a species. At the end of World War II, one country could kill all of us with nuclear bombs, now one person can kill all of us." As we increase these capabilities, what used to take the power of a nation can now be done by a person; for example, for $30 you can buy a book called Do-It-Yourself: Satellites. As such, the artificial intelligence that is augmenting our intelligence is giving us enhanced abilities; however, do we have the wisdom to use these abilities effectively?

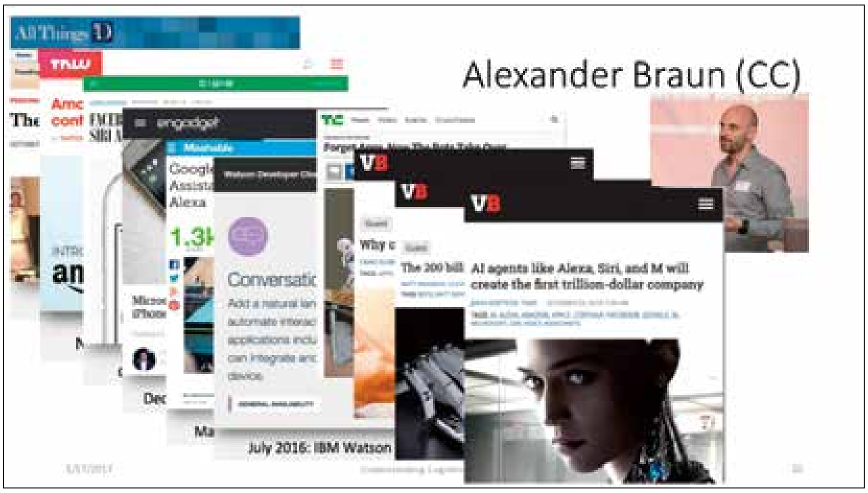
He also expands on a video by Moshe Vardi (from Rice University) that talks about the “great de-coupling.” For most of US history, the GDP, people’s jobs, and middle-class incomes all were coupled and all grew together. Now, however, they are de-coupling, where GDP is still growing but middle-class incomes are not, and jobs are not growing, which is increasing inequality. This is problematic, because based on historical data, the more unequal a society is, the more slowly its economy will grow. This relates to the “competitive parity” issue that Spohrer highlighted in his vision of 2035. Job concentration is also occurring, and Spohrer uses the example of how the three largest companies in Detroit in 1990 had a combined market value of $65 billion in real dollars and employed 1.2 million workers. Today, in Silicon Valley, the three largest companies have a combined market value of $1.5 trillion and need to employ only 190,000 workers. As such, it is all about relative speed: (A) Will technology destroy or downscale jobs? (B) Will technology create jobs or upscale jobs? And will B offset A? What is the relative speed of A and B? With the inevitable and exponential increase in technology, will the ideal become a universal basic income, or will it become the people-centered economy? “Technology deflation” is beginning to be quantified, and may result in public policy that funds a universal basic income, with incentive for entrepreneurs (see https://technomedium.wordpress.com/author/kmg4/).



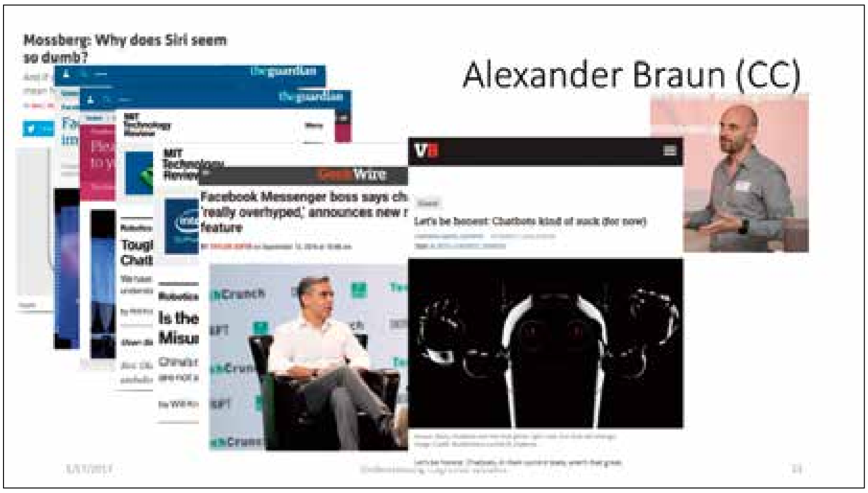
This is a map of the most common job in each US state in 2014.

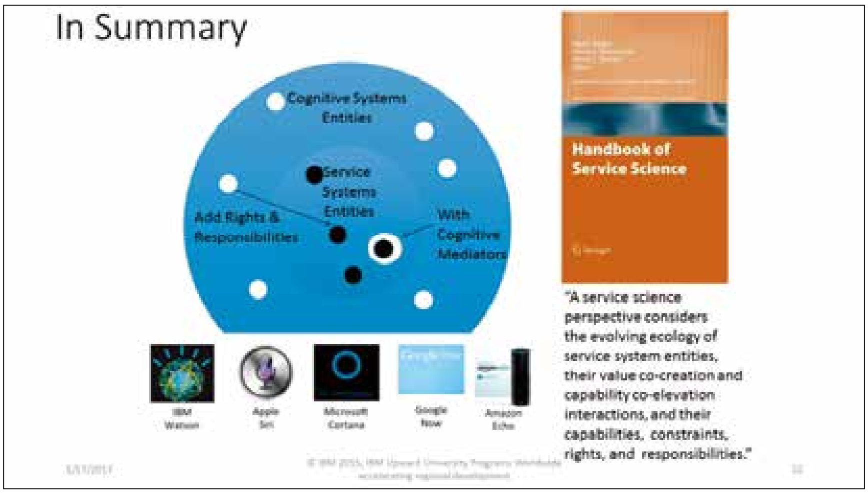
He references a recent talk given by Alexander Braun for the ISSIP cognitive series in which he discusses advances such as Apple’s Siri and Amazon’s Echo as voice-controlled assistants, as well as Facebook’s M that can answer questions. Microsoft is continuing to develop Cortana to make it even better and more intelligent, and Google’s Home and Google Now is also being improved. In addition, “chatbots” are now replacing apps in a predicted

$200 billion–$1 trillion chatbot disruption in the near future.



It is predicted that AI agents like Alexa, Siri, and M will create the first trillion dollar company; however, tougher Turing tests have already exposed chatbots' low intelligence levels, the trends and predictions cannot be set in stone. Spohrer hinted, on this topic, about the AI "winters" that can occur.

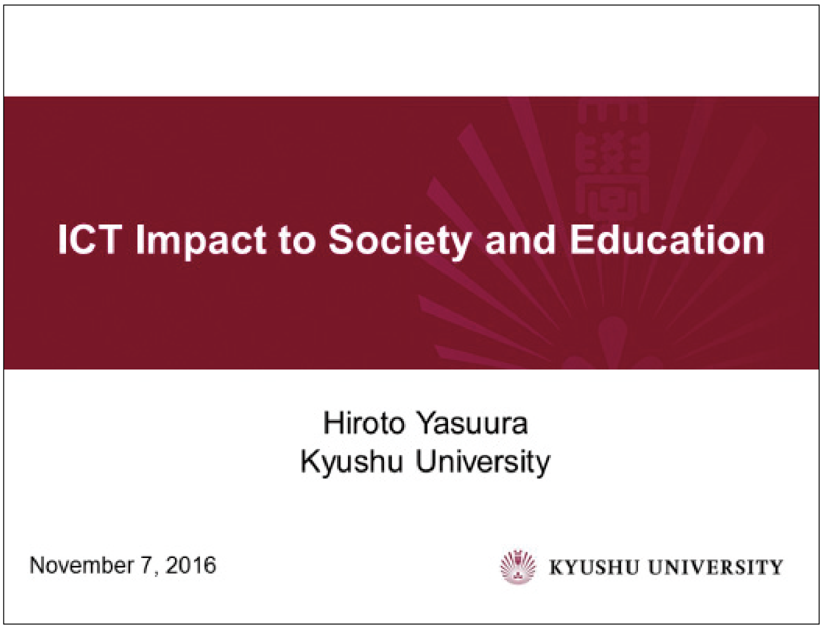


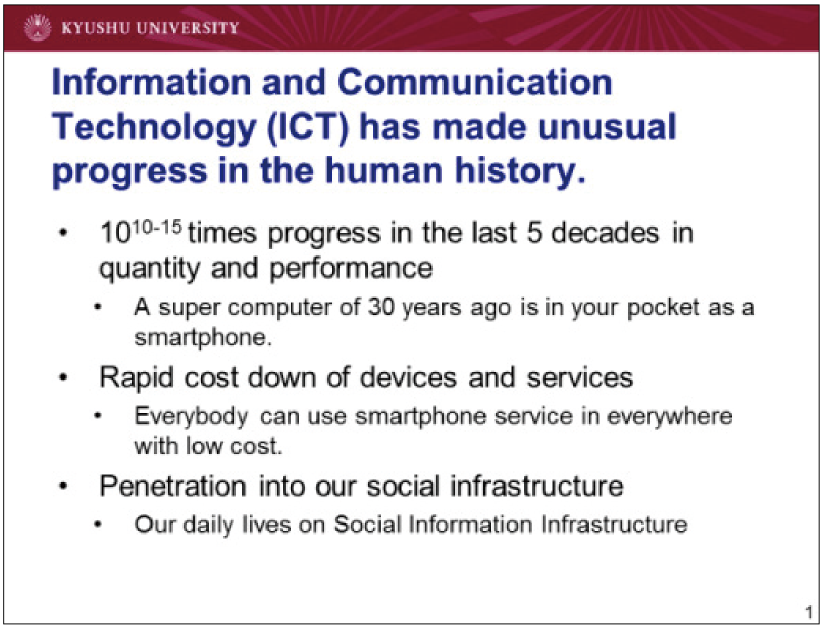


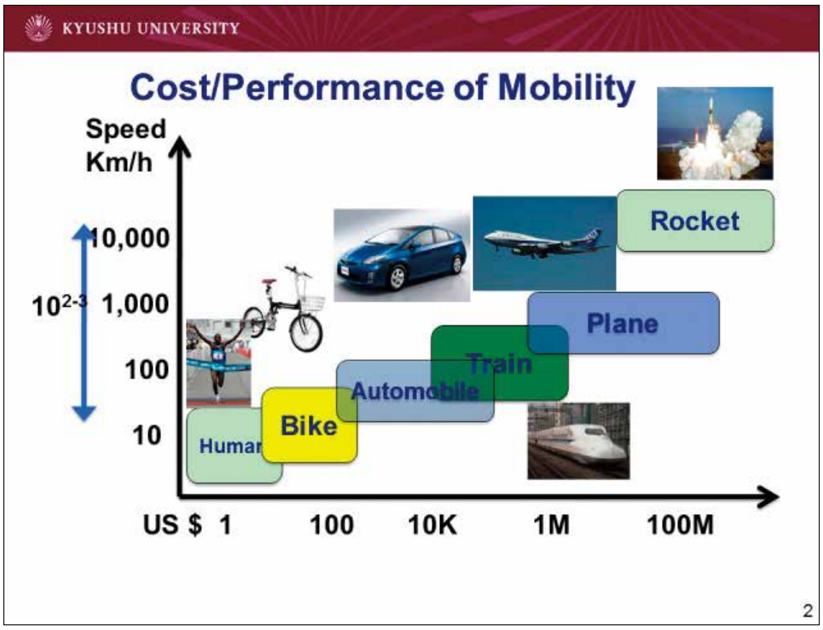
In summary, there are many challenges ahead to actualizing “wisdom service systems,” particularly if the goal is a people-centered economy. From a service science perspective, there are cognitive system entities out there already; for example, the family dog is a cognitive system entity but it does not have any rights or responsibilities. When a cognitive system gets rights and responsibilities, then it becomes a service system entity, which is what ISSIP is studying. They are trying to understand what is the next generation not only of smart service systems but what is the next generation of wise service systems and how can we use this capability to create a wise society that lives harmoniously with science?

(2) ICT Impact to Society and Education, Hiroto Yasuura, Professor Kyushu University

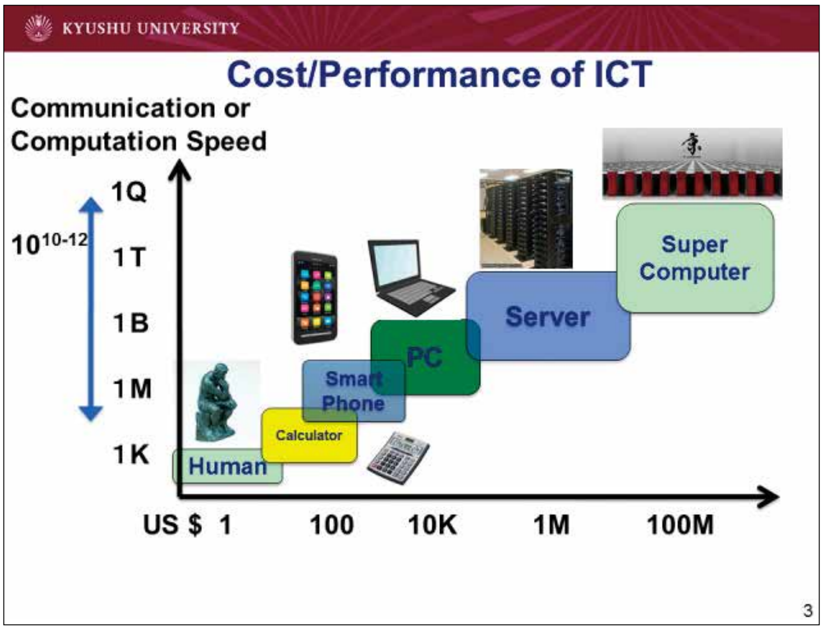
Hiroto Yasuura, the Executive Vice President of Kyushu University who also works for the JST, discussed the impact of ICT on society and education. While the JST is a small research group of primarily younger scientists, they are focused on the future of information technology and its ability to change society itself.

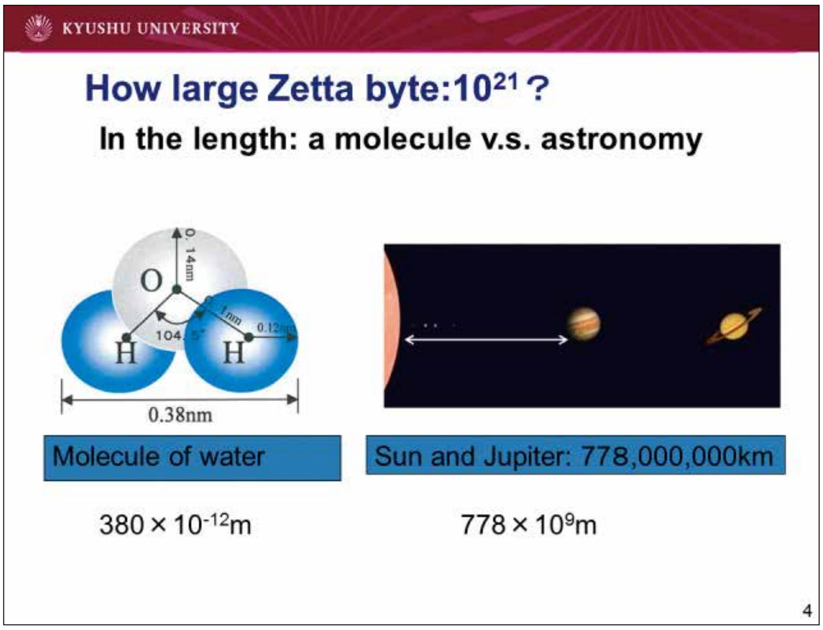






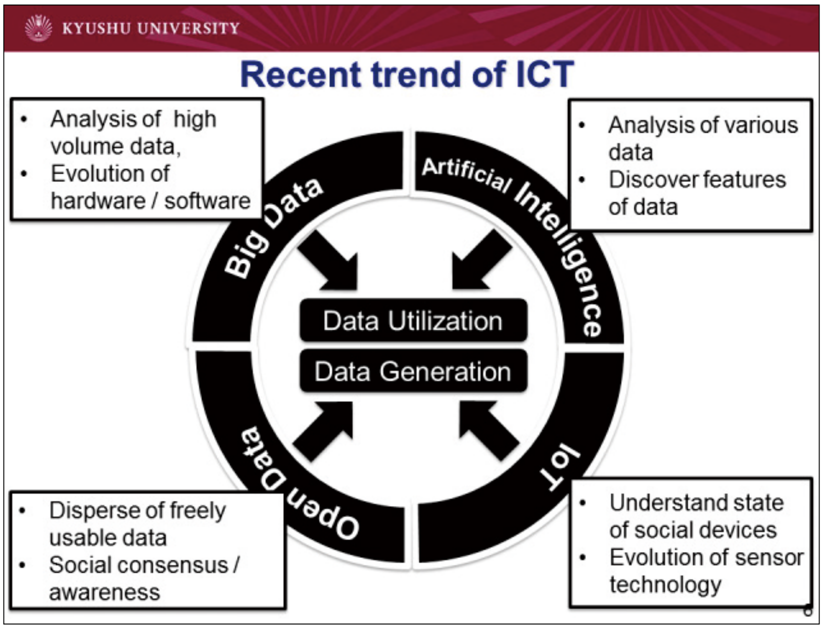
By using a graph based on transportation speed and cost, Yasuura draws a comparison to general technological advancement: the faster you go, the more it costs. In the ICT area specifically, however, there are tremendous differences in this graph, though this disparity (and advantage) is not yet commonly understood by most people, in terms of efficiency.



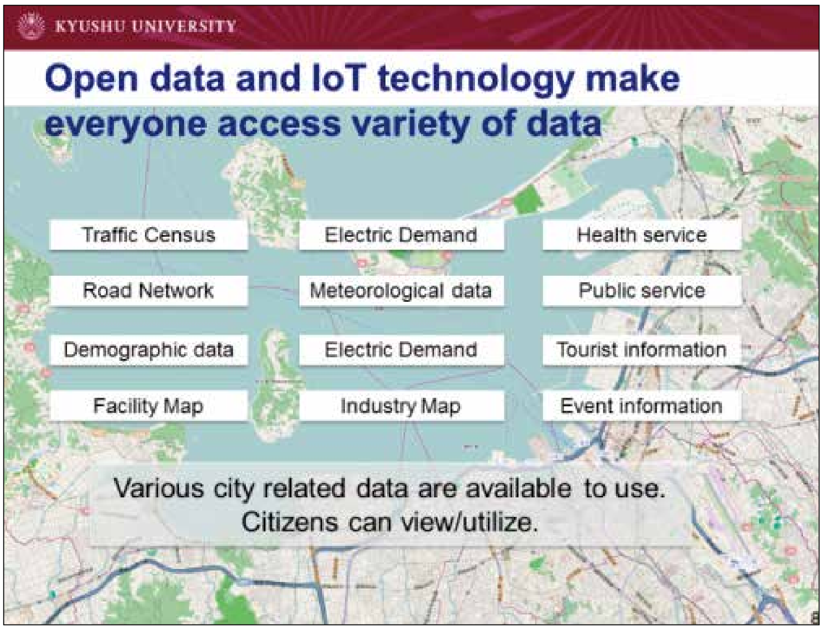


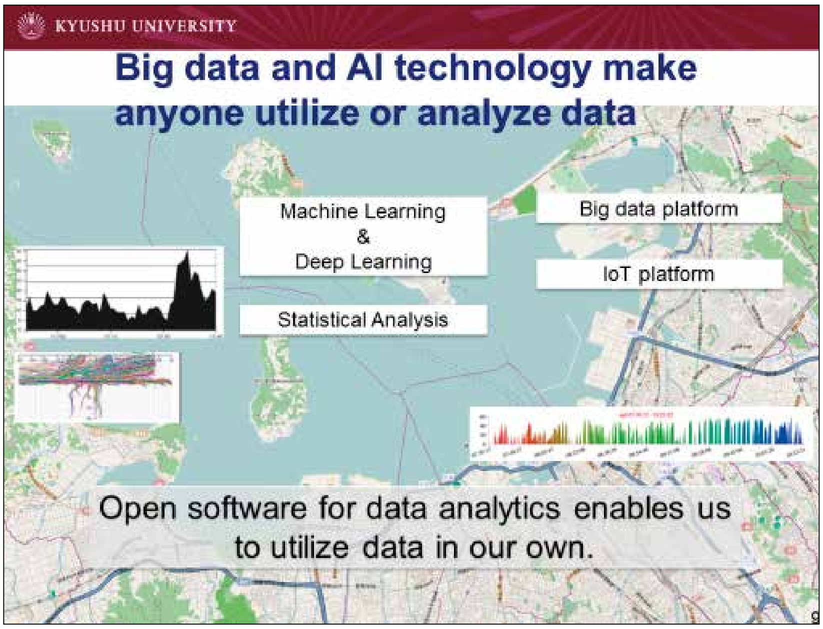
In the current era of Big Data, what does that term mean as far as how advanced technology has become? It is 10 to the 21st power, or the difference in the diameter of a molecule of water versus the distance between the Sun and Jupiter. That is pretty significant and can show how ICT is changing the social system.

Yasuura states that ICT is the root of innovation, and people are now capable of very large computational power and harnessing vast amounts of data at a very low cost. As such, social systems should be redesigned and based on ICT, but this will not be accepted by many people because they do not fully understand the power that is already available and accessible.

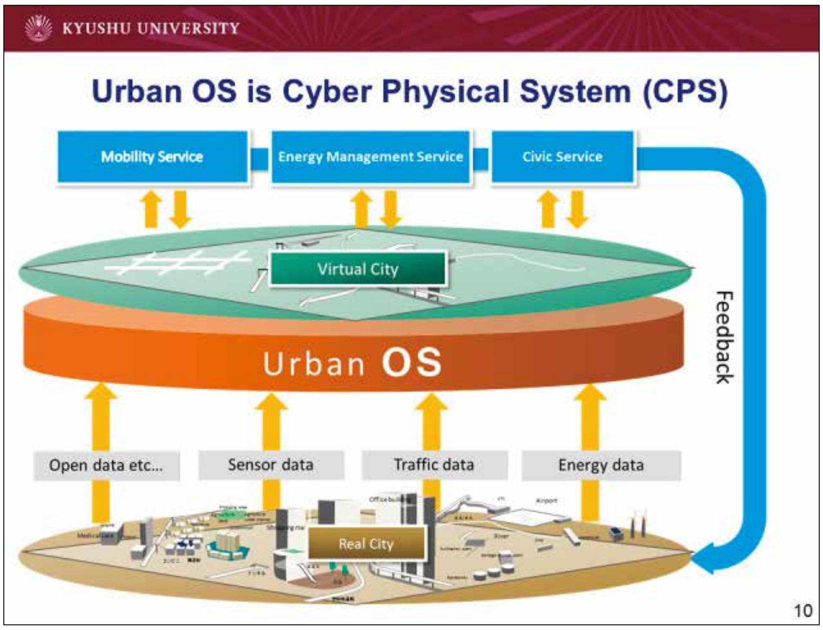


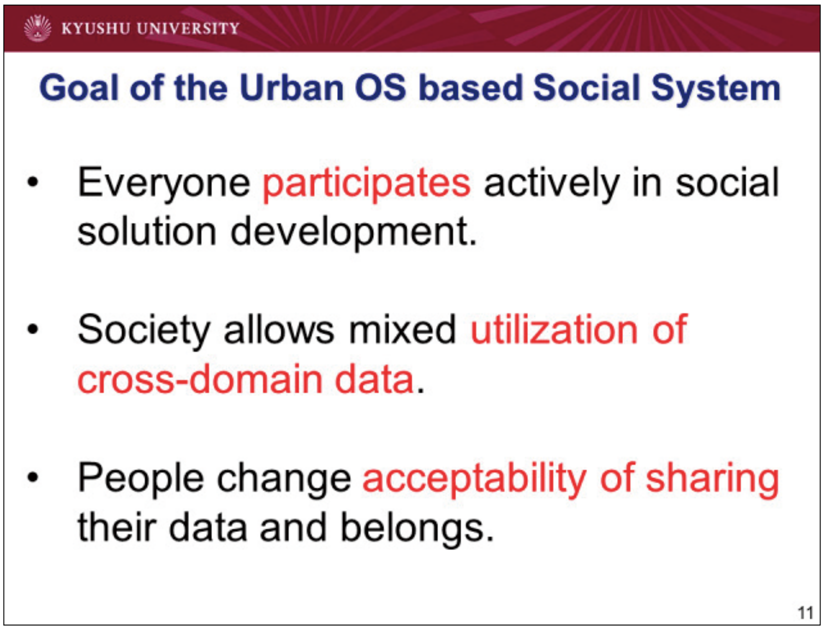
The media uses trendy words such as Big Data, AI, IoT, open data, etc. to talk about movement and advancements in the field, but in thinking about an ICT-based social system, the Japanese government provides the concept of Society 5.0. Similarly, U.S. PCAST published research and plans for a "city web" or informationenabled cities. Regarding company-based development, in Europe there is a company developing an "urban OS" living plan, called PlanIT. A similar project is carrying out in Kyushu university under the support of JST's Center of Innovation Project. Other similar plans for programmable cities are in the works in Barcelona (Spain) and Bristol (UK).



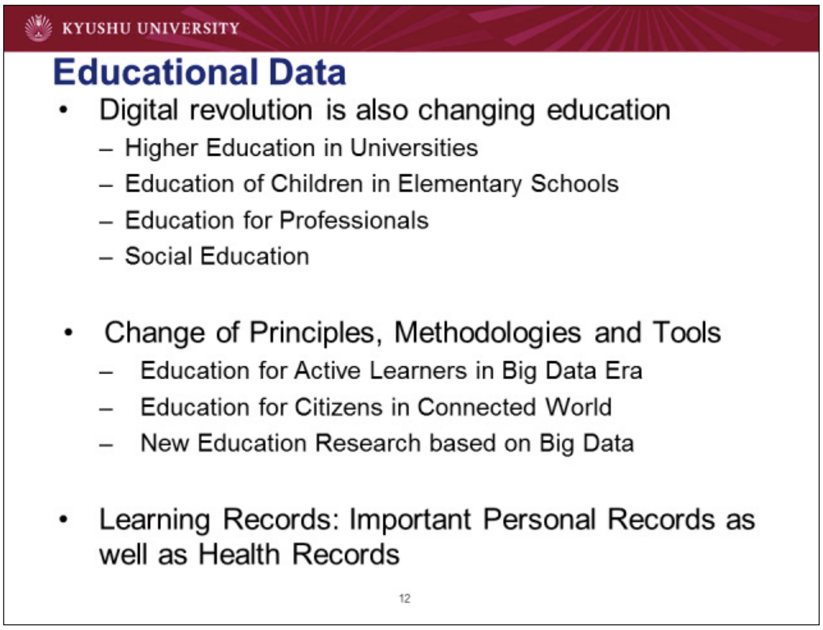


Yasuura also shared visuals of his "cyber-physical" urban OS system, which uses public data; however, he states that one of the challenges with the program is how to best use such data within the urban OS platform to create usable information. This may include the need for several social programs (e.g., regarding ownership of the data and how it is permitted to be used); as such, the urban OS is not only a technological issue but a social one as well.

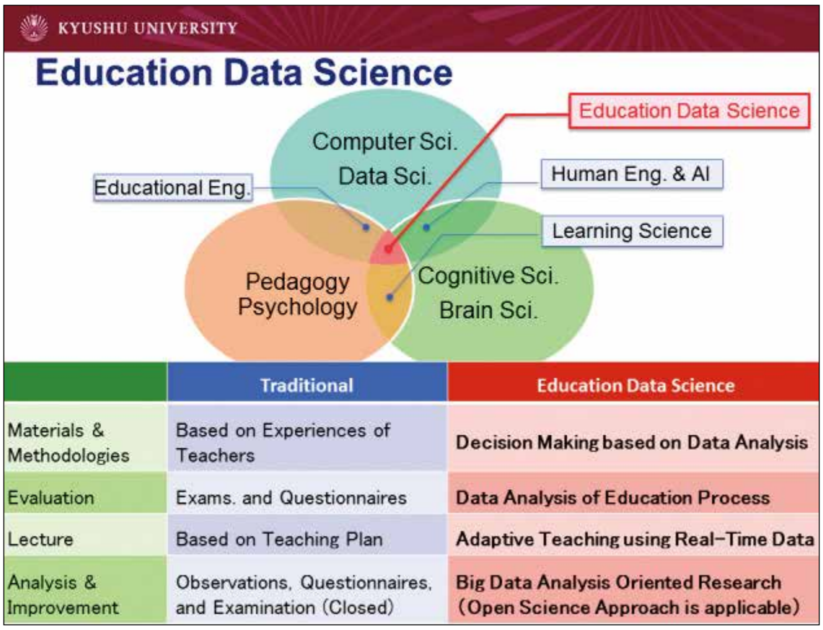




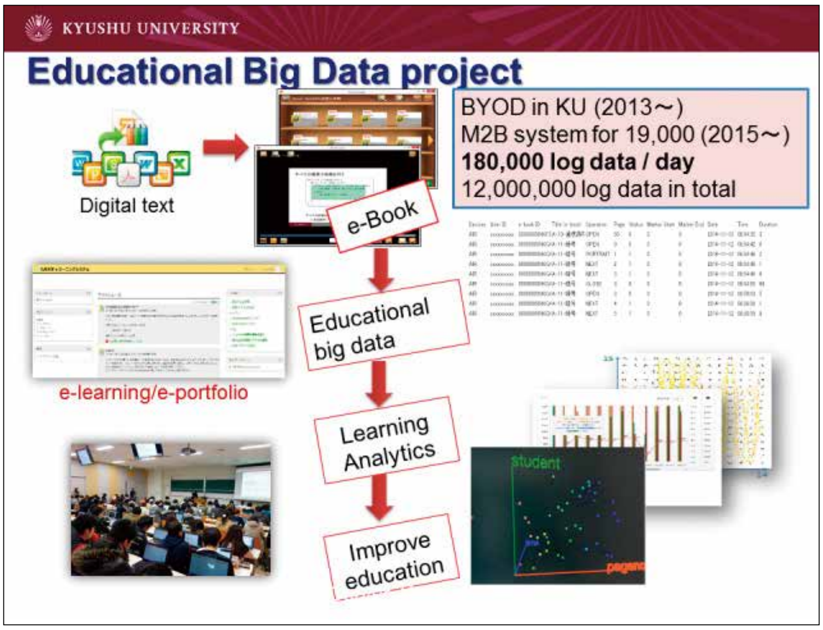
The primary goal of the program is that everyone can participate actively in social solution developments, and that society allows mixed utilization of cross-domain data. Participation in and understanding of these types of programs is expected to change people's level of acceptability regarding the sharing of their data and ideas (i.e., part of the social dilemma in such a system).

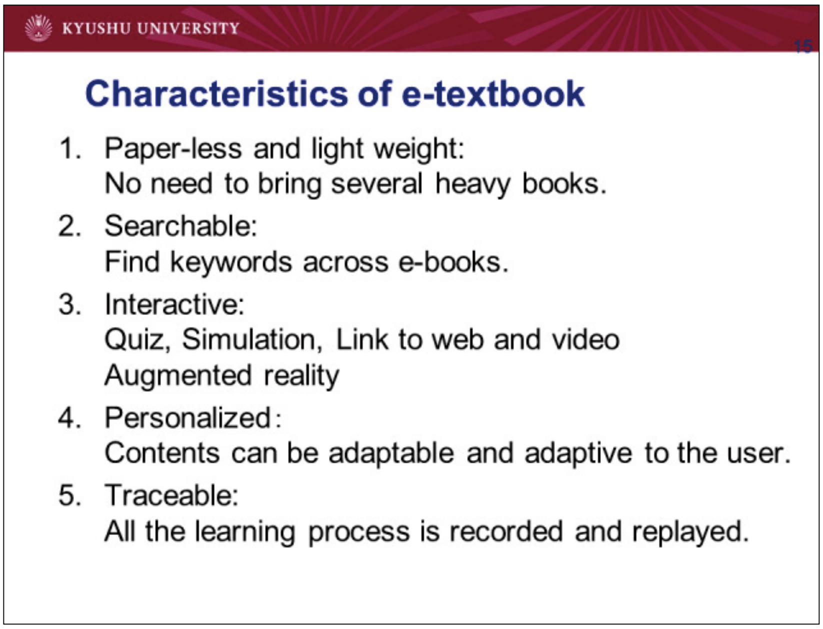


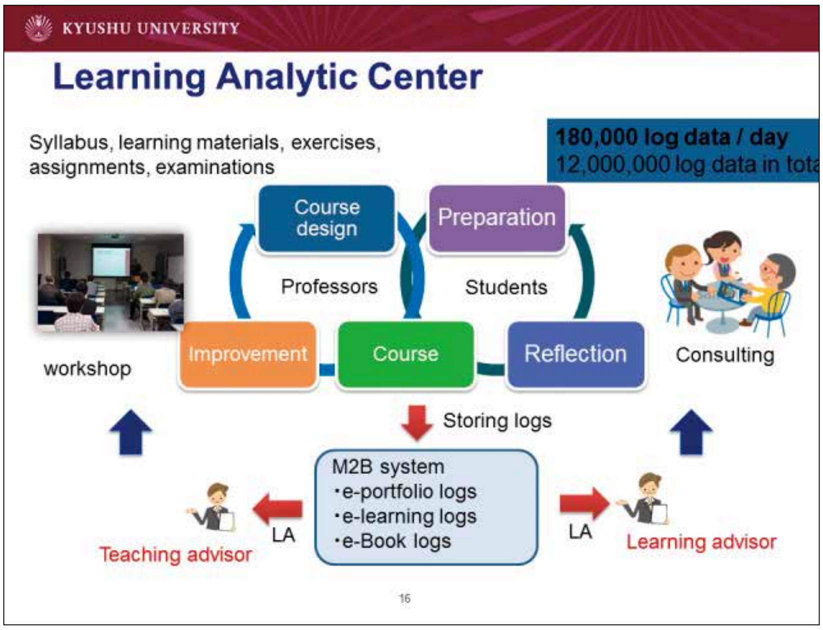
Education (one of the most-often used social systems) is also changing quickly through the use of ICT; for example, e-learning is being utilized more frequently now at the higher-education level and this is expected to also increase at the elementary and high school levels within the next decade. Professional education, which is a component of job creation, will also be looking to ICT for new principles, methodologies, and tools for education. But Yasuura asks about the approach and principles that should be used to educate active learners in the Big Data era and, subsequently, how to use the results from information technology. Education research based on Big Data (e.g., personal learning records, as well as health records) is a new area of study that is expected to increase going forward.



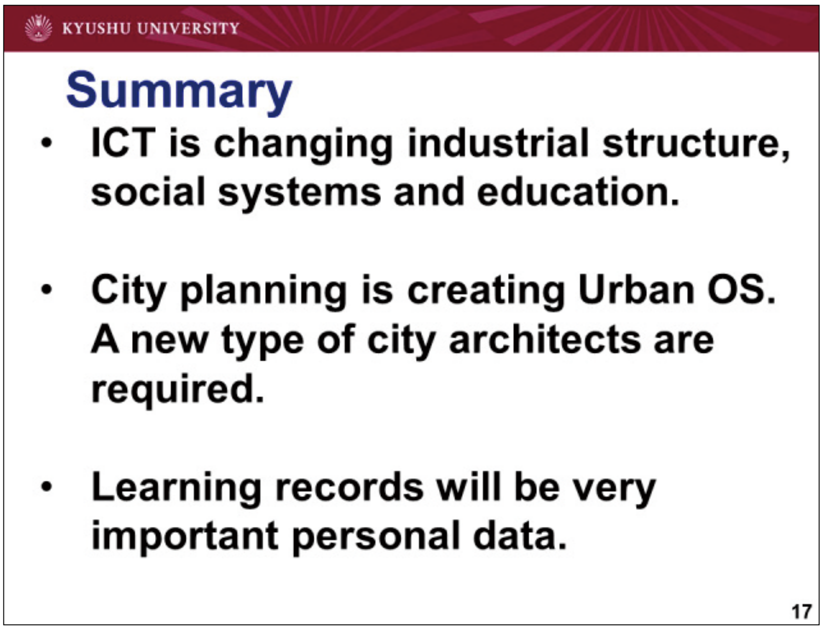
Yasuura moved on to talk about education data science, which is at the intersection of computer science/data science and psychology/cognitive science. At Kyushu University, Yasuura and his colleagues began a project in 2013 centered on “Bring Your Own Device” (BYOD), wherein all undergraduate students (~10,000 of them) bring their own device to class rather than traditional textbooks. The professors provide the data text and the basic e-learning system, through which they can collect data (e.g., how many minutes did each student spend on which page, what portion of the text they underlined). Analyzing this data (around 180,000 log data/day) can provide information on how to improve education and students’ experience. For example, he lists several advantages of using e-textbooks and ideas about how to make it more personalized.


KYUSHU UNIVERSITY
Educational Big Data project
BYOD in KU (2013～)
M2B system for 19,000 (2015～)
180,000 log data / day
12,000,000 log data in total
Digital text
e-Book
e-learning/e-portfolio
Educational big data
Learning Analytics
Improve education
student


KYUSHU UNIVERSITY
Characteristics of e-textbook
1. Paper-less and light weight:
No need to bring several heavy books.
2. Searchable:
Find keywords across e-books.
3. Interactive:
Quiz, Simulation, Link to web and video
Augmented reality
4. Personalized:
Contents can be adaptable and adaptive to the user.
5. Traceable:
All the learning process is recorded and replayed.



To focus on this learning analysis, Yasuura and his colleagues created a center for learning analytics, beginning with two services for students and two for professors. For the latter, the service can return information about the quality of their teaching methods as well as specific student reactions. This can be more accurate than relying only on in-class participation and reaction, as some students feel comfortable raising their hand but, for example, many Japanese students do not feel comfortable engaging in such active feedback; as such, more comprehensive feedback might be gained from using an ICT system. For students, the service can analyze patterns of the learning and can clusterize the students in order to improve specific learning styles. This data could also be useful for job-seekers as well as companies and governments, though a trial for these uses has not yet been conducted.



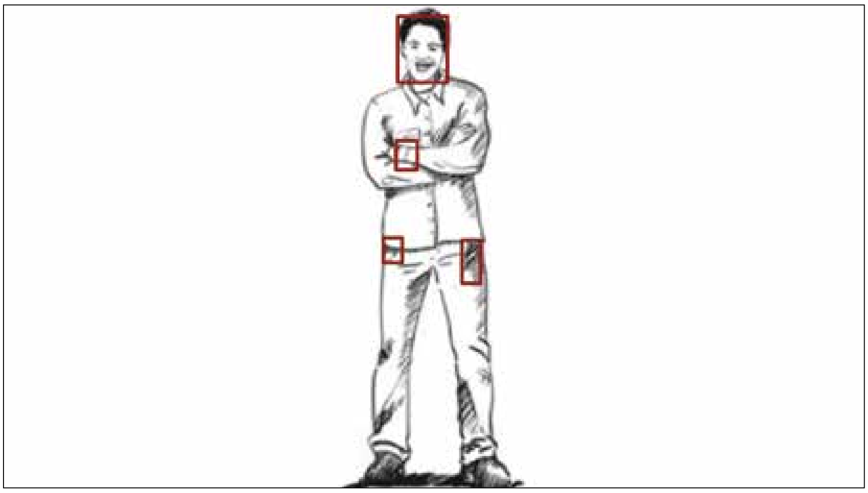
In summary, Yasuura notes that ICT is changing industrial structures such as city planning (e.g., the urban OS, in which ICT workers are just as critical as contractors/construction workers), social systems, and education. Regarding the latter, from elementary school to university, students will be able to "own" their learning history and tailor it for new jobs, evaluation of your abilities, and to clearly show what kind of education you have received.

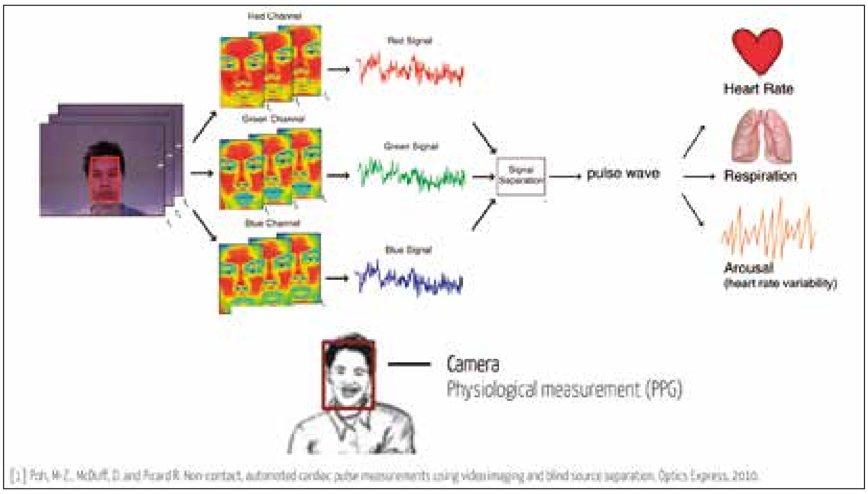
(3) How Artificial Emotion Intelligence Will Change Our Lives, Daniel McDuff, Microsoft Research

McDuff's address at the summit focused on how technology would change our lives even more dramatically once it learns to recognize non-verbal cues. For example, we currently use devices that take in information through keyboards or through speech, which means that they only understand words.

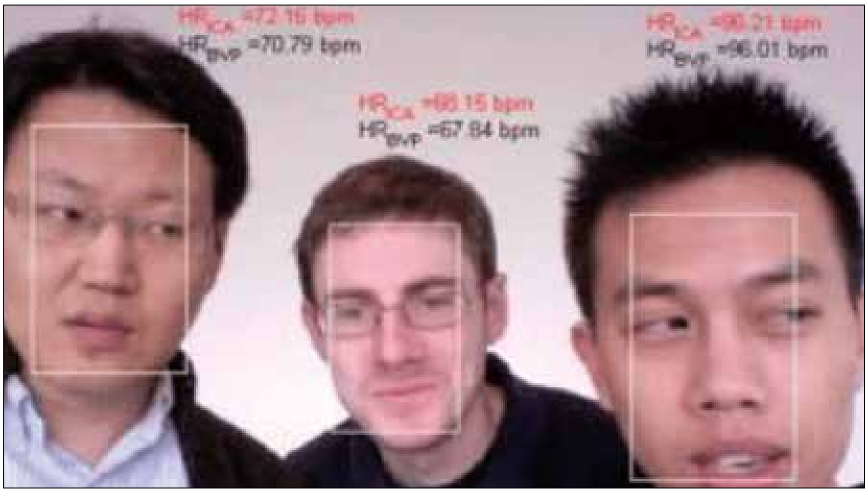
In real life, however, most of our communication and interaction with other people is through non-verbal cues, behaviors, and emotions, as these elements play an important role in other aspects of our life, such as what (and how) we remember, the decisions that we make, and also our overall well-being. For example, a person's ability to recover from illness can often depend on their overall emotional health. Currently, however, our devices lack the ability to understand much of this type of information.

He goes on to provide examples of how we can measure behavior and non-verbal signals through devices that we use in everyday life, including mobile devices, shared devices, and whether we use them for personal or business purposes. They each collect different pieces of information about us, such as our behavior and emotions, and the hardware within these devices can be used to measure this information over long periods of time. The next step, then, would be how to build an understanding for computers to respond and adapt to these types of signals.



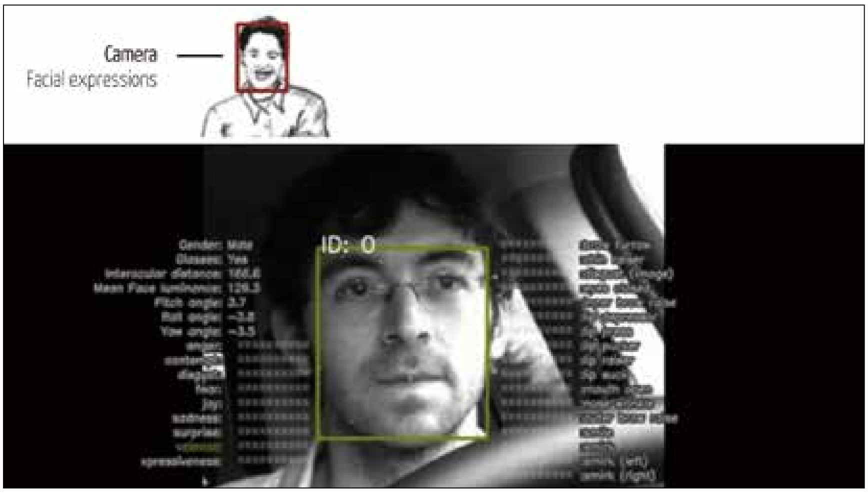


The first examples he uses are the webcam on cellphones and computer monitors/laptops that can capture information about facial expressions, gestures, and physiology, as well as wearable devices that can also capture physiological information while in contact with the body. These devices can capture information about our activities, where we are going, and what we are doing, as well as voice prosody, emotional voice tones (i.e., not just what they are saying but how they are saying it), and contextual information such as who we are with.

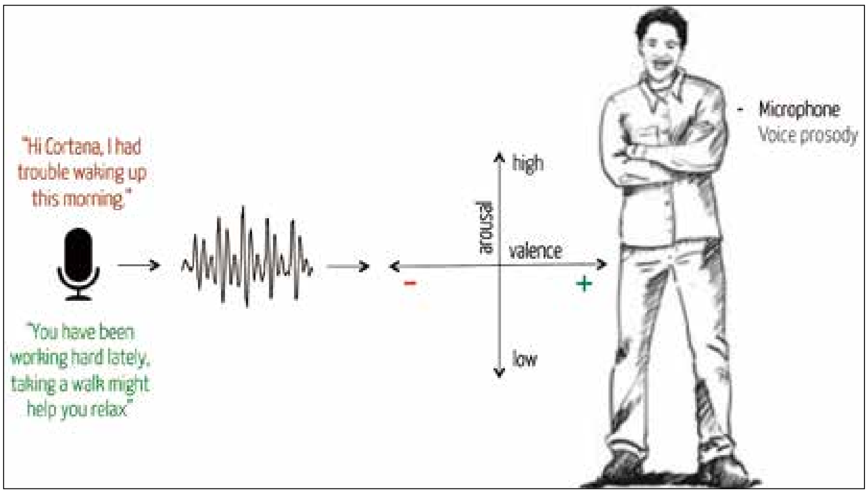


Through the webcam we can capture information about physiological responses, which can be used to measure vital signs like heart rate and nervous system arousal; for example, when you are concentrating hard on a task, the changes in your physiology can actually be measured just from a camera feed or from analyzing video.

Another subtle indicator that can be detected through devices is the vibrations of your body. McDuff states that everyone at the summit with a cellphone in their pocket is carrying around an accelerometer and gyroscope, and these tools on the device can be used to detect heartbeat and breathing rates just based on the vibrations of the holder’s body. The only requirement for this detection is a camera, which is ubiquitous, and gives us the potential to do large-scale measurement toward understanding people’s physiology.

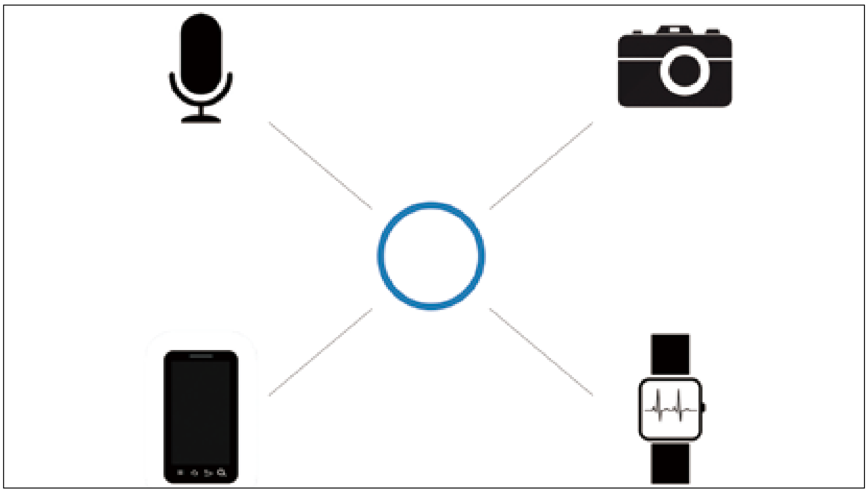


The face is one of the richest communicators of emotional information, and due to improvements in deep-learning computer vision, it is now possible to measure these behaviors accurately in real-world settings. These advancements make it possible to capture huge amounts of data from thousands of people around the world that is coded with behaviors and facial expressions so that machines can learn from this data and effectively replicate that coding in real time.



One of the more common ways in which humans are now interacting with devices is through speech, which circumvents the need to type information into a device; however it also provides access to another signal, which is tone of the voice (i.e., not only what people are saying but also how they are saying it). Research is currently looking into using voice tone to understand the emotions of a user.

Wearable devices/wearable technology is still constantly evolving, beginning with the Google Glass, which caused quite a bit of excitement but failed to establish itself as a successful device, through today's smart watches, though it is still unclear whether these will reach large-scale adoption. What they do, for now, is provide rich information about physiological responses as well as about context from both inherent and self-reported data. This data will be useful in long-term studies, to get a bigger picture of how people's emotions play a role in their productivity and even as specific as in their stress in the workplace.



From this data, McDuff posits, "person-specific models" can be built, wherein different devices capture behavioral and emotional information (i.e., multimodal sensing) to provide a rich picture of how someone is feeling and behaving. And then what we can do with this information is to build person specific models. As such, understanding the relationship between these captured measurements via quantitative information is going to be a key part of research on technology and emotions as related to interactions and daily tasks.

McDuff shared with attendees a visual in which a computer is trying to understand someone's emotional state over time—whether they were relaxed, calm, excited, or had positive or negative feelings. The person's devices were also providing access to other information about what they were doing at certain times, such as who they were communicating with. What McDuff found with this study was that the subjects, who were using a "diary format" of their own to gather similar data, were able to drill into information about their emotions over the time period of the study and were able to discover new things about their behaviors and how what they were doing was influencing their feelings. He provided the caveat that the field is only at the start of being able to understand this type of information and plans to run these studies in realistic settings over longer periods of time.

One application for this type of data analysis would be for companies seeking to collect large amounts of data about people's emotions in different contexts, whether through wearable devices or through video and audio. Emotions are highly variable across different individuals and across cultures, even in the way that men and women express and report emotion. Collecting a wide scope of data will be the only way to eventually will build computing systems that can properly understand emotions in the ways that humans do.

Culture plays a significant role, as mentioned, so McDuff spoke to attendees about ongoing efforts to analyze the ways in which people express emotion in different countries by collecting a large data set of people who voluntarily contribute information about how they were feeling via their webcams. These types of studies have revealed significant differences across different countries due, in part, to factors such as how individualistic or collectivist the culture is. Most related psychology studies until this point have been focused on populations of 10 or 100 people at a time, but now to have similar validation across larger populations is encouraging for further and applied research.

But how will all of this impact our lives? McDuff states that, first, devices are becoming much more personal to us. He references Spohrer's presentation that talked about the rise of personal assistants and chatbots and agrees that these systems are not performing the ways in which people need and want them to, primarily because these technologies do not understand us in the ways that we expect them to (e.g., their lack of understanding of humans' emotional states and nonverbal cues). So in order to get technologies and applications that have a higher level of usability and satisfaction, we will need to build devices first that are much more in tune with how people are feeling and that are able to provide much more accurate feedback.

McDuff provides one example of this in companies that are currently building social networks around cognitive behavioral therapy in order to establish networks of people who can help each other overcome different aspects of mental illness. Data from these types of projects will also be useful in building machines that can perform this same function—essentially, a machine that can provide someone with personalized advice about how to deal with certain situations and how to reframe those situations to provide a different perspective. Computers are currently not able to this in such a personalized and sensitive manner, McDuff believes that it is the direction in which the industry is moving.

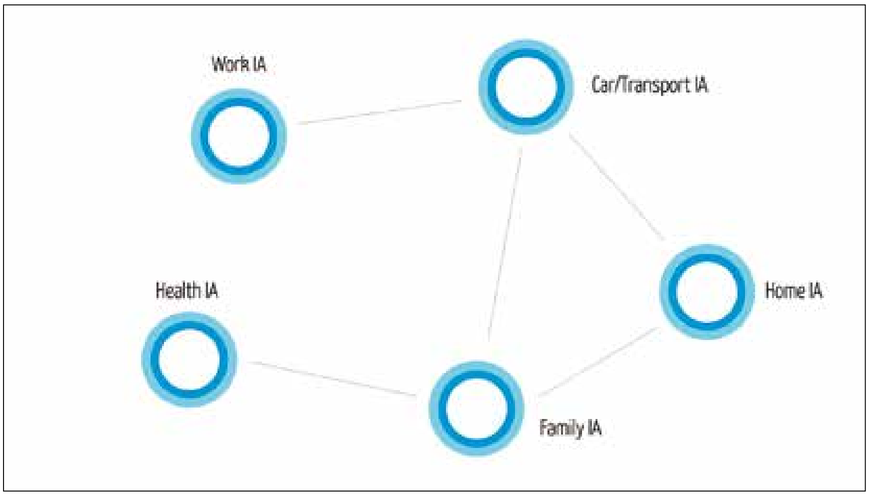
There is, however, a risk that this type of advanced, emotional computing could result in people becoming even more dependent on technology, but McDuff hopes that it actually will improve our communication abilities with other people, thereby increasing interactions and the quality of those encounters. Expanding on this thought, he believes that it will allow technology to blend more into the background of our lives because instances of frustration with devices will be reduced. Microsoft is currently trying to understand what makes people productive and how technology can increase this productivity at work and in other aspects of their life. One aspect to this is understanding what are appropriate times for technology to provide you with notifications and/or to interrupt you during a task, and this requires not just information about what the person is doing, but how they are feeling about that task (e.g., are they in a “flow state” of being particularly productive, and should not be interrupted). Sensors, and data gathered from these sensors, are being used in order to understand these aspects of technology use and application.

McDuff believes that one of the most powerful ways that this emotionally intelligent technology can help people is not only in allowing us to be more productive or to have more pleasant interactions with both people and technologies around us, but actually to help improve general well-being (not just people suffering from a specific illness). He believes that the accumulation and analysis of quantitative information about human behaviors will be the most direct path to understanding how things in our lives influence behavioral patterns. For example, it could be used to aid clinicians in understanding the impacts of depression on an individual, such as being at risk for suicide based on behavioral patterns and their reactions to certain stimuli. This is currently difficult to do through surveys and other types of self-reporting that is the current standard.

McDuff moves on to discuss considerations about what happens when this type of data becomes measurable and quantifiable on a large scale. Companies that are in the business of building connections with consumers will of course be interested in this data, as evidenced by initial efforts particularly in media measurement, wherein advertising spaces want to understand people's emotional connection with a brand. One challenge to this, however, is how individuals will keep certain data private while sharing other data (with other people, companies, organizations, nonprofits, etc.). He quotes from an article written during the advent of cameras and when photographs first began to be used in the press, when people were having photos of them taken without their permission and being published. The author of the article highlighted that as any new technology is developed that is able to capture information and representations of people, we must (culturally, socially) redesign the ways in which we protect people and allow them to manage that type of data.
As such, data privacy and intent are crucial questions that need to be addressed in concert with scientists, engineers, social scientists, and others.

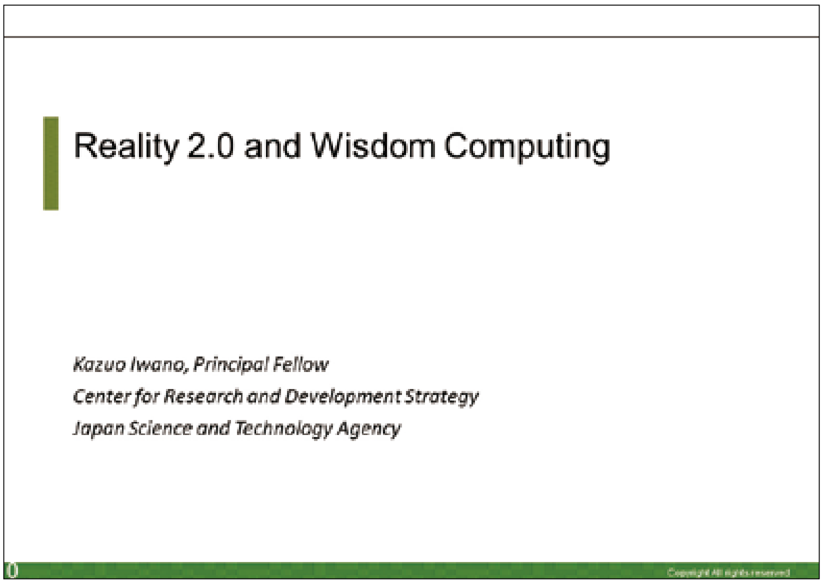
Data sharing could be useful in enabling the construction of products and services that are targeted and higher in quality and usefulness; for example, McDuff proposes a scenario in which he purchases a new product and chooses to share the data about his emotional reaction or response to using that product with the company that produced it. They could then quantify his individual response across other people's reactions who are using that product, and could ultimately redesign it in ways to improve the experience that a large group of people are having with that product. This would result in a market shift where customers iterate concerns and experiences to a manufacturer, and that company can then redesign products and services based on people's emotional experience much more quickly than the current modes of testing and feedback.

Referring back to the quote about first publishing photographs, McDuff does not believe that we are facing a new problem; rather, it is something that has existed and evolved throughout modern times, with this iteration being new ways of collecting data about individuals. As such, it is important to have broad-based discussions about how we manage this data and design systems to allow people to keep private what they wish to remain private.

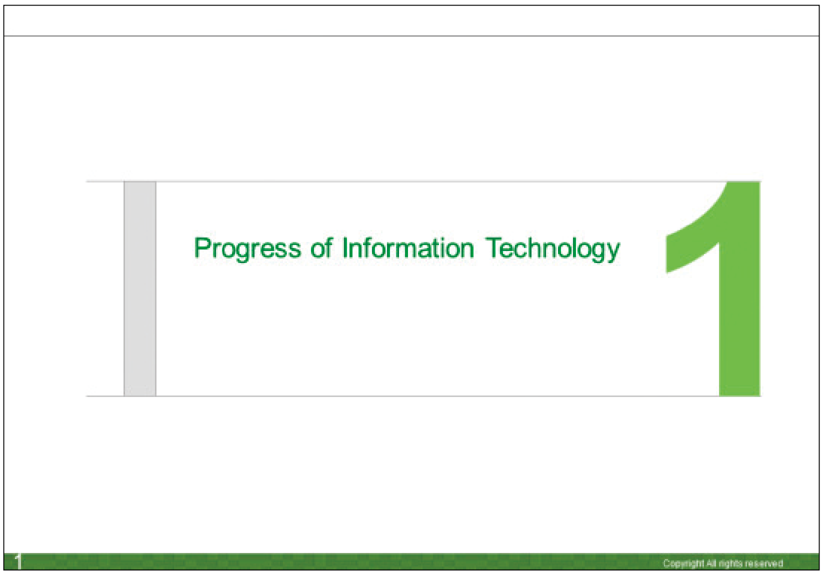


McDuff concludes his presentation by describing one of the ways that this could happen is having separate AI systems that each have different access points to the data that we own. For example, a person may have an AI system in their home that helps me with daily tasks and reminders, and that person chooses to share certain data about their behaviors, emotions, and activities with that AI system. That same person may have an AI system at work that only can access some of this data, so their employer might get data about certain aspects of the employee's life that they choose to share but it cannot access all personal data. These different AI systems will need to be designed in such a way that they are separate from one another in certain ways but also connected in certain ways in order to share information in other forms.

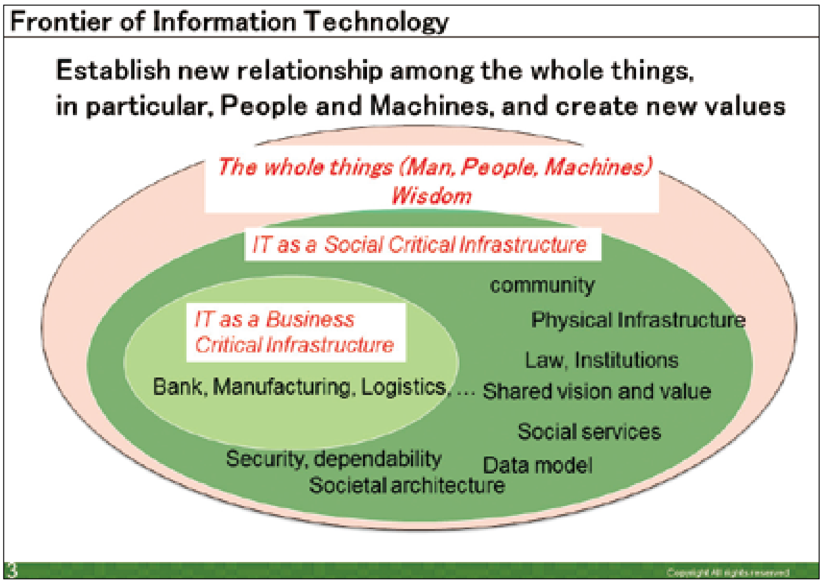
(4) Reality 2.0 and Wisdom Computing, Kazuo Iwano, Principal Fellow, CRDS, JST



Kazuo Iwano, who is in charge of the IT unit at the Center for Research and Development Strategy (CRDS), introduced initiatives from the group called Reality 2.0 and Wisdom Computing, which are related to the aforementioned people-centered economy.



Initially, he spoke with attendees about the progress of information technology and his view of what is currently happening. The frontier of IT, he states, is shifting from being business-focused to more society-centric (e.g., mankind). In addition, the location of business value is shifting from “things” to services and relationships, which builds a new ecosystem. Iwano also addressed the current blurring of boundaries between the cyber and physical worlds, which he terms Reality 2.0, which includes how relationships among people and machines are changing as well (e.g., Wisdom Computing).

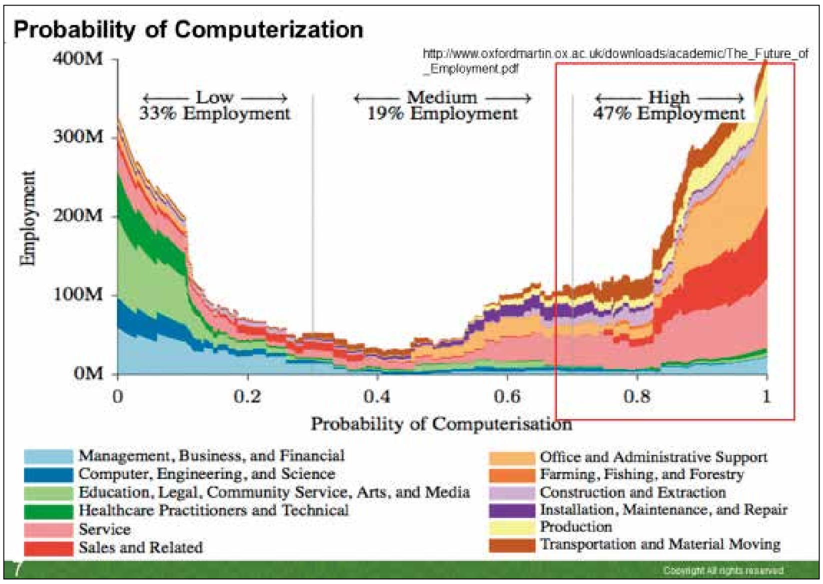


In the 1990s, IT was seen as a necessary part of critical business infrastructures, which was especially important for industries such as banking, manufacturing, and logistics. In order to build an effective system, it was based on specifications related to criteria such as cost, quality, and deliveries. In 2000, however, things changed and people began discussing IT in relation to society, such as cyber physical systems (CPS), smart cities/communities, and so the essence of IT shifted to be considered more of a social critical infrastructure, though it has not yet been wholly accepted as such. One of the barriers, according to Iwano, is that there are not currently any solid specifications on which to build a social system, and in order to design these necessary social values for the social system, we have to reach a "value consensus" with people in society, which will be the basis of a needed social architecture.

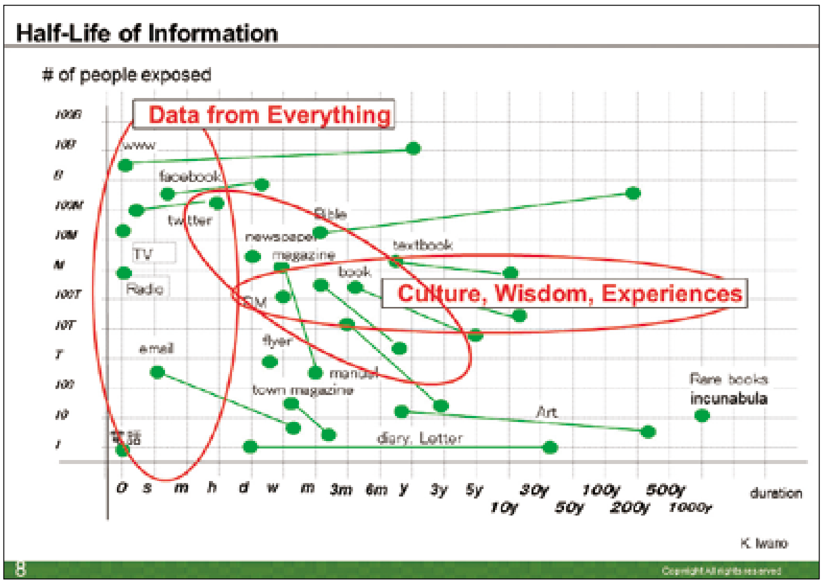
The next stage of IT evolution in Iwano's presentation is related to humankind and how we can increase the inherent wisdom of the world in order to make it "better." This wisdom will also be a constituent of the aforementioned ecosystem.

In shifting to a more detailed discussion of Wisdom Computing, Iwano provided a summary of Alan Turing, who was the forefather of computing machinery and intelligence, authoring papers that focused on the question: "Can machines think?"

He also touched on Erik Brynjolfsson and Andrew McAfee's book that discusses a "race against the machines," which stated: "Digital technologies change rapidly, but organizations and skills aren't keeping pace." Iwano believes this is especially true for universities and governments. As such, there is a huge gap between technological progress and societal/cultural change, wherein millions of people are being left behind.

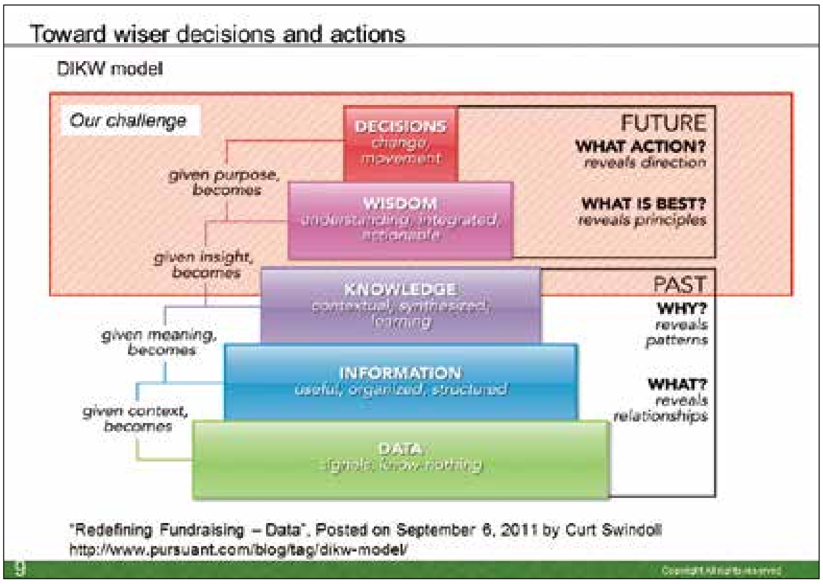


Professor Osborne in the United Kingdom believes that 47% of current jobs will be replaced by the machines within 10 years, though Iwano insists that this message is not meant to be a threat or warning; rather, it is a call for people to think about what kinds of new jobs we will have to create during this same period. Based on the idea of a people-centered economy, new types of creative jobs are likely to emerge, centered on skills that cannot be easily duplicated by machines.

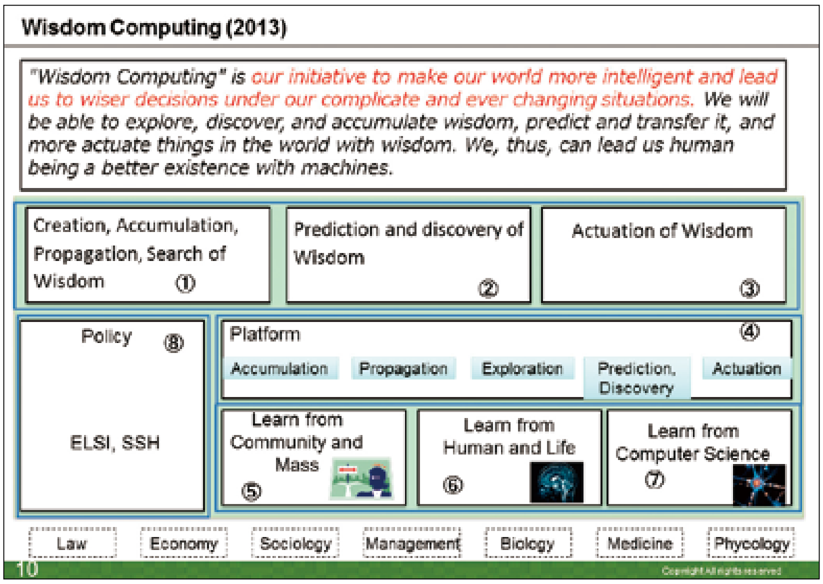


His next topic is focused on a visual that depicts the half-life of information, wherein the vertical axis is the number of people who are exposed to information online (e.g., 10 billion people), but the horizontal axis showing the half-life of that information reveals that it might only exist for one year. In terms of physical newspapers, several million people read newspapers either in the morning or in the afternoon; however, this information lasts only a few days. On a more personal level, some people keep diaries that they might only share with one or two other people, but the information lasts for 30 years; conversely, the Christian Bible, has lasted for 1,000 years or more. Regardless of the medium, there are gaps in all of this data, which makes wisdom a rarity. He posits the question to attendees of: How can we fill this gap?

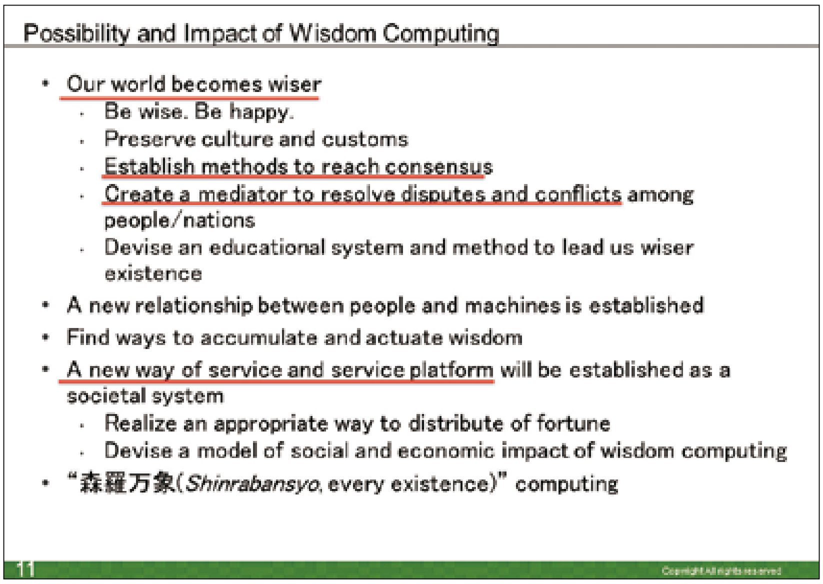
Some people within the IT sector may say that Big Data or AI can solve this situation, or possibly even social systems/social networks. However, with current technology, it is not likely that this is feasible; as such, he talks about how JST initiated kind the concept of Wisdom Computing.

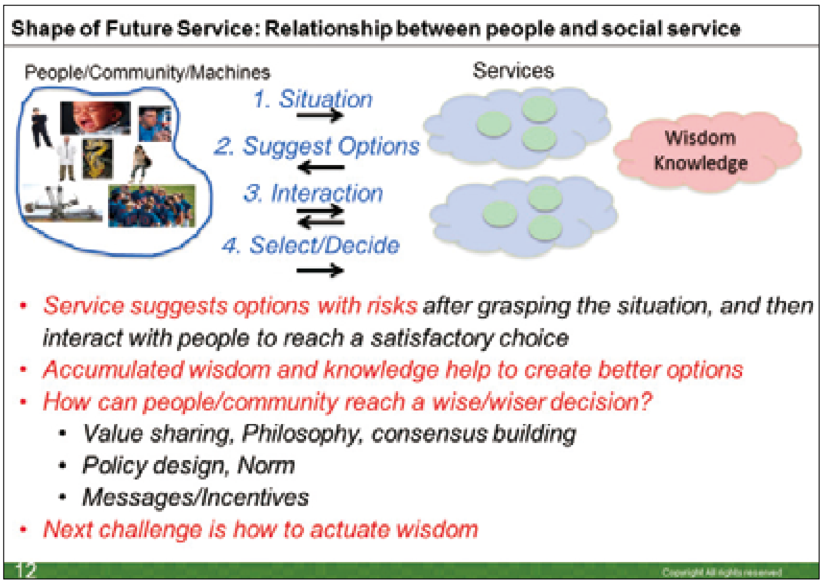


He displays a visual of a ladder chart, with ascending "steps" for data, information, knowledge, wisdom, and decisions. Big Data and AI, on this chart, are focused on analyzing current data; however, looking to the future, wisdom will be necessary to reach the top of the ladder, or better decisions.



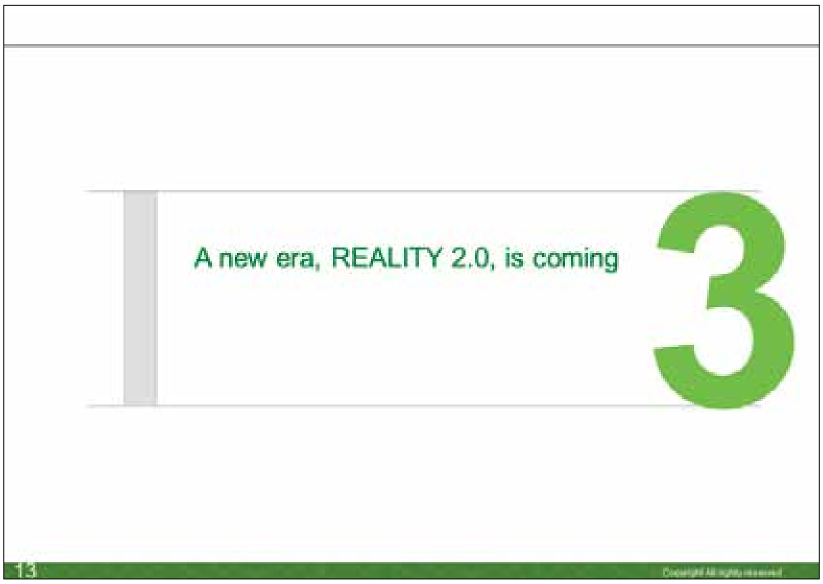
In 2013, JST initiated their concept of "wisdom computing," aimed at achieving the ability to reach better decisions regarding societal issues as well as within people's daily lives. Wisdom computing, then, consists of specific components focused on creation and accumulation of wisdom, predictions of this wisdom, and actuation of wisdom. Actuation of wisdom, according to Iwano, is a kind of "brainwash," and so there are risks involved, necessitating ethical policies (e.g., ELSI and SSH) as well as policies to address potential legal, societal, and social issues. These policies and components are all contained within the same service platform that can help realize appropriate ways to distribute the positive effects of wisdom computing, as well as help to create cognitive mediators to resolve potential confrontations and conflicts among people and even nations in order to "live wisely."

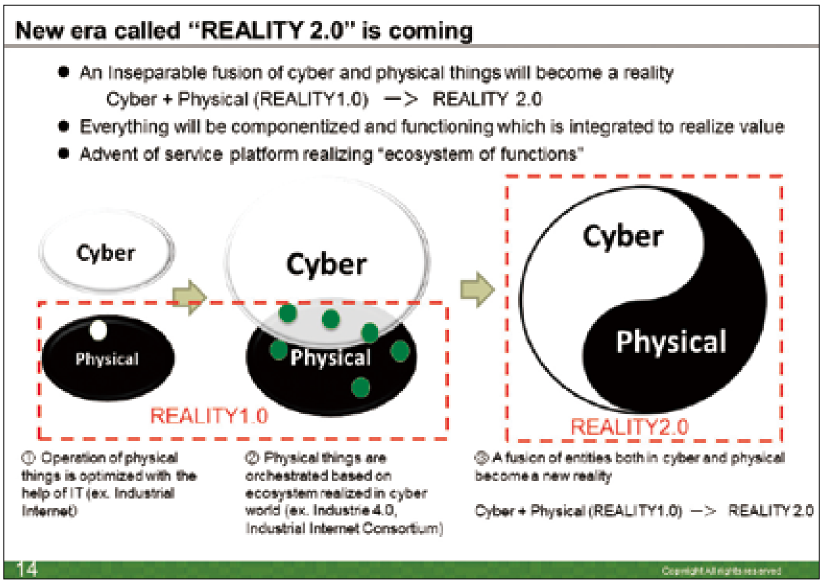




He also discusses the future of these services, where people, the community, and machines will receive services from certain providers that will need to understand the human condition and societal norms without having to rely on verbal communications or Big Data. Referencing McDuff's presentation at the summit, Iwano also stresses that it will be key for machines and technology to be able to understand "silent signals," in order for these service groups to provide appropriate options to people, communities, and even other machines—options that take in to account any risks, profit, or variables. To reach this level of understanding, people will need to first interact with the service groups to help them "learn" how to reach better decisions through wisdom.

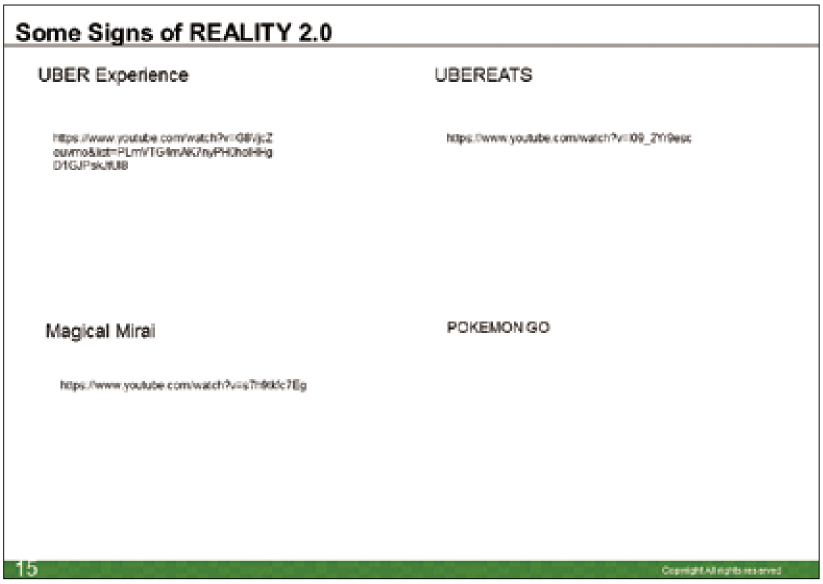
But how can people and communities reach wiser decisions? Iwano believes that social acceptance is an important factor, and he also referenced Professor Yasuura's presentation at the summit about education, which will be the key component is raising up the maturity level of society, in tandem with Reality 2.0.



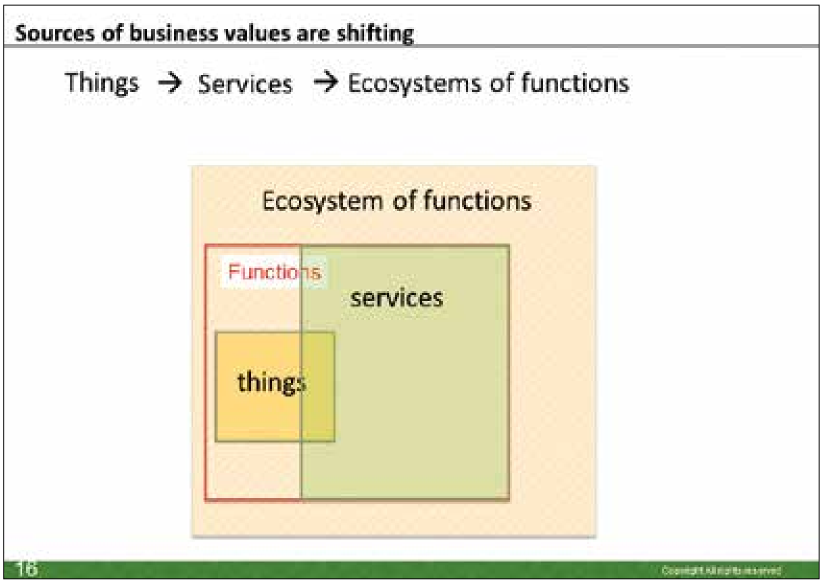


People believe that their identity and existence is located within physical parameters that allow them to receive information. He uses the examples of Industry 4.0 and the Industry Internet Consortium, which form an ecosystem in the physical world and then receive information seamlessly from cyberspace.

However, Iwano believes that this concept is evolving to where everything has two aspects of its existence: a cyber existence and a physical existence. This is why the existence of Reality 2.0 is inseparable from the idea of fusion between cyber and physical existences. As a result, the concept of identity will change, not only among individuals but also communities and society. If the concept of identity changes, then related or associated will change as well, which ties back to Iwano’s discussion about the shape of services in the future.

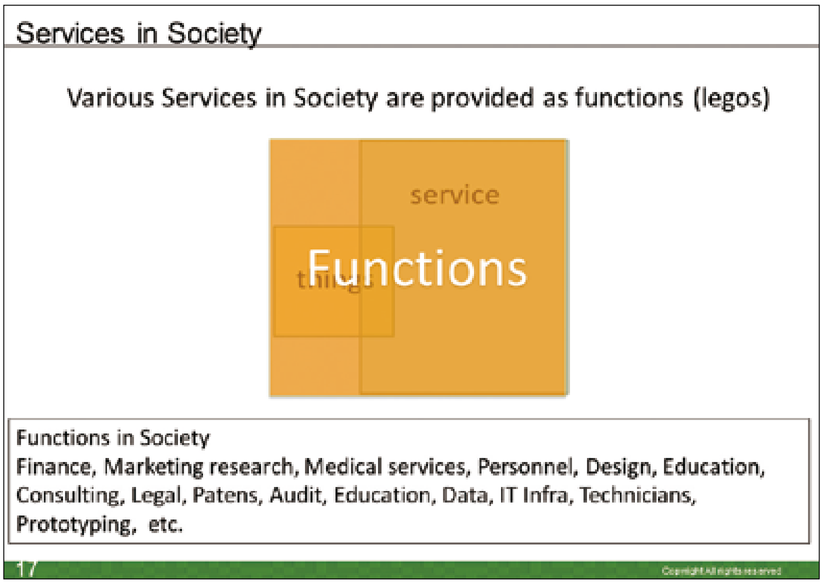


Iwano then uses Uber, which is trying to build an ecosystem based on their services, as an example of Reality 2.0. Without both IT and physical services, Uber could not exist; the same can be said of Pokémon Go or the Japanese Magical Mirai, the latter of which requires a physical concert hall and a computerized singer/dancer. These are all examples of mixtures of physical and cyber atmospheres.

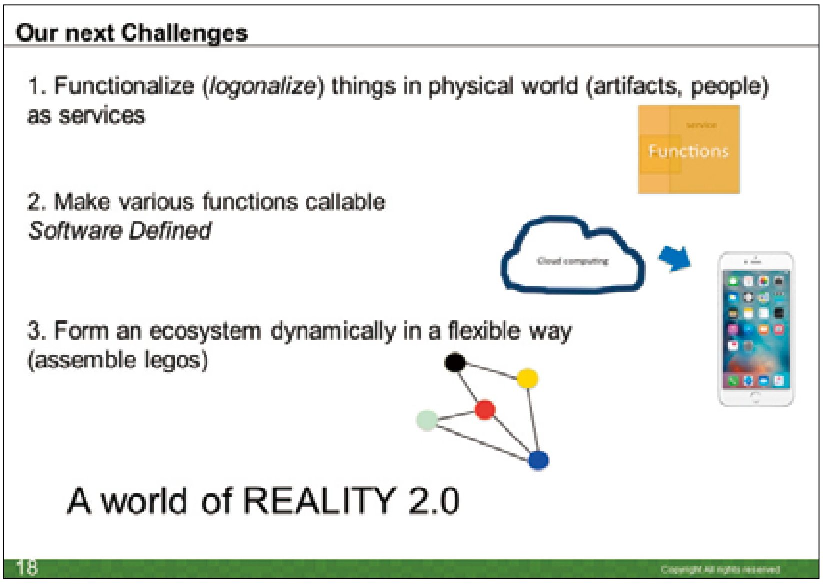


As noted previously, business value is shifting from “things” to services. In order to create newer and larger business values, however, things should be embedded in the services.

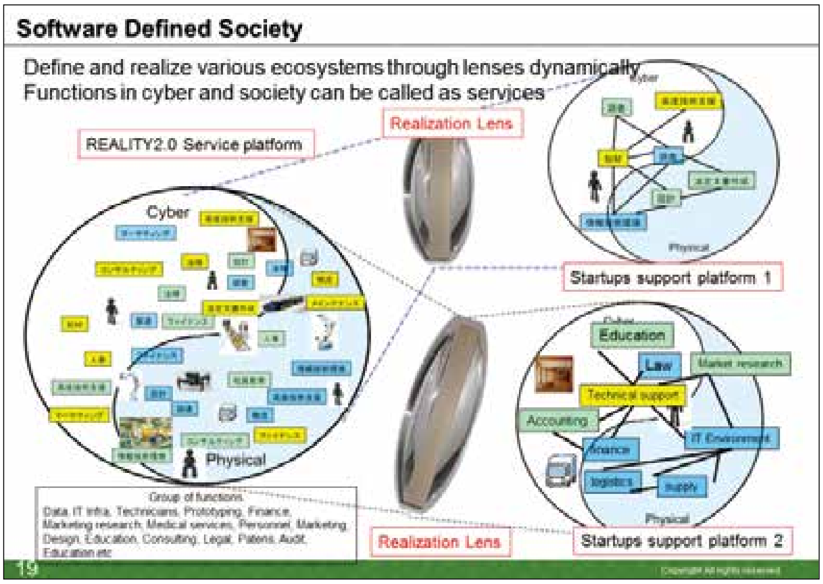
Services then provide functions, which are located in the same overall ecosystem, and within this ecosystem are levels that each provide a variety of societal functions, such as marketing, education, manufacturing, or provision of personnel.



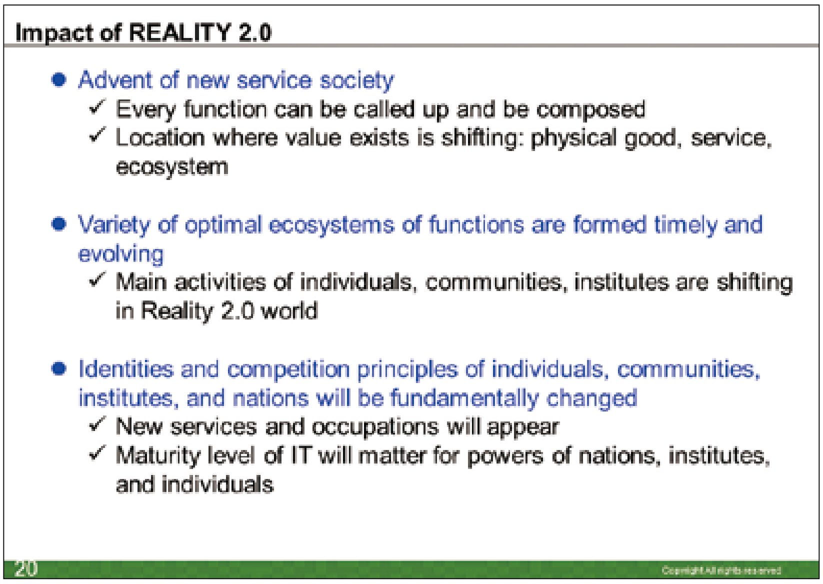
He also compares Silicon Valley in the US to Japan, which does not currently have a similar ecosystem to create the same level of startup companies, as Japan does not currently have a good connection between the IT ecosystem and societal functions.



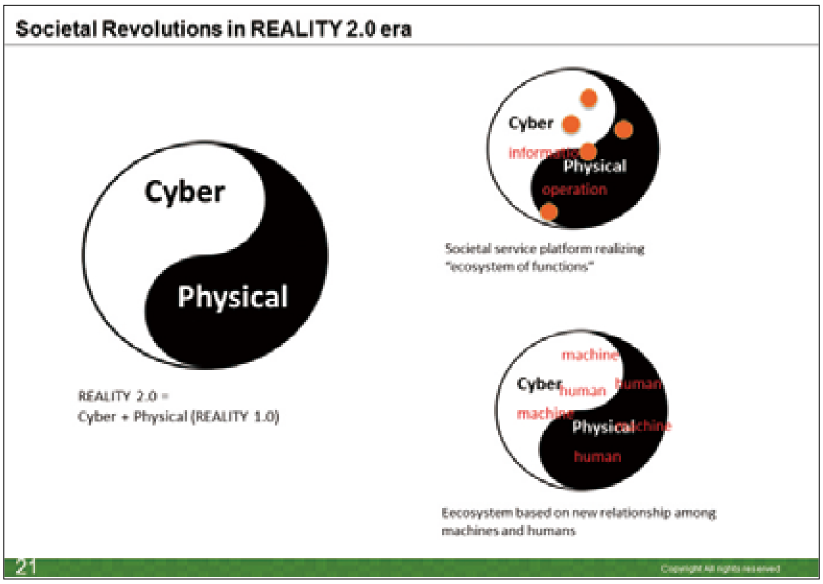
Challenges to Reality 2.0 include how we can functionalize, or "logonalize," things in the physical world, and then once they have been functionalized, how can we call up these functions on, for example, our smartphones? This is what Iwano describes as “Software Defined,” which should also be a part of the aforementioned ecosystem.



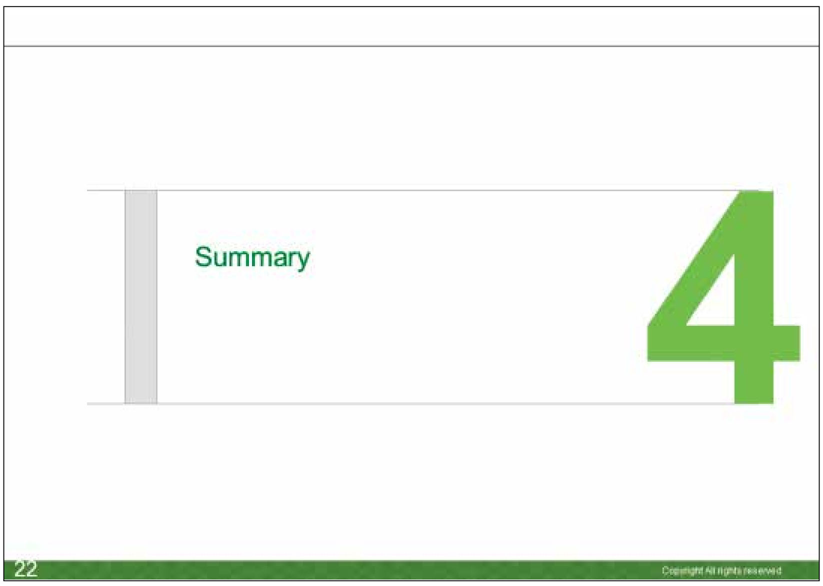
In his visual of a “software defined society,” there is a wide variety of component types related to societal function. Then, using a kind of “realization lens,” he shows how we can mark the ecosystem for specific and dynamic objectives. If this kind of structure can be realized within society, then we can increase things such as GDP or people’s overall level of happiness.

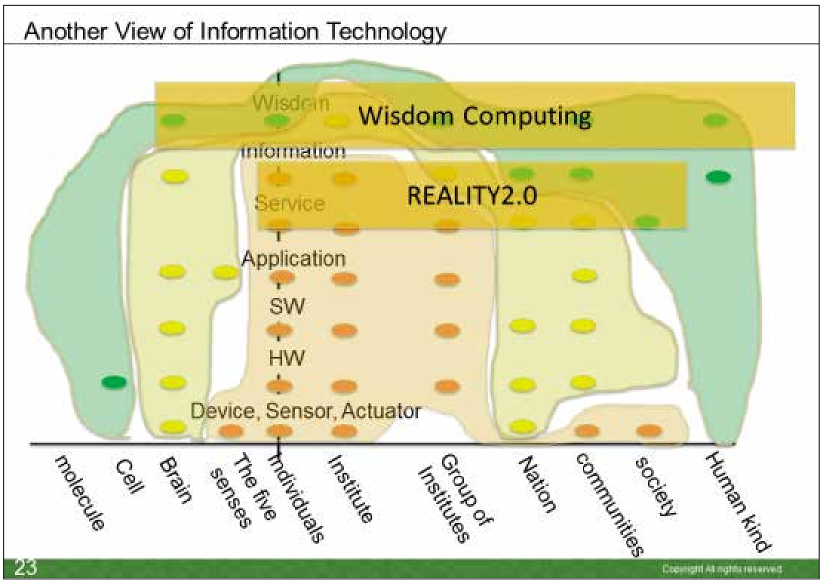


The impact of Reality 2.0 and the resulting advent of a new service society and variable, optimal ecosystems of functions are formed over time and are constantly evolving. As such, the identities and competition principles of individuals, communities, institutes, and nations will be fundamentally changed over time as well. As such, discussions about policy, the maturity level of society, and a different kind (or variation) of an economic system must be initiated as well.



In the future, Iwano believes that individuals within a society or community will find that multiple people or multiple machines will form a single identity. While we are unsure, currently, about how that will look, he posits that this is the kind of world that will follow Reality 2.0.





In summary, Iwano provides a visual for attendees that shows the progression from cells to individuals to nations and humankind and how data, hardware, software, application services, and information wisdom progress in tandem with this evolution, culminating in Reality 2.0 and Wisdom Computing.

Following Iwano's presentation was a question and answer session. The exchanges have been edited for clarity.

Teruyasu Murakami (Audience):

My name is Murakami from RIIS and NTT DoCoMo and I have a question for Jim. I hope you remember that I attended your meeting 10 years ago and was very affected by it. Over the past 10 years, I have been working to develop a community to study service science and I was even the co-chair of the first international conference on serviceology by Arai-san and Hidaka-san and others. Now, you are talking about cognitive system and cars. My question is: Are you talking about an entirely different creature or are you talking about SSM, ET, and C? What is the sort of subject you're talking about?

Jim Spohrer:

I tried to make that clear in one of my last slides where I showed a Venn diagram, which was a circle representing cognitive systems and then in the center there were service systems and the idea is that to be a service system, you have to be a cognitive system. So people, businesses, cities, governments are cognitive systems, and in the backup slides of my presentation, there is a picture that shows three levels of cognitive systems: the digital cognitive based on competition, the biological cognitive systems, and the social organizational. What's happening at IBM is what we call "cognitive business," which involves all of our biological and organizational Reality 1.0 that is now getting merged with cybercognitive systems to encourage intelligence augmentation.

It's like an amplifier happening to all service systems. So, if you think about biological diversity, all the animals and plants in the world, and now as a service scientist you think about service systems and all the people and businesses and organizations and cities, we're at a stage in Reality 2.0 where all of those entities are going to get a big boost in capabilities, but that boost is so large that the likelihood of destructive interactions or positive interactions is very, very high. So, we have to start thinking about the rights and responsibilities of these new types of service systems. Yes, it is service science, but it is the next level of capability for value co-creation and capability co-evolution, which is really what we are trying to draw attention to.

Teruyasu Murakami (Audience):

Service is a co-creation process between provider and receiver. Take Watson, for example, in which we can examine relationships between questioners and answerers, or the people who question and the machinery that answer. But I can't figure out the co-creation process in it. Is it a sort temporary stage of something?

Jim Spohrer:

I think Hidaka's presentation addresses that, because he talks about service-dominant logic. And when you think about the machine, you don't think about it without the organizations that built it, because a machine has no autonomy. I know that is hard for people to think about the fact that a pencil is not just a physical thing, a pencil is all of the knowledge and all of the processes from all over the world that led to its development and creation. I think service-dominant logic tries to explain that. You're asking very good questions but they go into the philosophical edge of service science, so I worry that many people are wondering what you are talking about, but I think you know and I know that other people, like Hidaka, know.

Kazuyoshi Hidaka:

Thank you very much. I would like to ask Iwano about our next challenges that you phrased as steps 1, 2, and 3 and your discussion starts from defining the functions of the society. How do you find the functions in the future?

Kazuo Iwano:

I think a function will be defined by the society and its people, and the functions are very close to the requirements or needs of the people. So, speaking of the kind of components within society, like manufacturers, marketers, and professors, these types of people form societal experiences from the top-down.

Kazuyoshi Hidaka:

Yes, and my actual question is that point. So do you think it is possible to define the functions preliminarily?

Kazuo Iwano:

I think there are a couple of things that we can define preliminarily, such as a priori education or policymaking, though the latter might be replaced by AI. We can define certain things, but eventually we have to devise new functions in the new society. So that new function might be devised by the people or our wisdom.

5. Technology Session

(1) Future Research Directions: NSF Smart and Connected Communities, Sunil Narumalani, Program Director, NSF

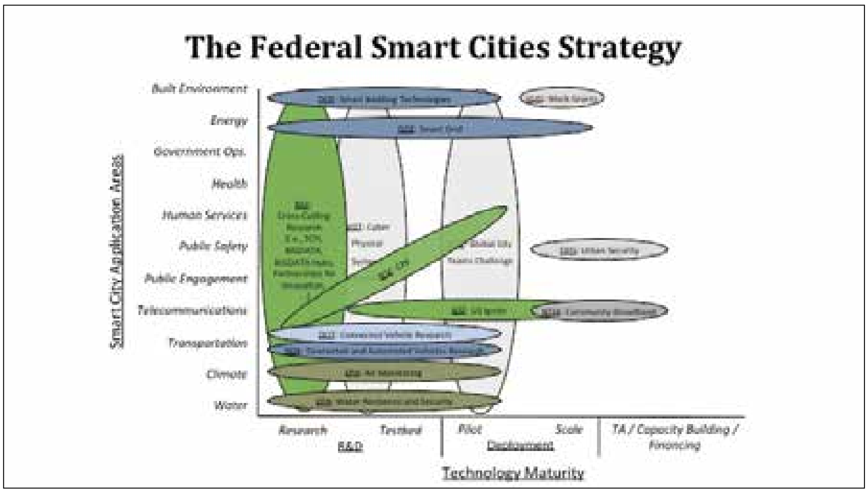
Dr. Sunil Narumalani, who is the Program Director in the Behavioral and Cognitive Sciences as well as the Acting Deputy Division Director for the same unit at the National Science Foundation, discussed what NSF has being doing in regard to smart and connected communities.

The key takeaways from his talk were that, first, there is a national coordination of agencies that work on smart and connected communities. He also discusses how this research began with only the term “smart cities,” but evolved later to the more broad “connected communities.” The NSF provides research funding for different programs across different directorates and fields, and has also published a dedicated document on smart and connected communities that invites proposals for funding related to projects and studies on smart and connected communities.

He organized his talk to first discuss the Federal Smart Cities Landscape—the foundation within the NSF that provides funding for smart cities—and its development and fiscal year activities, followed by an overview of related NSF publications and then a summary of smart and connected communities solicitation.

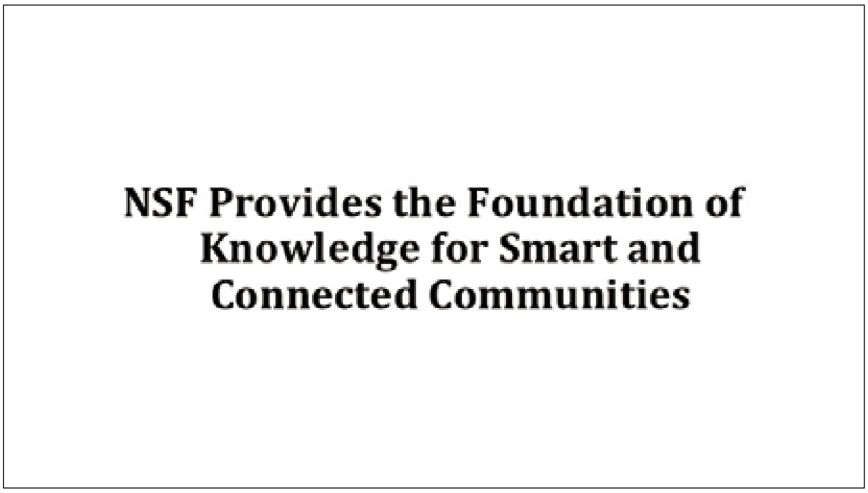
Narumalani first provides an overview of the federal landscape surrounding smart cities, which began formally in September 2015, showing attendees a quote from then-President Barack Obama about the importance of communities getting together and bringing out the best in one another, and making sure that whatever transpires is for the greater good of the broader community. He also provides a visual of a PCAST report (Presidential Advisors on

Science, Technology) in which a smart and connected communities framework was developed with the involvement of different agencies such as NASA, NIFA (the National Food Agency within the USDA), Department of Transportation, National Institutes for Health, and the NSF. The NSF supports basic scientific research, and many of the other agencies involved have different functionalities and different missions.

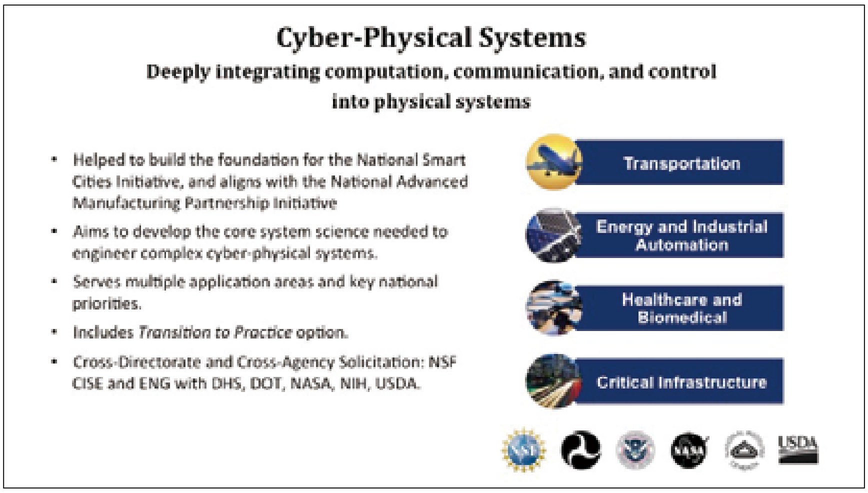


To illustrate the strategy of the federal framework around smart cities, Narumalani provides a graphic in which the x-axis shows the maturity of technology and how the evolution takes place from research to eventually capacity-building. Along the y-axis are the different potential agencies and functionalities that are involved in this evolution over time. He uses green bars to show where the NSF fits on this timeline, with a large vertical green bar depicting "basic research," which is a core function of this endeavor, even now extending into the testbed and pilot stages.

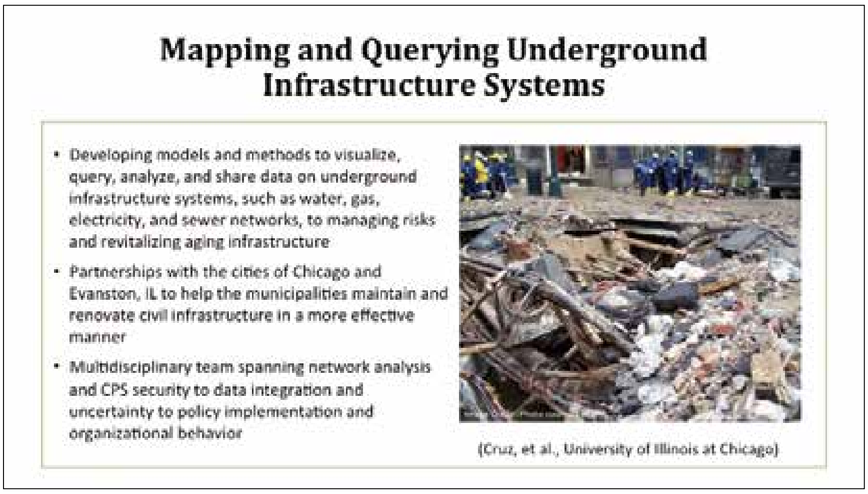
As he stated previously, each agency's aligns with its mission in terms of development, using the Global City Teams Challenge to illustrate this point using the NSF. For example, the NSF has been a substantial participant in US Ignite and NIST (the National Institute for Science and Technology) as well as the Smart City Challenge initiates by the Department of Transportation. Columbus, Ohio, won an award for this challenge at, initially, $40 million which the city was able to leverage into a $100 million investment.



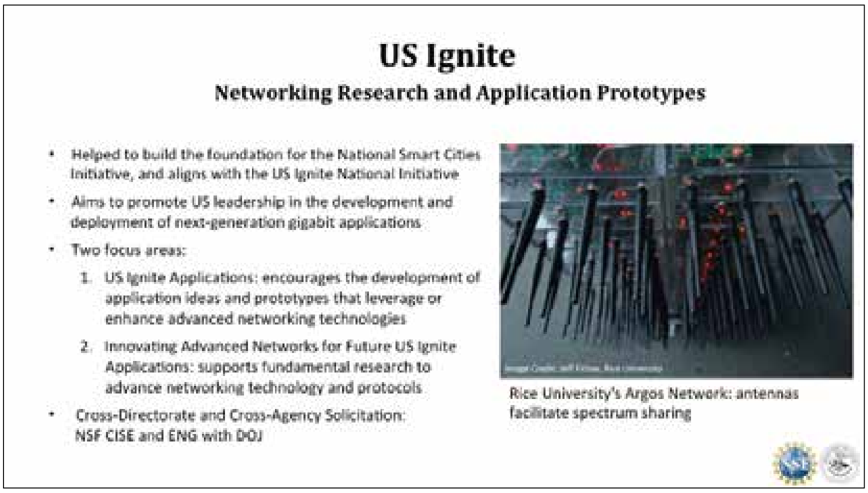
NSF provides the foundation for smart and connected community through investments in cyber-physical systems, advanced networking, and Big Data, among others across application areas such as energy, environment, health, and public safety. He points out the special use of the word "application" in this context because NSF is a basic science agency, but the translation of the basic research that is done moves into the private sector and non-government sectors as well.



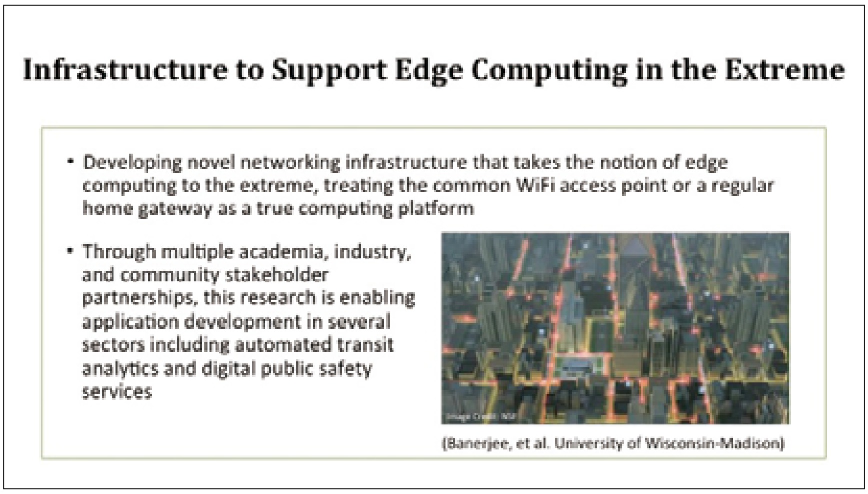
Narumalani uses one of the programs, cyber-physical systems, to show how various areas are affected by some of the funding provided by NSF: transportation, energy and industrial, healthcare benefits, and critical infrastructure.



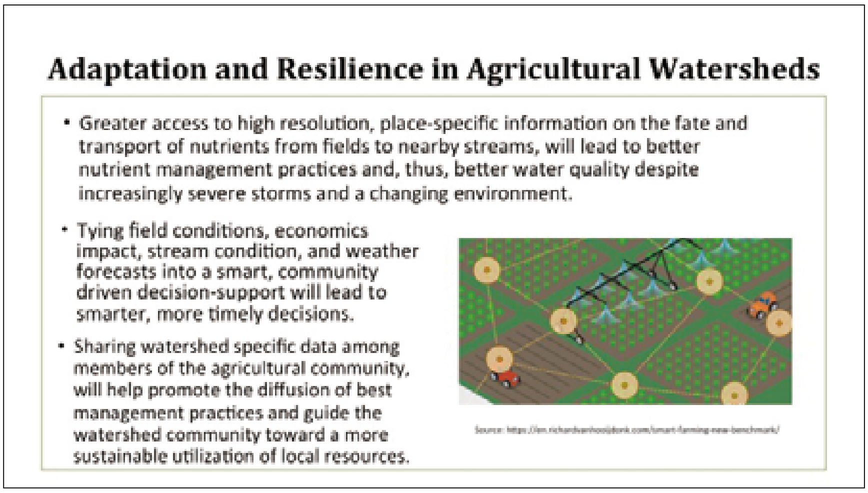
One of the ways in which the NSF is helping to solve issues within communities is by mapping and quarrying underground infrastructures, which is important in cities throughout the world; for example, concerning the gas lines, power lines, cables, anything underground that can could be damaged by someone digging. The NSF is working to make these systems more efficient and intuitive, to reduce the possibility of accidents and disasters. Again, he stresses how the basic research component of the NSF expands into applied areas.



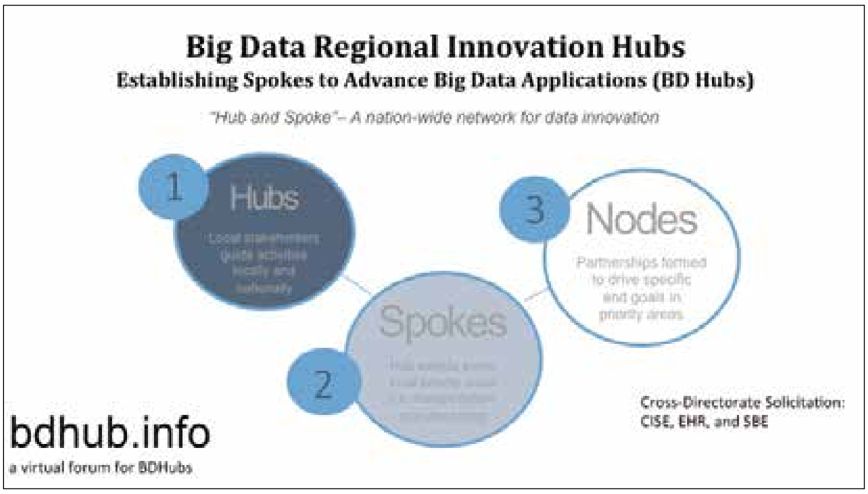
US Ignite, in which the NSF is involved, is the promotion of U.S. leadership for high-speed networking and applications. In June 2016, NSF changed the solicitation to make it more focused on using advanced networking systems for smart and connected communities.



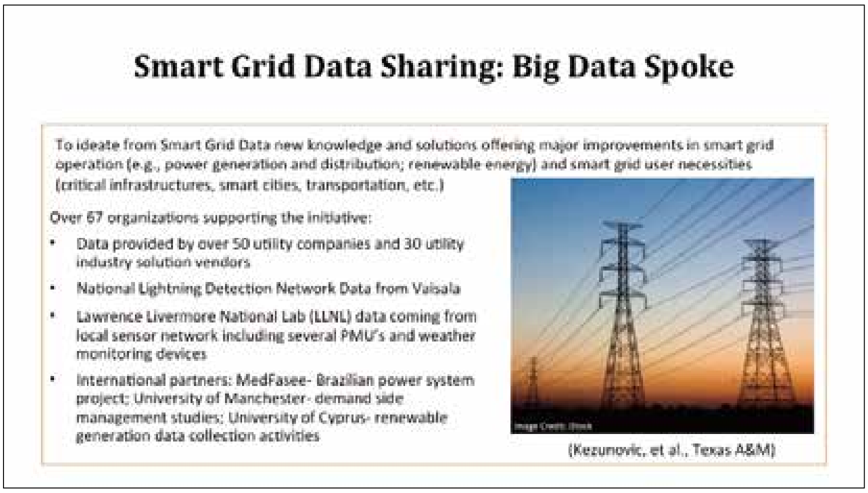
In addition, the NSF has infrastructure to support Edge Computing in the Extreme, which is part of the US Ignite's project for Wi-Fi access points in order to develop faster community systems, so that data can be transported more quickly over wireless networks.



Narumalani also stresses that agricultural communities are an important component to smart communities (i.e., you have to feed the population). He describes how smart sensor systems can be used in agriculture to improve productivity and yield, as well as to monitor watershed and other potential impacts on the yield of the area.



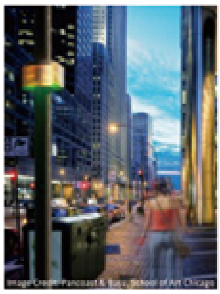
NSF has invested significantly in Big Data across different formats such as basic research, in cyber infrastructure, in education and workforce development, in diversity, etc. to develop different the "hubs and spokes" as well as the nodes to advance Big Data applications. As an example of this Big Data investment, Narumalani speaks to attendees about an electric grid project, in terms of bringing together different utility companies and utility industrial solutions to the nodes.



He also refers back to the aforementioned Global Cities Challenge for cyber-physical structures in which the NSF has been investing toward different physical devices and networks to help with this challenge. In addition, he provides another investment example of making electrical shuttles for safe and for reliable mobility, headlined by the Department of Transportation's Smart City Challenge winning team in Columbus, Ohio, which received NSF funding toward efforts to realize these electrical shuttles.

Major Research Infrastructure:
Urban Scale Instrument to Measure City's Fitness

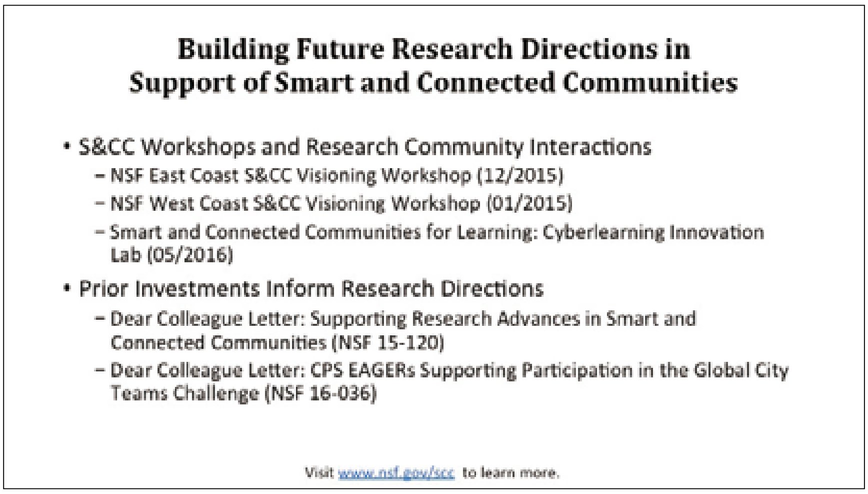
- Developing and installing nodes for measuring the urban environment including carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, ambient sound, and pedestrian and vehicular traffic
- Data will be free and publicly available through the City of Chicago Data Portal
- Partnership between City of Chicago, University of Chicago, Argonne National Laboratory, School of the Art Institute of Chicago, Northern Illinois University, and University of Illinois at Urbana-Champaign



(Catlett, et al., Argonne National Lab)

Urban scale measurement to gauge a city's "fitness" is another area in which NSF is investing in nodes, here to measure carbon monoxide levels, ambient sound, and pedestrian and vehicular traffic through its major research infrastructure program, or MRI. Using the example of this type of activity in Chicago, Illinois, environmental data is being measured in partnership with the City of Chicago, the Argonne National Laboratory, the University of Chicago, and other local institutions.

NSF Develops a Multi-pronged Smart and Connected Communities Approach in FY 2017

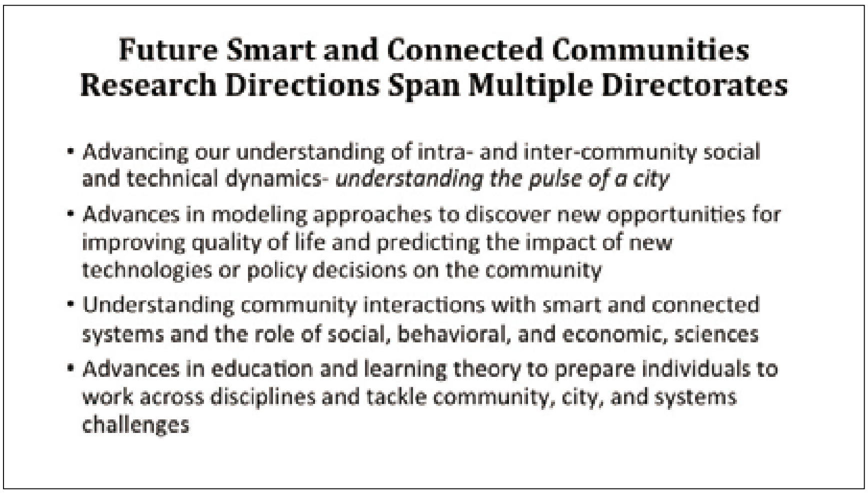


Next, Narumalani provides an overview of the NSF's multi-pronged approach to smart and connected communities investment in 2017. The group held workshops on the East Coast in Washington, DC, in December 2015, another on the West Coast in Seattle, Washington, in January 2015. The purpose of the workshops was to support basic science education and get input from people in the community on what areas in which the NSF should be investing in innovative research (he references Iwano's talk of wisdom computing as the type of ideas that NSF is interested in, rather than task-based or incremental research). These big-city endeavors were followed up with input from agricultural communities as well.

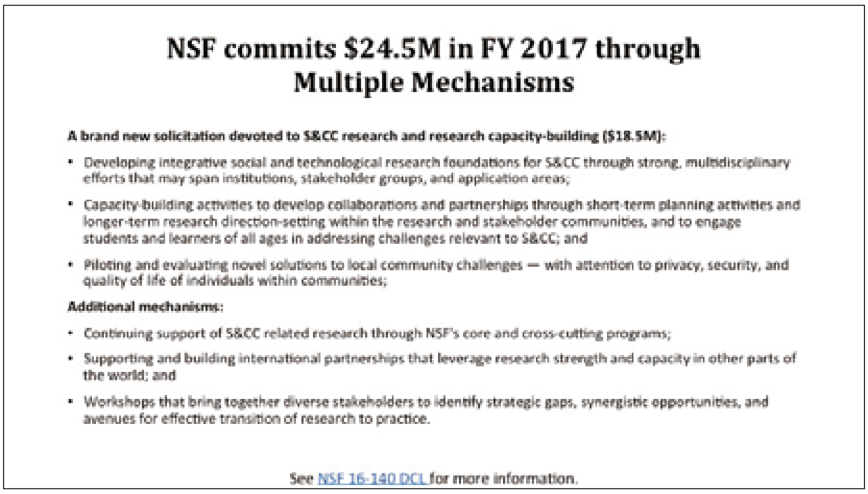
The ultimate goal of gaining this information from researchers and stakeholders is to forge a more appropriate and efficient path of multidisciplinary research across the board from the perspective of engineering and computer science, as well as in relation to social behavior and the economic sciences. The ultimate user of any development is, ultimately, human beings, so the NSF feels that it is critical to understand what people are going to do and what they want; otherwise, the technology would be useless. The NSF is also trying to ensure that relationships are built with the right partners and others within the communities. Then, workshops and other activities can be held to bring together people in order to build research capacity, not just in academic researches but also industrial partners and community stakeholders.

The NSF also wants to have international partnerships even though it is a U.S. funding agency. They want to ensure that the projects in which the group engages are geared toward the greater good of the broader international landscape. This type of partnership could provide opportunities, for example, to collaborate with institutions in Japan, which could apply for funding from the NSF and also engage in data-sharing, as open access would be an important component to this type of involvement.

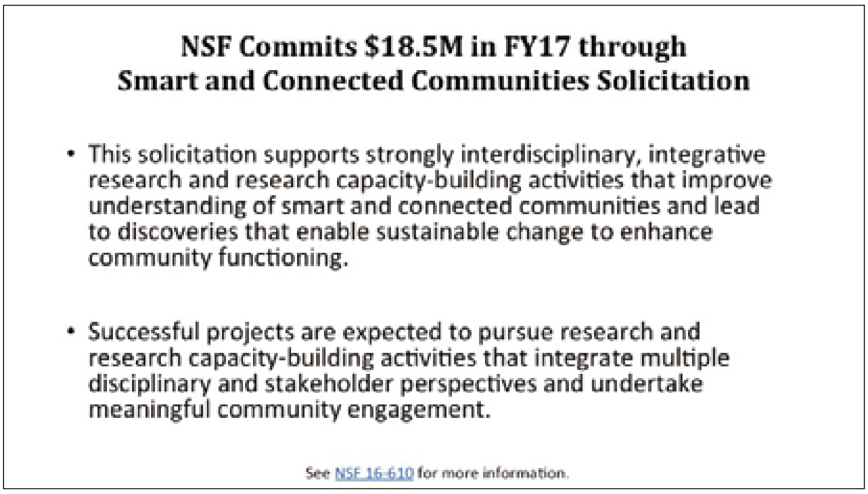
He also stresses that solicitations on smart and connected communities span multiple directorates (e.g., computer science, engineering, geo sciences, education, human resources, and social, behavioral and economic sciences). Smart and connected communities are an integrated cross-disciplinary sort of solicitation with various desired outcomes.



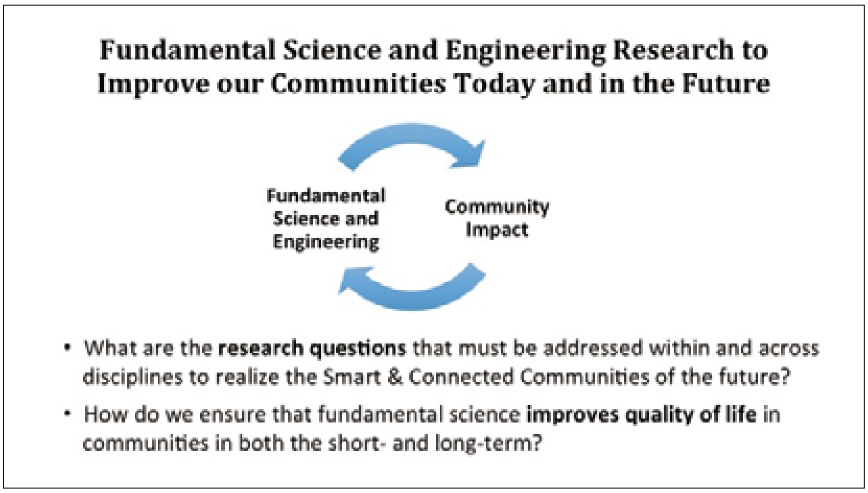
Understanding the pulse of a city, according to Narumalani, is an important part of what the NSF is doing, to advance modeling approaches, understand community interactions with different systems, and advance educational learning and basic theories.



The NSF is committed to spending $24.5 million in forthcoming fiscal year that began in October, with $18.5 million earmarked for the solicitations he discussed in his speech at the summit, with the rest earmarked for different programs such as Ignite and other similar mechanisms.

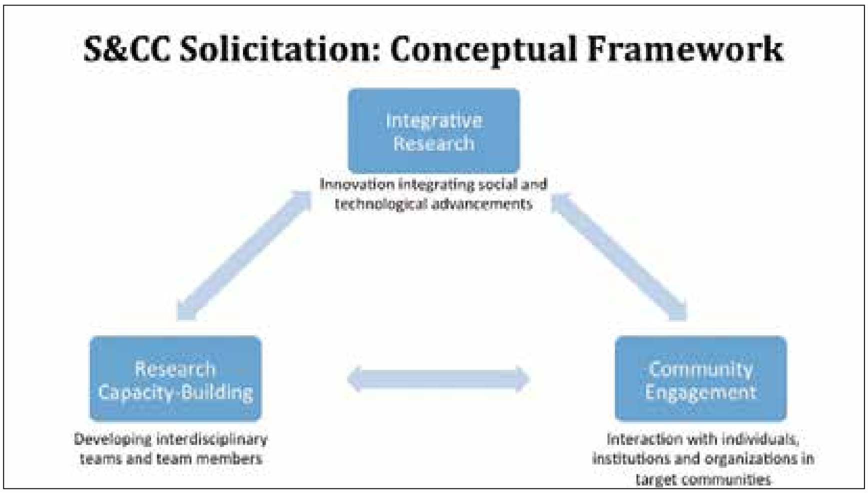


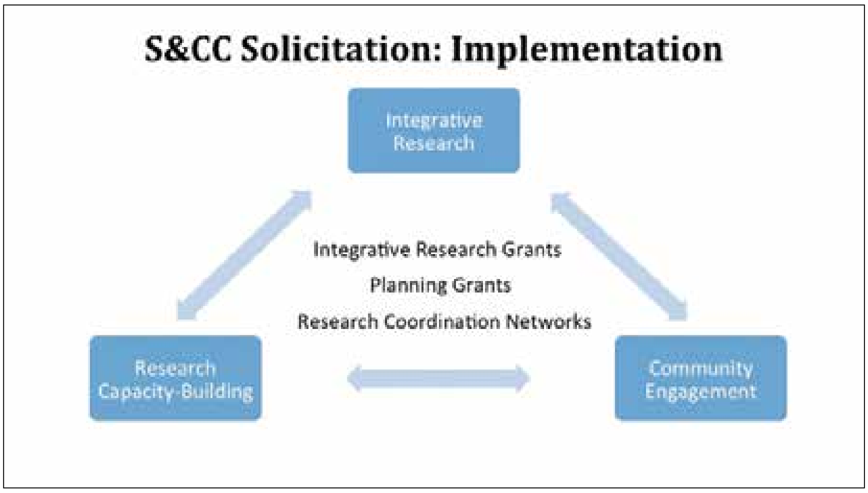
The solicitation commitment by the NSF is interdisciplinary and targets integrative research (e.g., a project might be heavily computer-science oriented but a social scientist will be present for certain aspects, and vice versa, in a social behavioral project that also has a computer scientist who is there programming code). This integration is aimed at reaching meaningful community engagement and enhanced community functioning.



As Narumalani states, “a community can be anything,” but for the NSF’s particular solicitation, it must be geographically defined and have a governance structure; as such, virtual communities are not yet a part of this program. As the program is extended over the next 10 years, however, virtual communities may start to become valid participants.

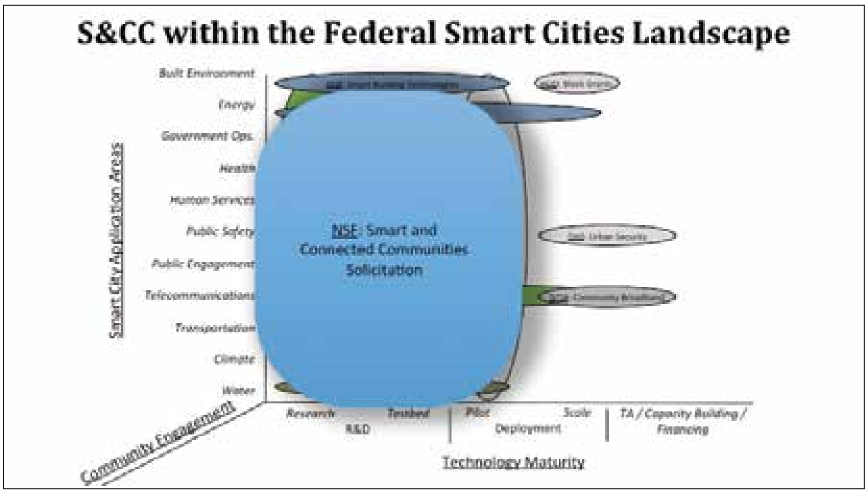
He then illustrates how fundamental science and engineering are fed into the community, and how the community then is feeding back and improving into fundamental science. In essence, it is a feedback loop and has to be something that benefits both players with the unifying and underlying purpose of improving quality of life. This visual is meant to encompass innovation and community engagement, where research-capacity building has different components and requires interaction with individuals and institutions.



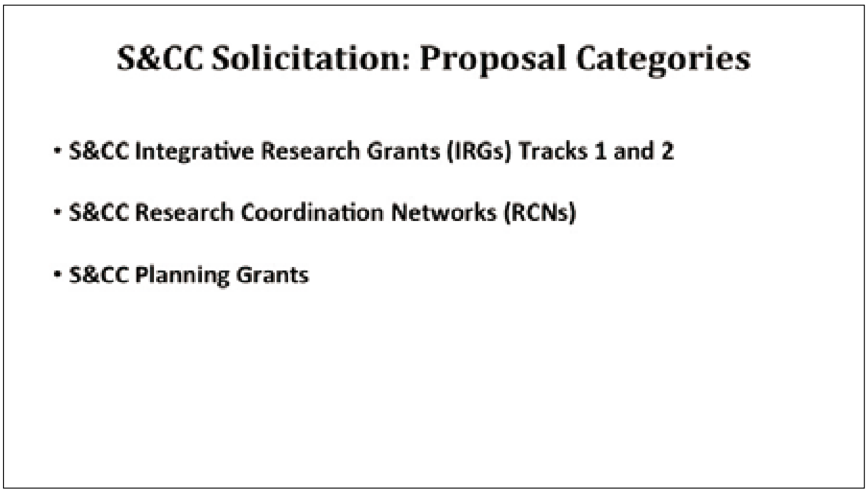


But can the university be a community? Narumalani does not believe so, because oftentimes the university serves as a leader by initiating the basic research that takes place; however, universities can partner with private sector companies as long as their proposals include community engagement.

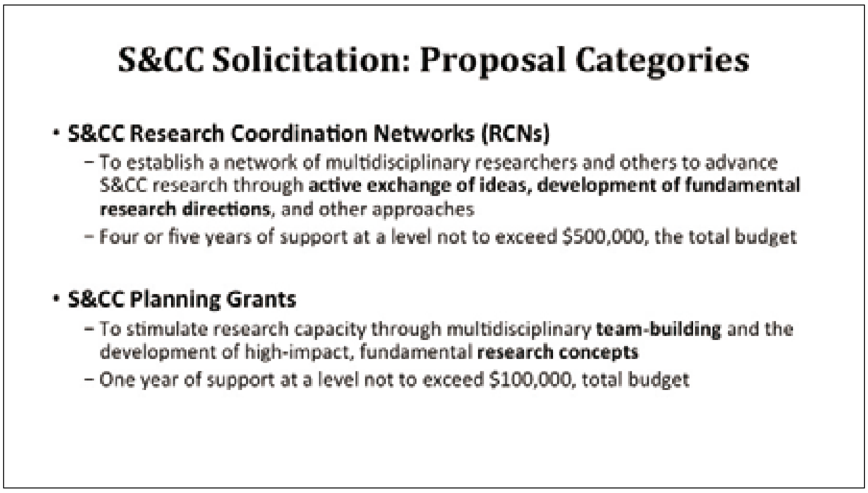
Implementation, then, requires "buckets" such as integrative research grants, planning grants, and research collaborative coordination networks. Integrative research grants are designed to garner ideas from the research community (planning grants, a little less so), and research coordination networks are an opportunity to build mechanisms through which scientists and people from other sectors can collaborate.



Similar to a graph that was displayed earlier in his speech, Narumalani refers to the Federal Cities Landscape, but in the updated chart, the NSF encompasses not just basic research but spans across different components on the x-axis, including testbeds and pilots. The group is looking forward to a future mechanism by which some results of early-stage research gets “off-ramped” into pilots and testbeds.

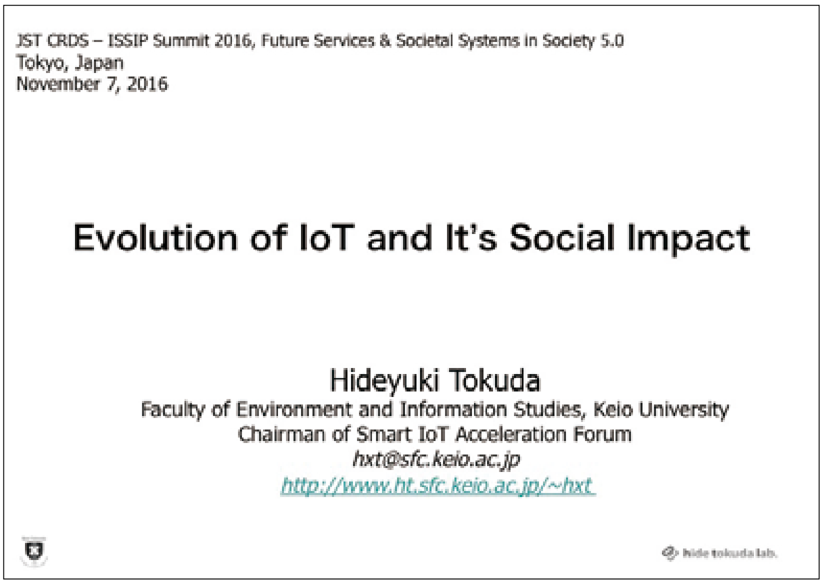


Within integrative research there are two tracks, where Track 1 comprises larger projects (e.g., a $5 million project that may span 3–5 years), and Track 2 comprises smaller projects (e.g., $1 million over 3–4 years). Track 1 usually sees interest from institutions or groups of individuals that are already mature, but that need additional support to take their idea to the next level. In Track 2, you will see groups that have a solid idea but need additional coordination in addition to funding.



Narumalani ends his discussion at the summit by speaking about the research coordination function, which is essentially an active exchange of ideas, during which participants develop fundamental research directions, which can lead to new ideas and, therefore, potentially newer types of research and other types of funding. Planning grants is more of an exercise of team building and starting to understand some of the basic research and new high-impact fundamental research concepts.

(2) Evolution of IoT and Its Social Impact, Hideyuki Tokuda, Professor, Faculty of Environment and Information Studies, Keio University



Hideyuki Tokuda, from Keio University, spoke about several ongoing projects at his institution, such as "ClouT," which is a project that integrates IoT and cloud technology to create smart cities. The projects all seek to utilize social and open Big Data, rather than Big Data at the enterprise level. Tokuda and colleagues aim to encourage local governments and municipalities to utilize this type of open data more often and in more capacities toward improving future society. First, however, he discussed with attendees his view of AI, in which he states that he prefers a greater emphasis on intelligence augmentation and skills geared toward integrating human intelligence (HI) with intelligence augmentation (i.e., HI plus IA is better than only AI). Then, he discussed the evolution of IoT before speaking about the social impact.

IoT in Japan is going through its "emergence" phase, with many companies discussing IoT and ways to integrate it into their business with the goal of finding new opportunities to create new values. In terms of AI, this would involve the convergence of IoT, Big Data, and accelerated AI. Without data, for example, you cannot use machine learning.


Accelerating
Convergence of IoT, Big Data, AI
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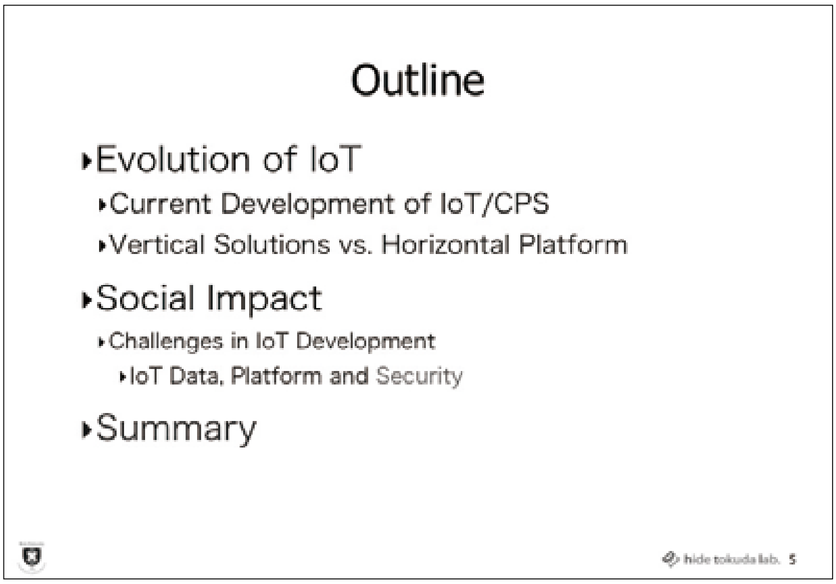
Outline
Evolution of IoT
Current Development of IoT/CPS
Vertical Solutions vs. Horizontal Platform
Social Impact
Challenges in IoT Development
IoT Data, Platform and Security
Summary
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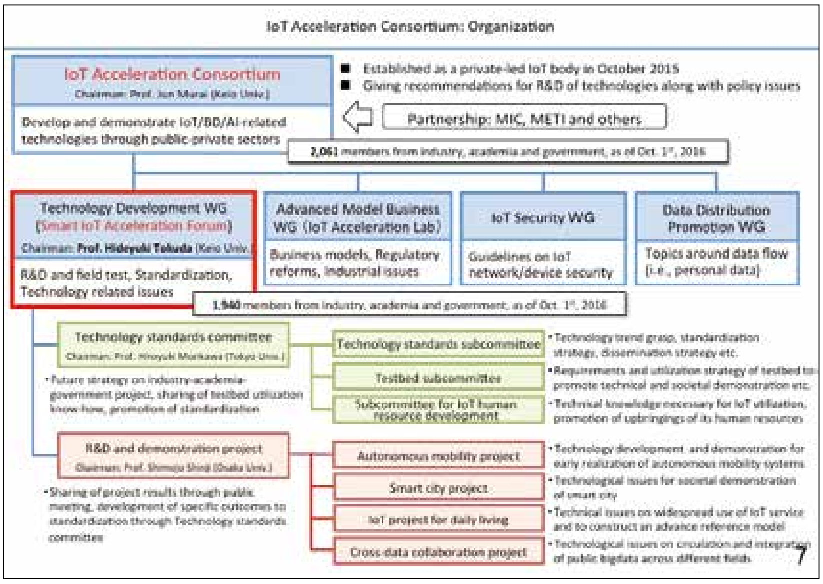
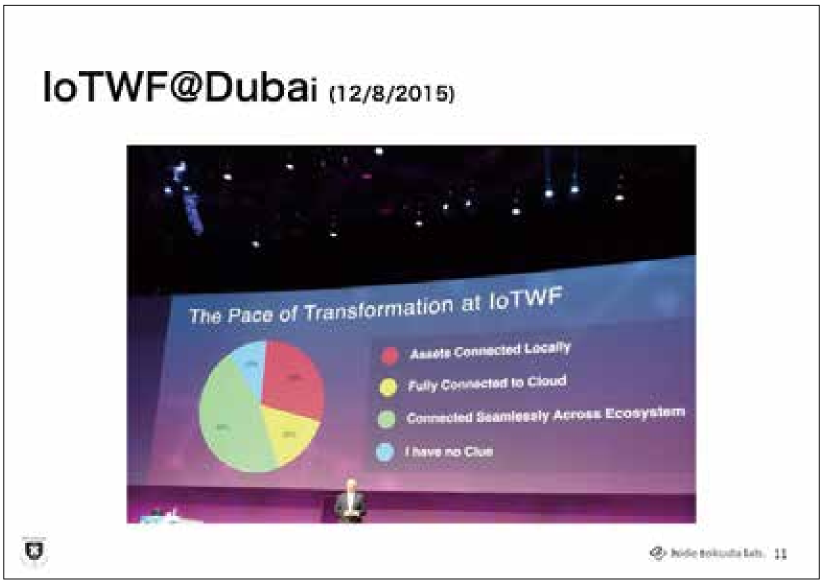
In October 2016, Tokuda and colleagues launched an IoT acceleration consortium in Tokyo, involving about 900 companies who were all interested in accelerating IoT and technology within their business.



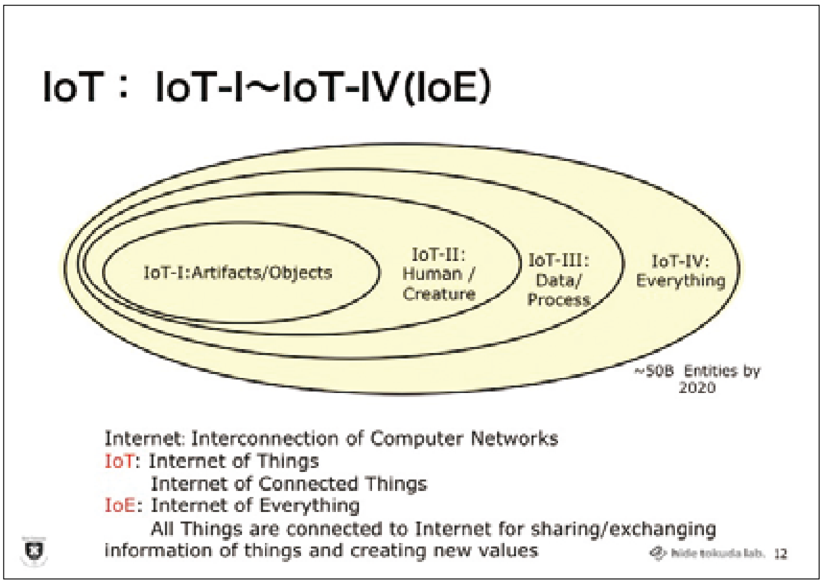
He displayed for attendees a slide that detailed the four working groups of the consortium: Technology Development Working Group (on which Tokuda is the Chair), or the Smart IoT Acceleration Forum; Advanced Model Business Working Group, or IoT Acceleration Lab; IoT Security Working Group; and also the Data Distribution Promotion Working Group. Under these smart IoT acceleration forums is a Technology Standards Committee as well as R&D and Demonstration Project teams. All four working groups and committees are aimed at accelerating the convergence of IoT, Big Data, and AI.

Outside Japan, this same sort of effort was occurring in February 2013, as Tokuda was one of the steering members for the IoT World Forum, organized by Cisco at their campus in California. Only ~50 people from around the world were invited to this meeting.

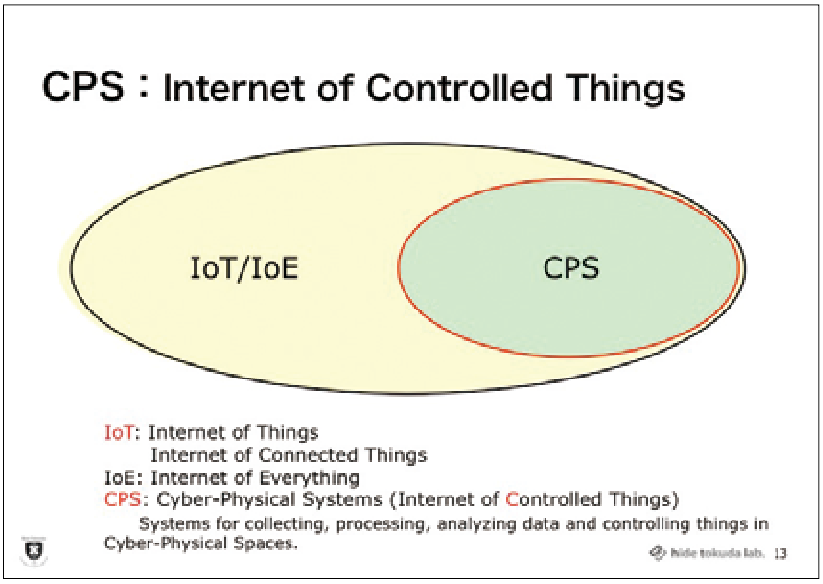
Later, the forum was hosted in Barcelona, then in Chicago, and then in 2015 it was hosted in Dubai.



One of the common questions for attendees of the forum is “How far are you pushing IoT technology in your business?” Roughly 29% of participating companies confirm that their assets are connected locally, with 15% stating that they are “truly connected to the cloud.” In this global consortium, Tokuda has witnessed that companies who state that they are already connected seamlessly across the ecosystem are outpacing the percentage of Japanese companies who state the same; as such, IoT seems to be accelerating outside of Japan.

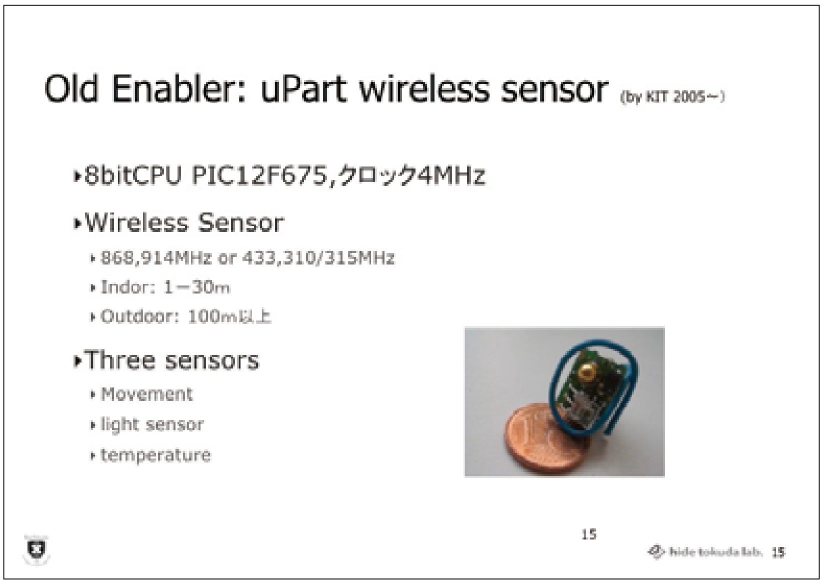


Tokuda stressed that IoT is more than connected objects in physical space, as it can include objects, artifacts, humans/creatures, data/processes, etc. that are connected to the Internet with the purpose of sharing, exchanging information, and creating new values.

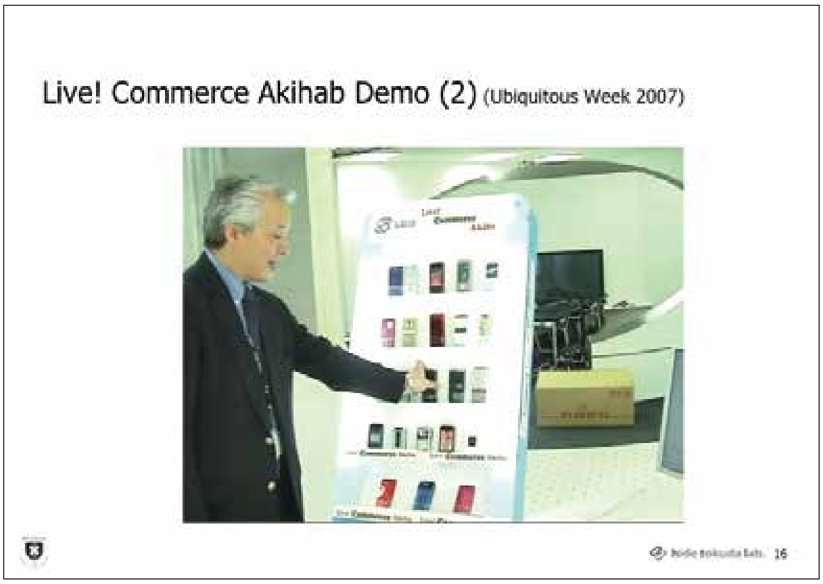


He also touched on cyber-physical systems (CPS, also discussed by Narumalani earlier in the summit), though for his current presentation, he renamed this concept as the “Internet of Controlled Things.” So, instead of individual object data processes, these are controlled by a certain entity.

One reason for acceleration is that there are so many “smart” enablers available currently, which makes it easy, cheap, and reliable to connect.



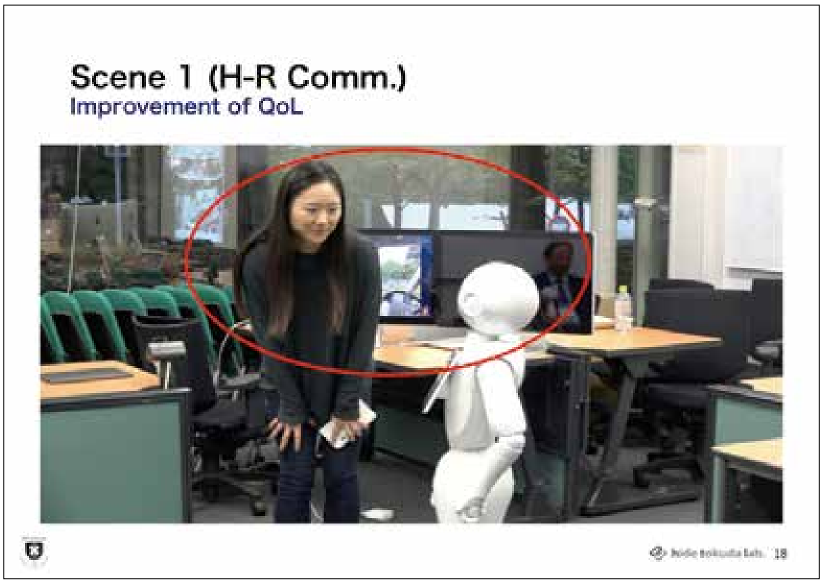
Approximately 11 years ago, one of Tokuda’s research partners at the Karlsruhe Institute of Technology created a tiny sensor called the uPart wireless sensor. The sensor cost around €20 and was an 8-bit CPU with three different types of sensors inside of it: movement, light, and temperature. There was keyboard or display, only a small sensor with wireless communication enabled.



He and his colleagues put this sensor into objects at a mobile phone shop over a period of two days. As customers browsed those specific physical mobile phones and held them in their hands for more than four seconds, the sensor would detect "interest" and gather pricing information and reviews/comments on that phone from the internet, so that the shopper could review this information before making a purchase.

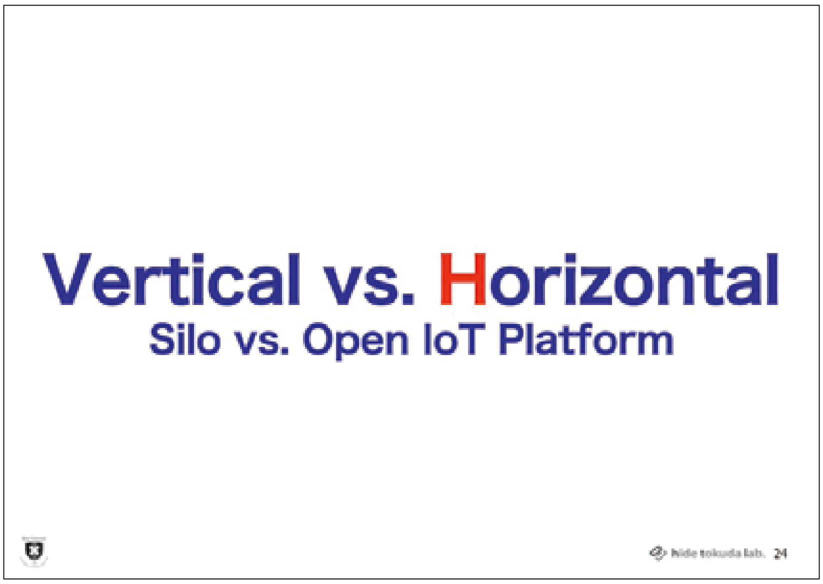
The chip could access roughly 4 million records, or 243 megabytes of data. When viewing results on a terminal, one could analyze the sales information. Even when a customer decides not to purchase a phone, one can use the pre-sale data for analytical purposes; for example, Model A was compared with Model D, etc.

Tokuda and his colleagues also engaged in a demo involving IoT and CPS to better understand how humans and machines can work together to shape a better future society, considering both technological and social issues. He then showed summit attendees a video set on the Keio University campus.

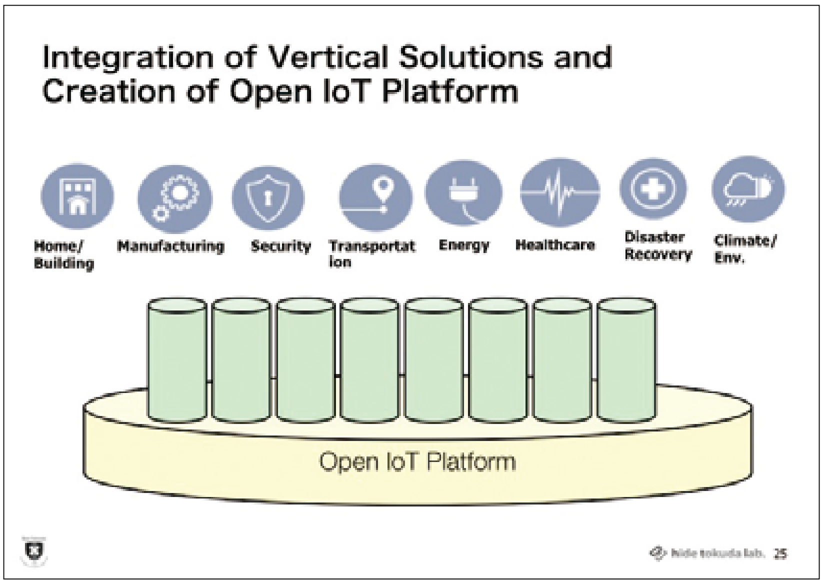


The first scene showed a fourth-year student pretending to be an elderly person living alone with a personal robot in order to improve her quality of life. If the "elderly woman" has an appointment at the hospital but forgets, for example, the robot (called R-1) may receive a phone call from an agent at the hospital as a reminder.

After receiving the alert, the robot tries to make a reservation for an autonomous Uber to take the woman to the appointment (though in the video shown to attendees, Tokuda and colleagues used an international guest and professor to “pick up” the Uber). This would be considered a connected service issue for which there is not yet a proper protocol in the real world; however, the demo seeks to identify the social issues and technology involved with this kind of agent-to-agent communication.

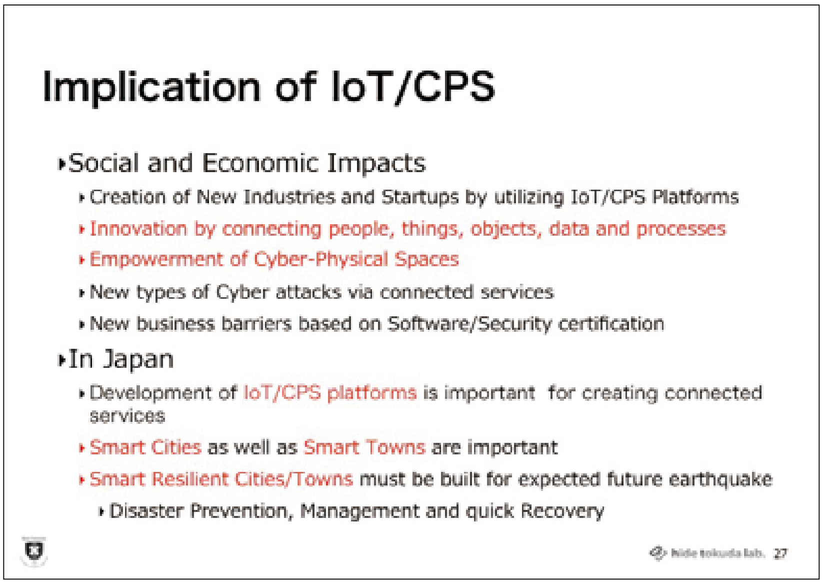


Researchers at Keio University and beyond are adopting so-called vertical solutions with an open IoT or CPS platform.

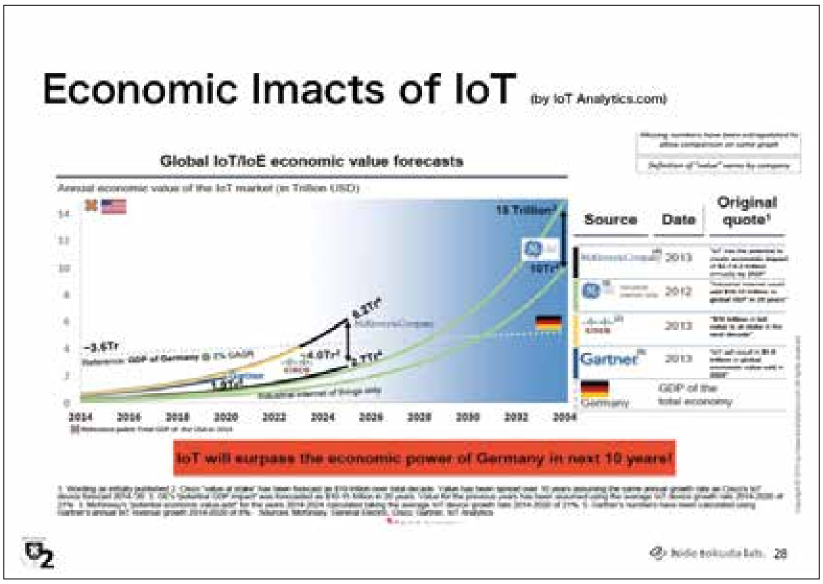


An open IoT platform allows you to exchange the data stream within a different domain; for example, the data would not be isolated in just the transportation silo but could be linked to healthcare, energy, and other sectors. Tokuda references Iwano's discussion of Reality 2.0 but posits that the kinds of solutions that he is discussing in the current presentation were more akin to a "Reality 1.2," because there is still a fence between the domains.

Tokuda next discusses the social impact of accelerated IoT and Big Data development.

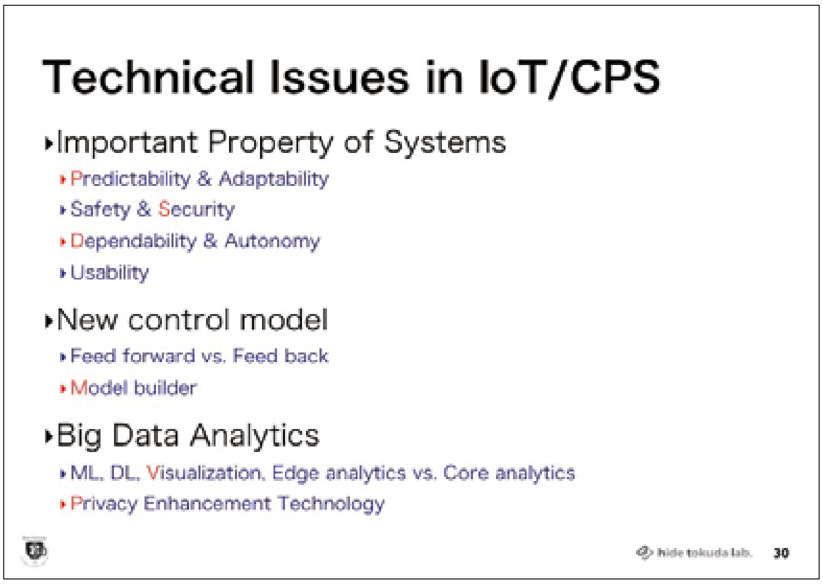


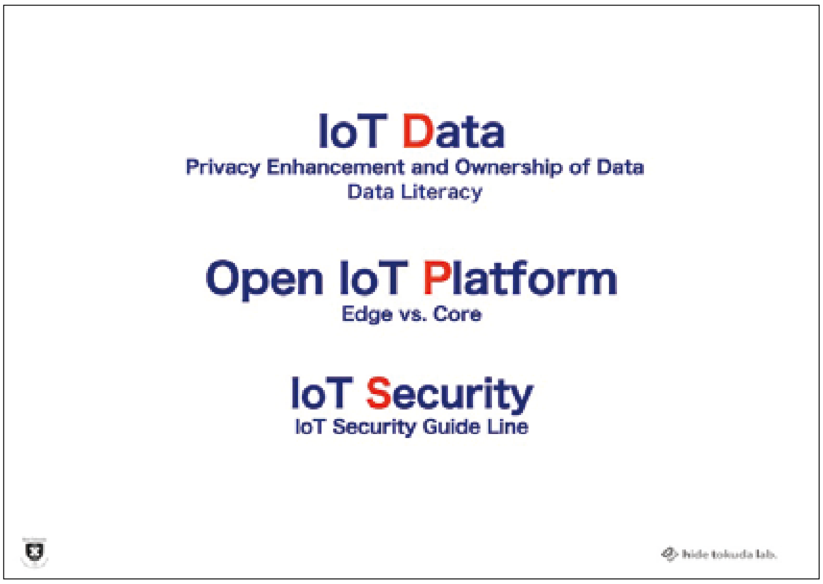
In terms of social economic impact, the innovation of using IoT and CPS platforms connects objects, people, data, and processes and also empowers cyber-physical spaces. As such, this can create a new industry and new startups; however, there is some risk as well, such as new types of cyberattacks via connected services and new business barriers based on software security certification among others.



In terms of economic impact, he uses the example of German company IoT Analytics Dotcom, which predicted that by the year 2023 the GDP of Germany will be roughly $3.6 trillion, and the IoT market will exceed this figure. As such, there appears to be a merit for creating connected services.

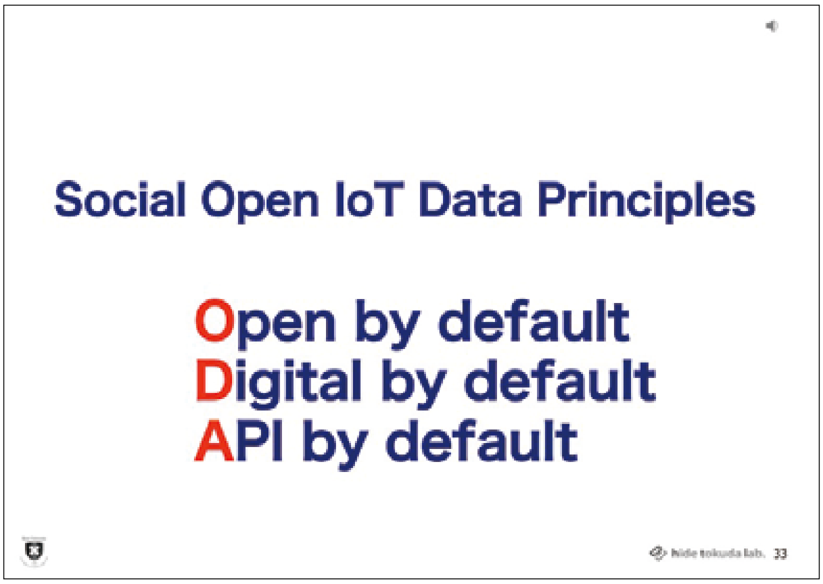
But as with the social impact, there are connected risks as well.





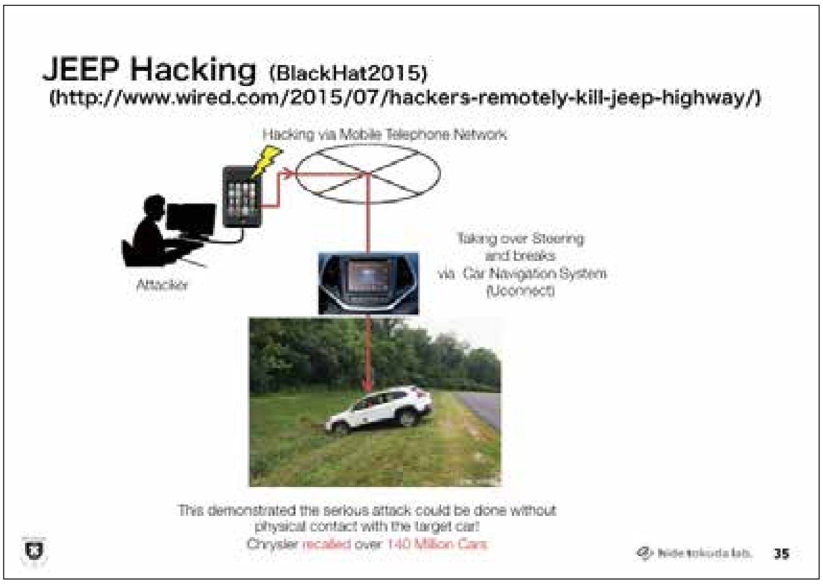
He provides a variety of detailed technical issues, but chooses to elaborate on three topics: IoT data, open IoT platforms, and IoT security. In terms of wisdom computing (again referencing Iwano's speech at the summit), this would actually be a type of open knowledge platform and knowledge security, or "wisdom platform/wisdom security."

One of the primary concerns with IoT and CPS is the question of who owns the data and what sorts of privacy enhancement and data literacy are required. Each country has unique data protection rules and notions of privacy and access control; it is not universal.

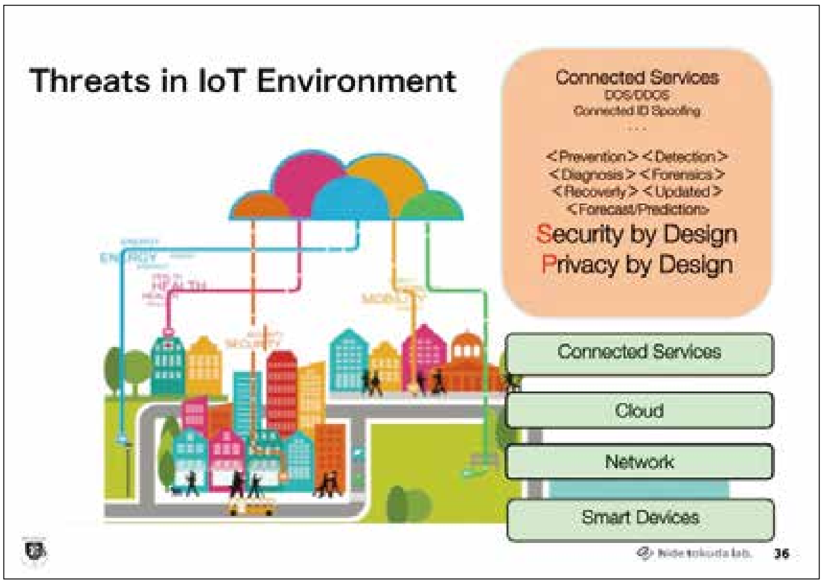


Tokuda emphasized a few simple principles for social open IoT data: open by default, digital by default, and the API default. Currently, some aspects are already open, but while some things are digital, others are not quite there yet. In addition, API is not well-supported in many cases.

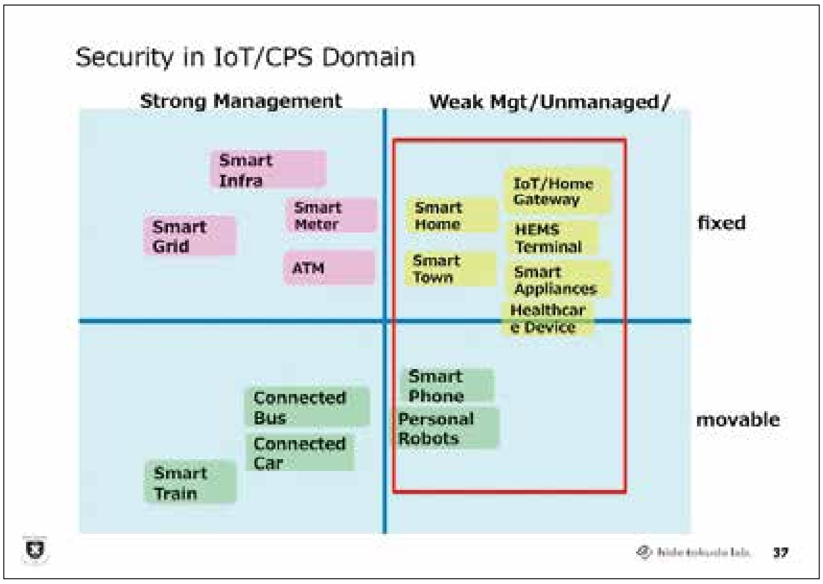
IoT security is serious because, unlike traditional cybersecurity, it can involve human lives.

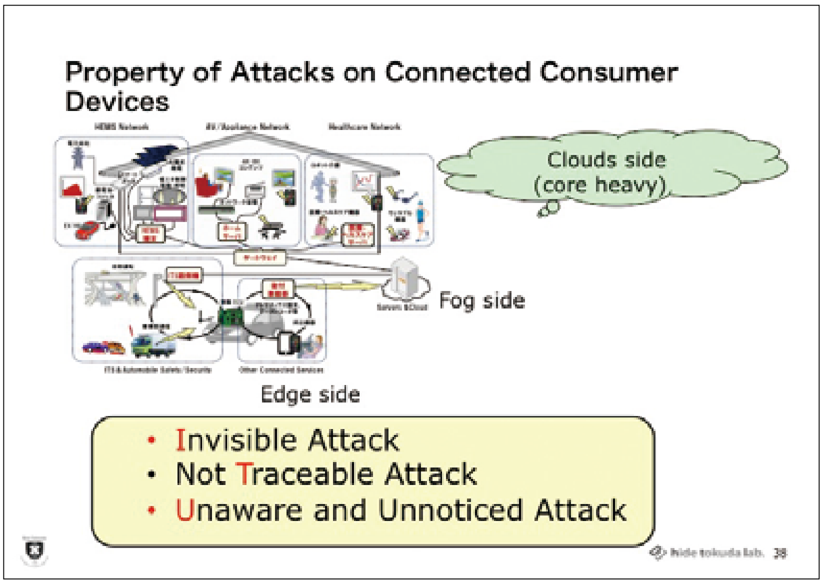


One example is the mobile hacking of JEEP automobiles in 2015. The “hackers” (which were actually researchers) were able to find a weakness in JEEP’s connected service called Uconnect. They rewrote the formula and then could penetrate into the embedded network to take control of the steering, brakes, and other functions. As a result, Chrysler recalled ~140 million cars and suffered incredible social damage as well as legal ramifications.



As such, creators need to ensure that the product or service will have security "baked in" at the very beginning of the production cycle (e.g., security by design or privacy by design), so that the entire lifecycle of device or services, connected devices, etc. will be concerned with the security and privacy aspects.



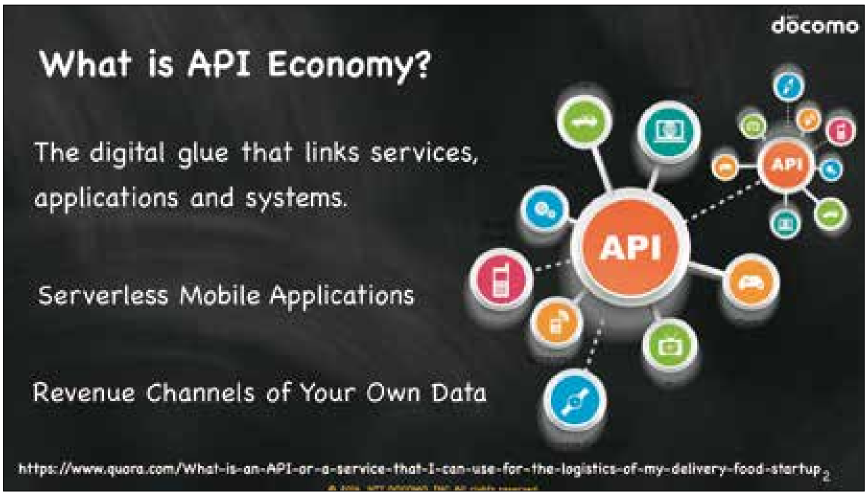


One unique aspect of IoT devices or services is the idea of “invisible attacks,” and because smart devices are becoming so cheap and small, it is often not a priority for some manufacturers to add a “black box” feature to make them traceable; as such, if the device is compromised, it is difficult to find out what is happening.

In the Japanese community, Tokuda and colleagues published the first version of IoT security guidelines for creating connected devices or services in July 2016. He stated that his team is working toward a better future that does not just push technology but also considers regulations and rules and how technology and social innovation can together shape a better future society.

(3) Micro Services and Innovative Organizations Toward an API Economy, Minoru Etoh, Senior Vice President, NTT DoCoMo

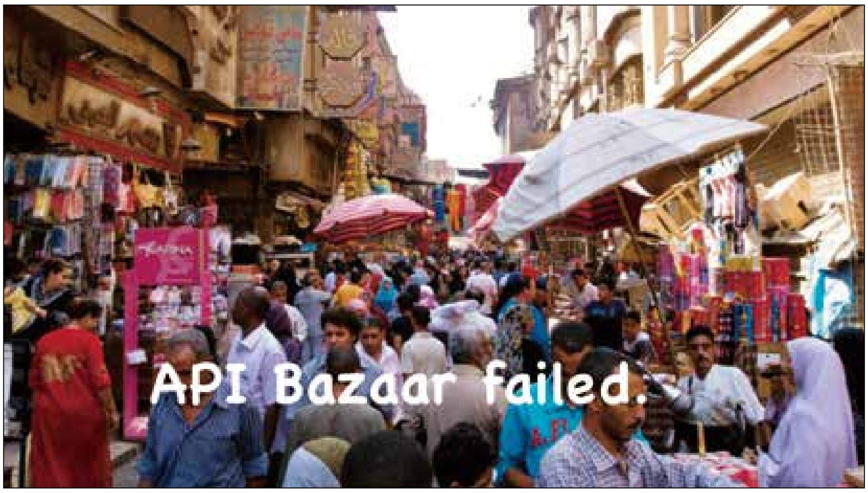
In addition to serving as the Senior Vice President, NTT DoCoMo, Etoh is also the Research Director of a new JST funding program related to AI, and presented at the summit a discussion about how micro services and innovative organizations can help us to work toward an API economy. He emphasizes that technology services should not be isolated from organizations, as innovation should be coupled with technology and organizations in order to work toward new things.



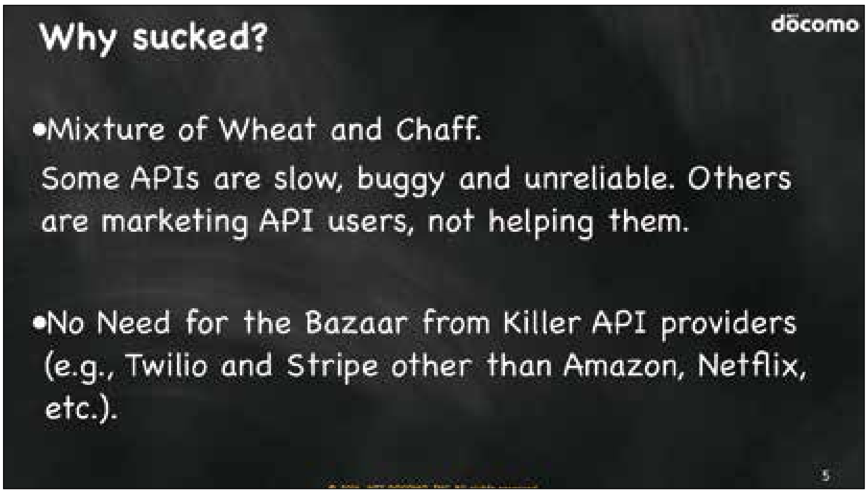
He agrees with Iwano about the future success of an API economy, because through the API, we can connect with each other through not only devices but also through organizations and be able to monetize insights gleaned from data and even API itself.

He views the API as a crucial gateway that links services, applications, and systems, and believes that it has become hyped by things like serverless mobile applications (e.g., AWS Lambda Functions, which do not require any servers). In his speech at the summit, Etoh first discusses Reality 1.0 before moving into Reality 2.0, coined by Iwano.

API economies first gained traction as being a potential success story almost three years ago; immediately following, several startups emerged (e.g., Mashape, which still exists) and they opened an API market on their platforms to sell or trade APIs. Apigee, which was acquired by Google aspired to provide secure, controlled, organized API gateways, while Mashery (before being acquired by TIBCO Software, SIS in Palo Alto) aimed to provide API management portals.

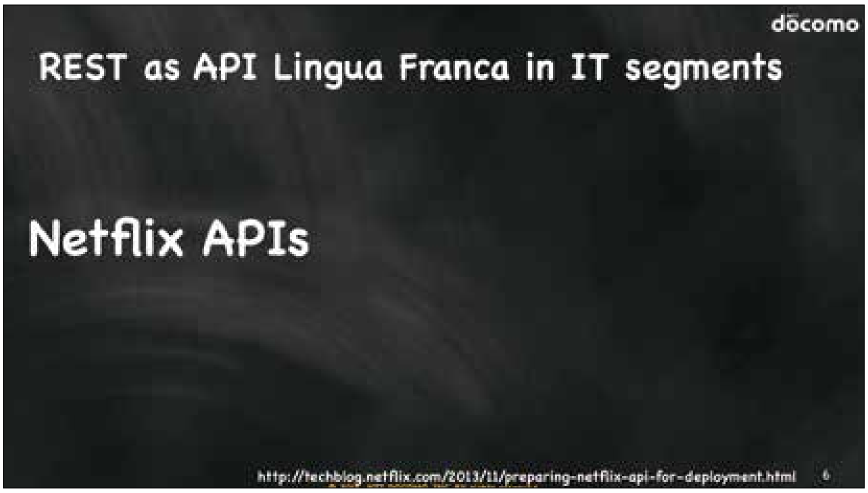


While the API economy did open up a vista of new business, APIs created from the bottom up have thus far failed, whether due to a lack of trustworthiness ranking or other factors. This symbolizes how the economy is, therefore, stuck in Reality 1.0.



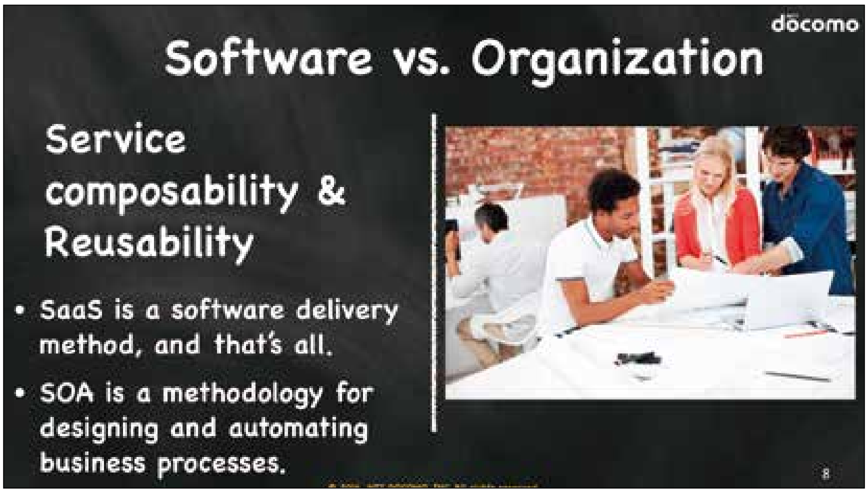
So many APIs emerged through a handful of small startups, including immature IT companies such as telcos (including Etoh's company, NTT DoCoMo) that created a kind of "wheat and chaff" mixture, with some APIs that were slow, buggy, and unreliable. Even in Reality 2.0, some human APIs or cognitive mediators may also be slow, buggy, and unreliable, so this could be a concern even as technology progresses.

API itself is not yet able to be easily monetized, and for big companies, they do not prefer the "bazaar"/market format of API providers. A good example of solid API platforms (outside of Amazon, Netflix, Spotify) is Twilio, which provides a good set of APIs and Stripe, which is a payment company.

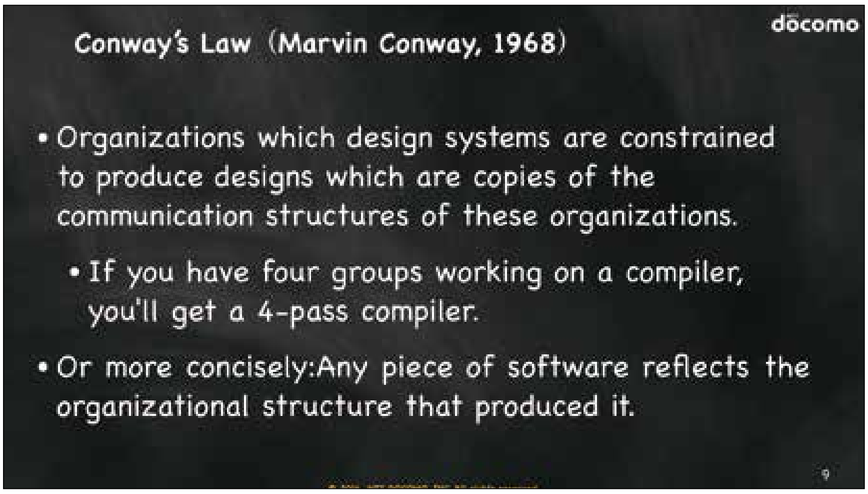


Etoh believes that REST technology is the lingua franca in IT segments (i.e., a language-based way to systematically communicate between entities not sharing a common first language), for companies to exchange data, insights, and functions. Netflix API, according to Etoh, is one of the more successful sets of lingua franca usage, so Netflix is selling its products through its APIs by organizing third parties to do so.

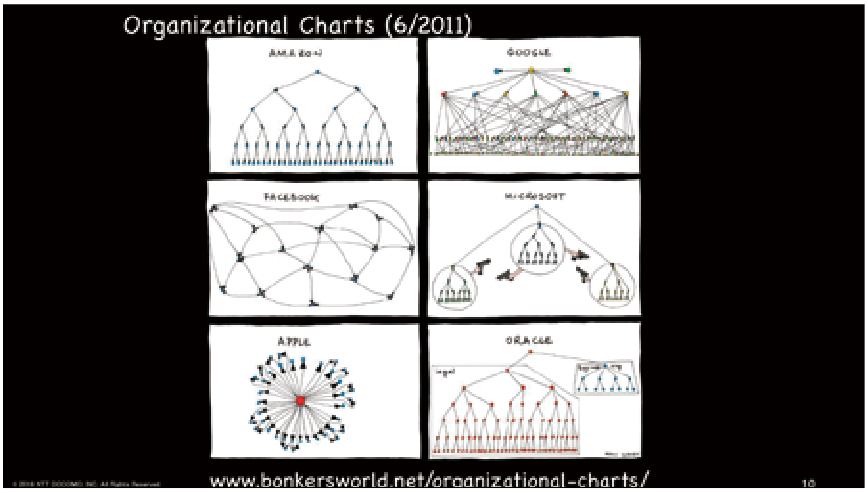
API itself is highly functioning in big company ecosystems; for example, SOA for sociotechnical innovations. While SOA was a good idea, new concepts of micro services have emerged, though they are not limited to technology but should be considered organizational phenomena. He builds on this with his next slide that dives deeper into software vs. organizations.



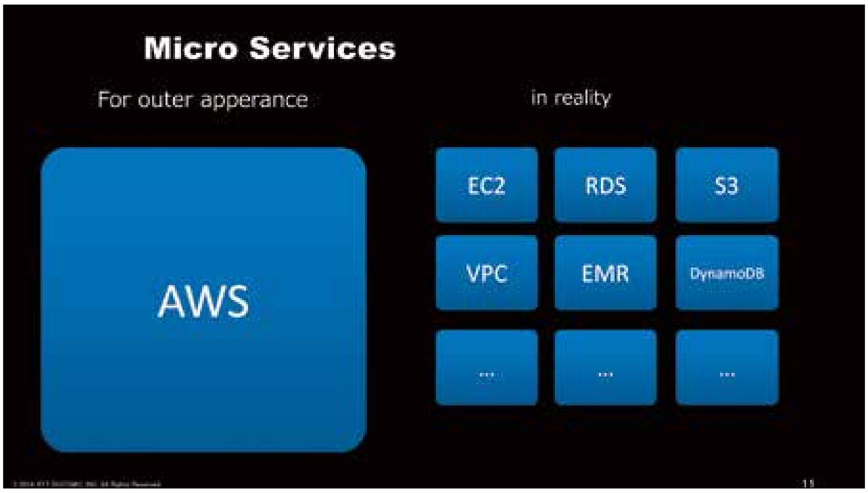
In Japan, most engineers tend to focus on only engineering aspects rather than organizational ones because they feel as if they do not have the right or power to reorganize their structure within the larger company. While they acknowledge that there is a service composability and/or reusability claim, when talking about SOA, SaaS, or micro services they automatically wonder what percentage of usability they can get out of it. Such technical discussions do often exist but they are not talking about organizational transformation. That is a crucial issue for most Japanese engineering companies.



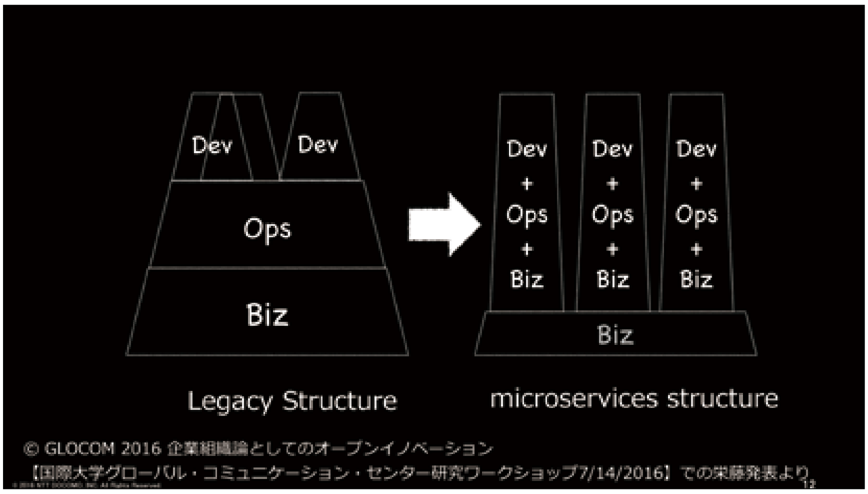
There is an empirical law called Conway's Law, coined in 1968, that states the following: "Organizations which design systems are constrained to produce designs which are copies of the communication structures of these organizations." As such, communication structures inside organizations define the software architectures, which Etoh finds very interesting. If, for example, four groups are working on a compiler, you will get a four-pass compiler. More concisely, any piece of software reflects the organizational structure that produced it, so going forward, we have to reorganize the current structure within the industry, company, or university first in order to utilize new technologies. Etoh states that Japan is behind other countries in this sense.



Etoh then displayed a slide of organizational structures, to show how these systems reflect the company's software architectures. His examples include Amazon, which retains small teams of fewer than eight persons led by a product manager with a Vice President as the middle point. These teams are organized across four or five products. Another example used was Google, wherein each researcher or engineer belongs to one major or two minor products, below product managers who report to a Vice President. Facebook's organization reveals a lattice structure, while at Oracle's engineering division has been isolated from the legal group and M&A strategies.

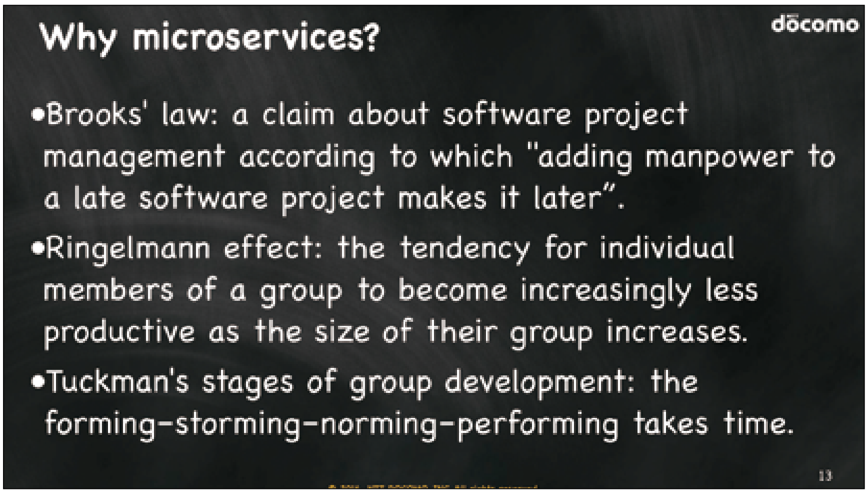


As an example of micro services, Etoh uses Amazon Web Service (AWS) and Amazon Cloud platforms. Externally, AWS appears to be a monolithic service, but within AWS, all functions are separated. They are developed, planned, and run by a team of fewer than eight persons who do not consult other teams and use REST for communications. It is a unique phenomenon in modern enterprise organizations.

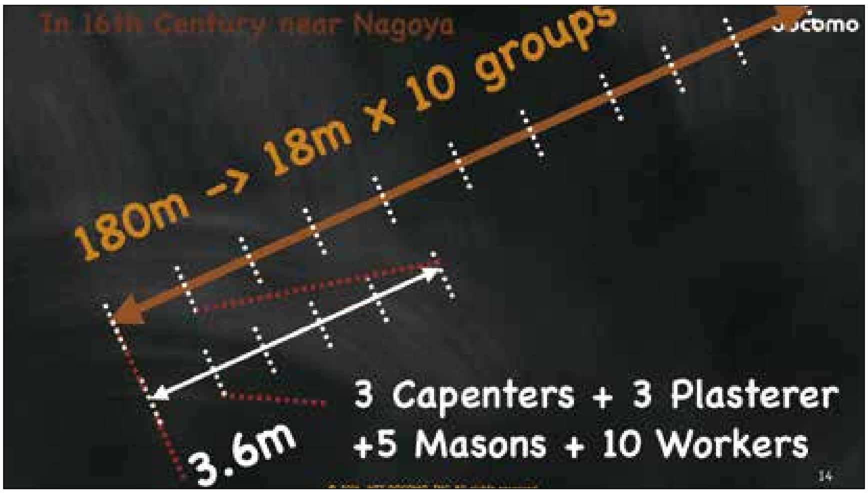


Still, many companies work on a legacy structure, resulting in monolithic plans of business operations and groups that are isolated, while R&D departments sit at the top of operation divisions.

Due to the progress of software productivity, however, in particular due to cloud or software development tools, these structures are going to shift. Each silo, then, will be able to autonomously develop its own products, which Etoh says is key to making agile and innovative services.

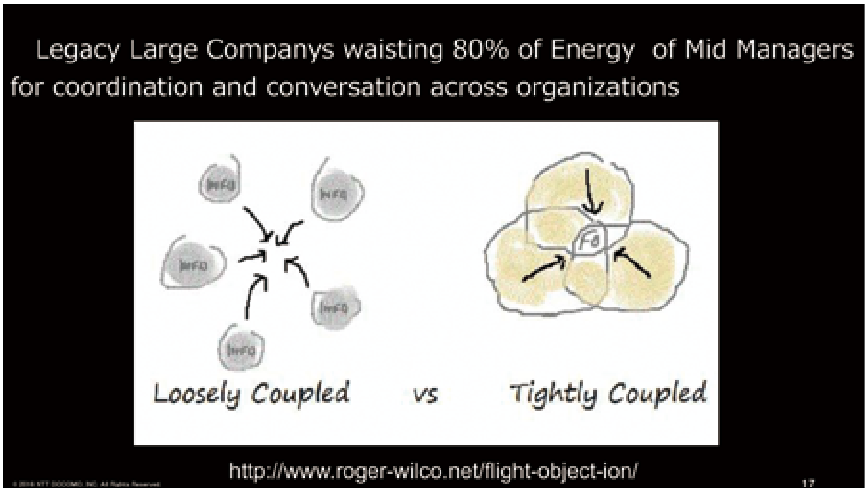


To answer the question “Why micro services?”, Etoh provides several observations. One is Brooks’ law, which states that adding manpower to a late software project makes it later. Another observation is the Ringelmann effect, which asserts that individual members of a group will become increasingly less productive as the size of their group increases. As such, the creation of small teams may be effective when we move closer to attaining Reality 2.0.

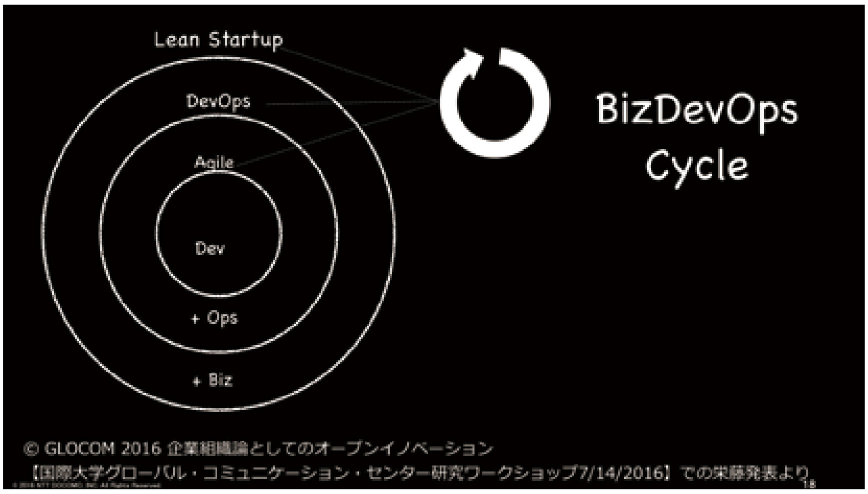


As a more colloquial example, Etoh described a 16th century event near Nagoya; Japan in which a regional tycoon named Nobunaga was facing an inevitable invasion of neighboring tycoons. They had to prepare a fortress in four days or five days, but had already spent 20 days by using legacy carpenters and mason organizations. The regional tycoon then assigned a junior general, Hitoshi, who was later promoted as Prime Minister and also dominator of Japan. His first task in organizing the work on the fortress was to make micro services; he divided the 180 meter castle into 10 groups with one leader each (e.g., similar to the VP level in an organization). These leader (or Vice Presidents) were then in charge of five lower segment leaders (e.g., micro service leaders); for example, 3.6 meters were assigned to one leader who reported to the "Vice President," and then below the leader were three carpenters, three plasterers, five masons, and 10 laborers. After working this new plan, the fortress was prepared in three days.

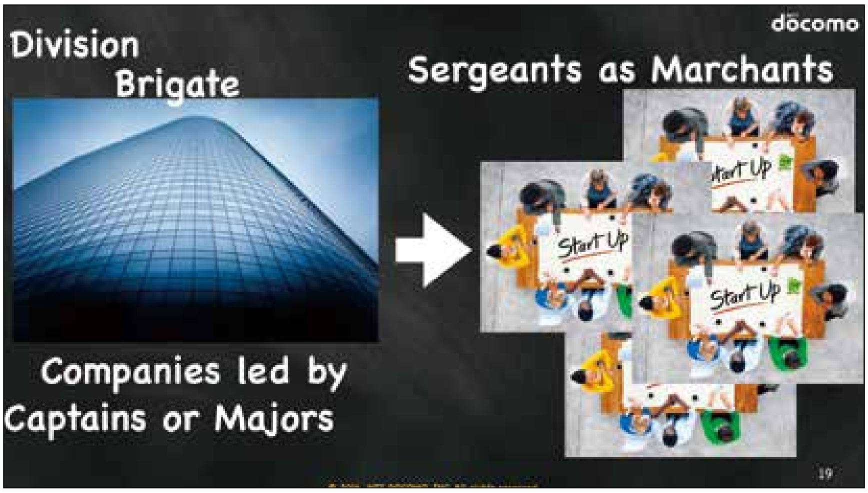
A similar event is also happening in software industries, where UI specialists, middleware specialists, or data-based analysts—in monolithic legacy companies—are segmented into specific types of specialties. While previously these industries were focused on monolithic systems, they have now been divided into, for example, three isolated components, then every component is further segmented into small teams: “You build, you run it.”



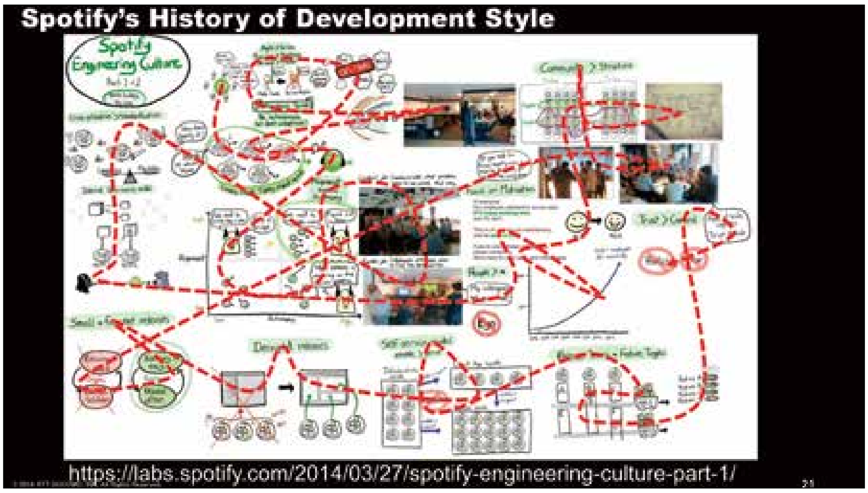
Legacy large companies are wasting 80% of their energy of middle managers who coordinate interactions across sections. This is because legacy companies are fond of tightly coupled organizations; however, a new attitude is required for success in the new API economy, where systems can be isolated but then loosely coupled. As such, Etoh stated that Reality 2.0 is going to essentially be a “moderately isolated” society.



Through such isolations, “BizDevOps cycles” are possible. As such, Etoh reiterates, R&D should not be isolated from business planning and all units would benefit from small, autonomous, self-motivated teams.



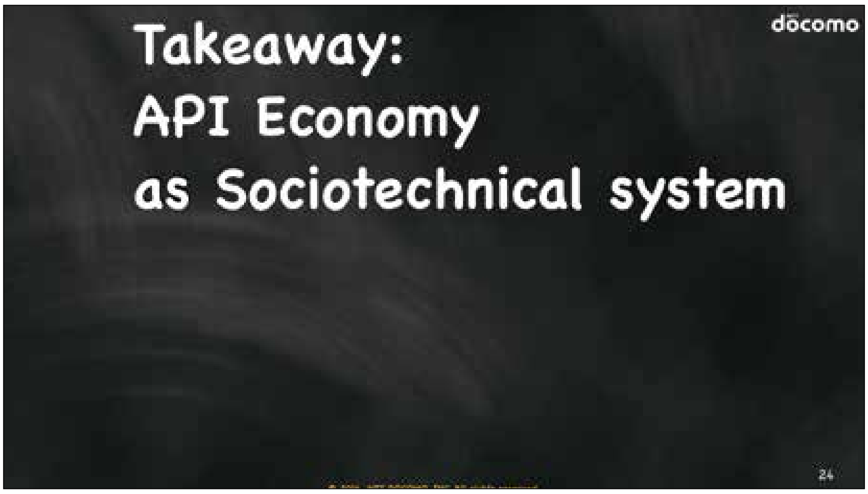
Etoh posits that startups are so effective and efficient in agile development out of necessity, whereas big companies, with 200–300 engineers on one project necessitate another level of management, which can slow innovation.



Etoh then shows attendees a slide depicting Spotify's circuitous history of its development style through the present, when it is seeking to partner with organizations that have the best software development tools. Spotify has been struggling to develop its cultural and also organization styles.

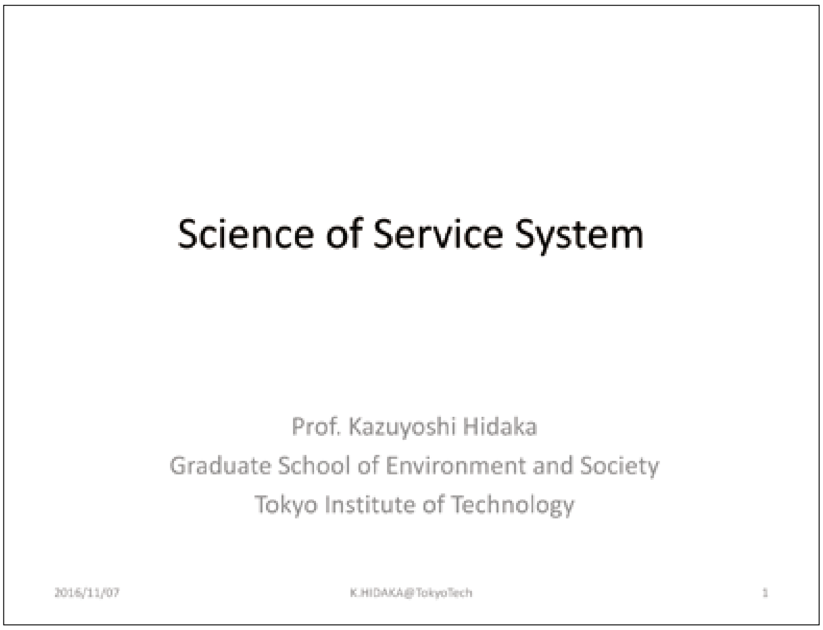
In addition to startups and advanced network service companies, GE Digital has also adapted micro services via its industrial IoT analysis platform: Predix.io. Predix is well-known among IoT industries and is an example of how even legacy giant companies adapted micro services.

Etoh believes that API, by default, is an important component to realizing Reality 2.0, as it enables social interactions between systems, humans, and companies/organizations. Behind the cultural or organizational issues, however, is the issue of how to make APIs with small teams, because the self-autonomous system is important.



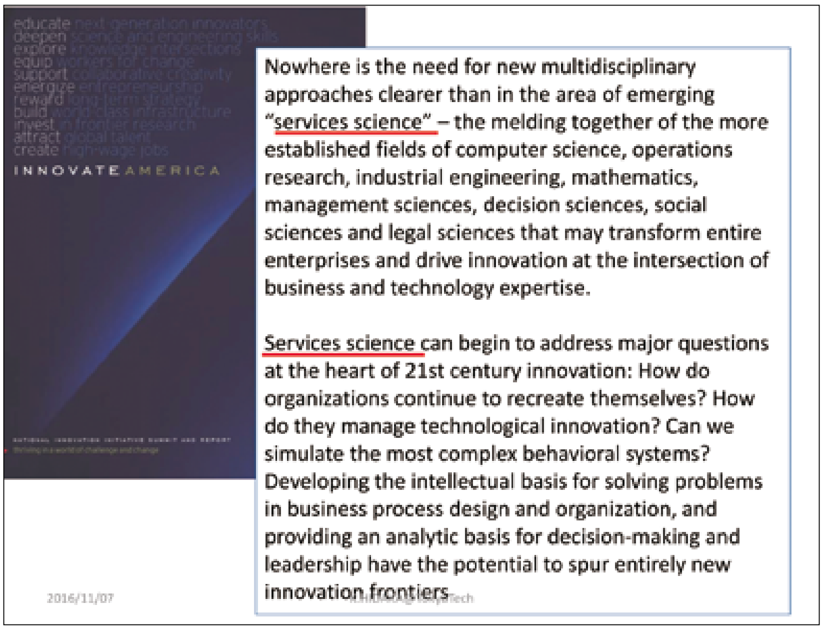
He then moves into discussing blockchain technology, which involves sociotechnical systems (e.g., businesses, technologies, societies), and concludes his discussion at the summit on with illustrations of how technology is not independent from organizational or social issues.

(4) Science of Service System, Kazuyoshi Hidaka, Professor, Tokyo Institute of Technology

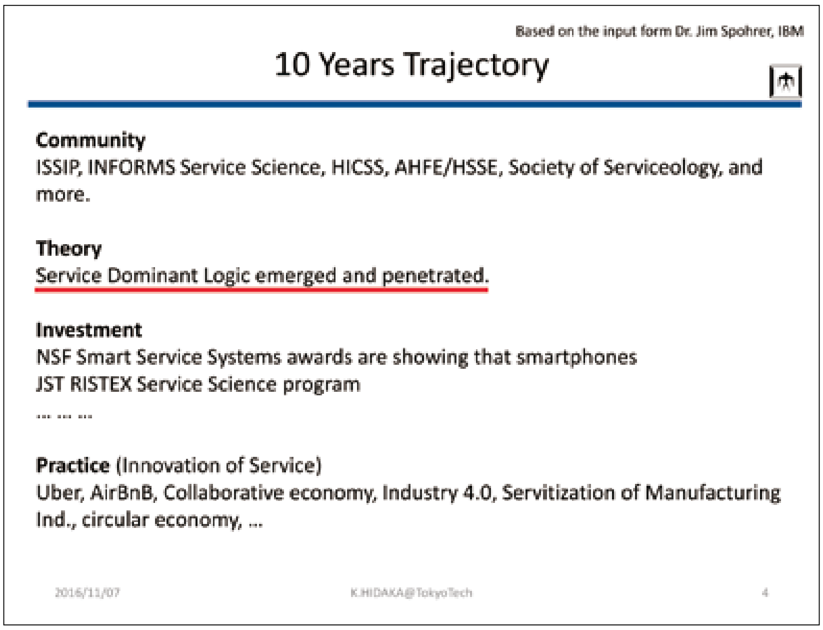


Hidaka is also a proponent of Reality 2.0 (introduced by Iwano at the summit), but focuses on how services must exist in the real world because it is a matter of value, which is inevitably evaluated by humans (who obviously have to exist in the real world, rather than a digital one).

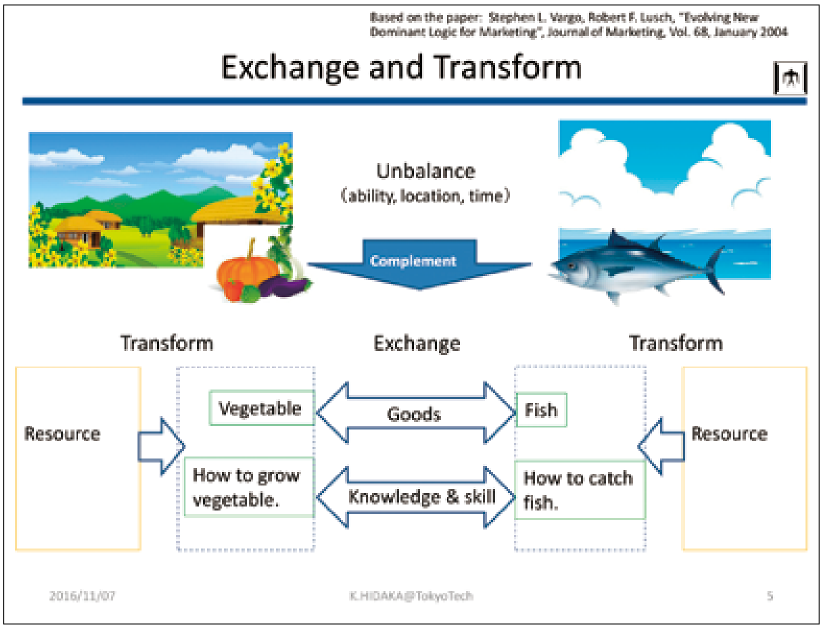
Service science discussions, according to Hidaka, started at IBM approximately 10 years ago, though service studies and service research has had a much longer history, especially in marketing.



Hidaka began his speech by sharing a published report titled Innovate America, which is also referred to as the Palmisano Report, detailing the need for multidisciplinary "services science," which can address question such as "How can organizations continue to recreate themselves?" and "How can we simulate the most complex behavioral systems?"

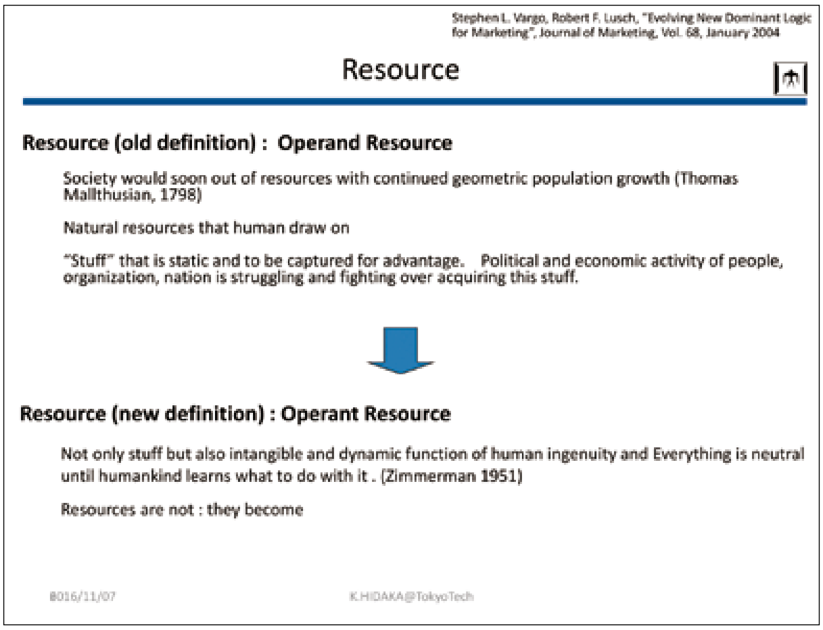


Contrary to what Hideyuk stated, that SOA is an IBM dream, Hidaka does not think service science is a dream. His speech at the summit focused on two things: one is very fundamental theoretical foundation, and the other is an overview of insights from a JST project related to service science. In addition, he touches on common design issues of a service system.

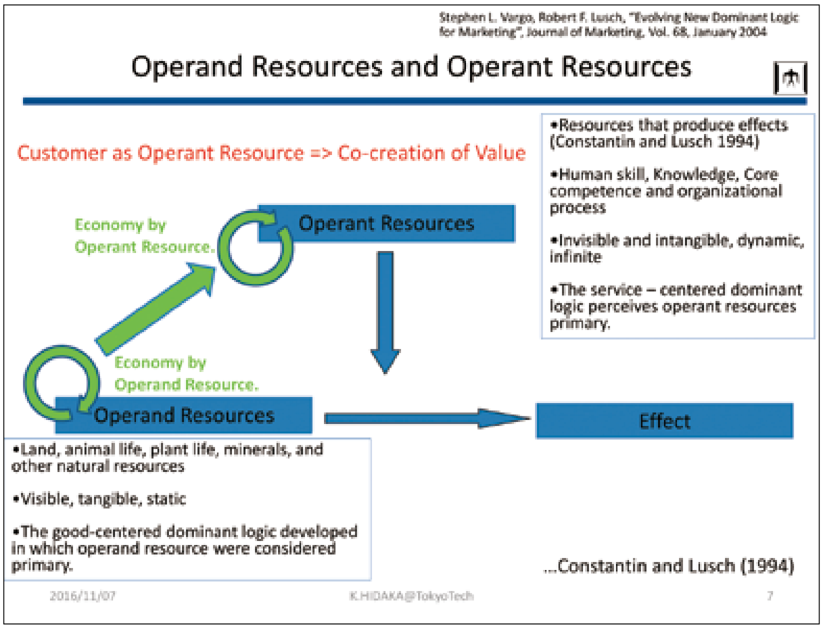


Hidaka equates the issues with service science as equivalent to the broader economy; for example, in the farm area we can get vegetables and in the sea area, we can get fish. However, we cannot get fish from the farm and we cannot get vegetables from the sea. Outside of this allegory, there is an imbalance regarding the ability, location, and time, so the different areas need to complement each other. How we can they do that? By exchange.

The question, though, is what do we exchange? One way is to exchange the physical goods (e.g., vegetables with fish and fish with vegetables) but the second way is to exchange the skill and knowledge (e.g., how to get vegetables and how to catch fish). The first is an exchange of goods and the second is an exchange of knowledge and skill. Within these two "exchangeables" we can see a transforming resource. This is a fundamental structure of our economy; as such, our economy is made from exchange and transformation.

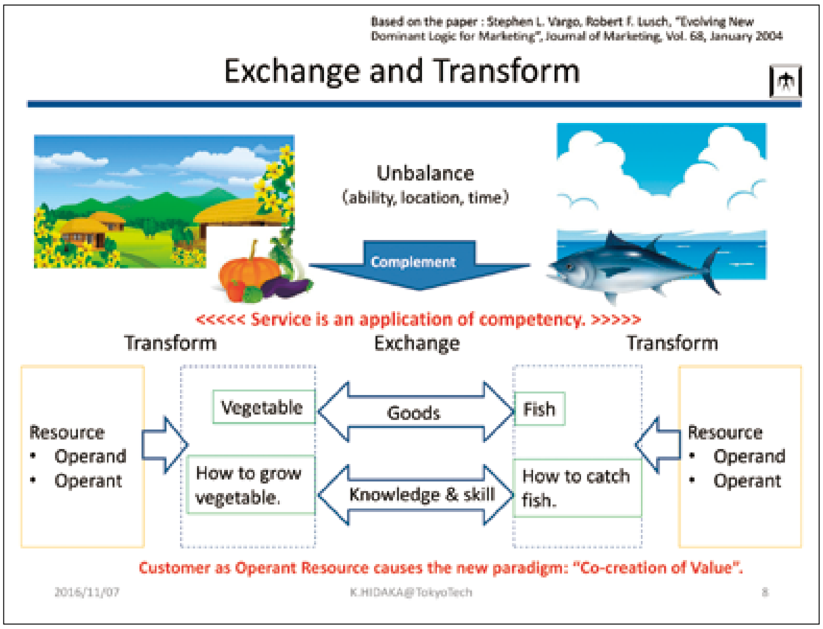


But what is a resource? This is Hidaka's key discussion point as he talks about the two types of resources: operand resources and operant resources. Operand resources are natural resources, or an old and understandable type of resource; but the operant resources are knowledge and skills, or, rather the competencies of humans.

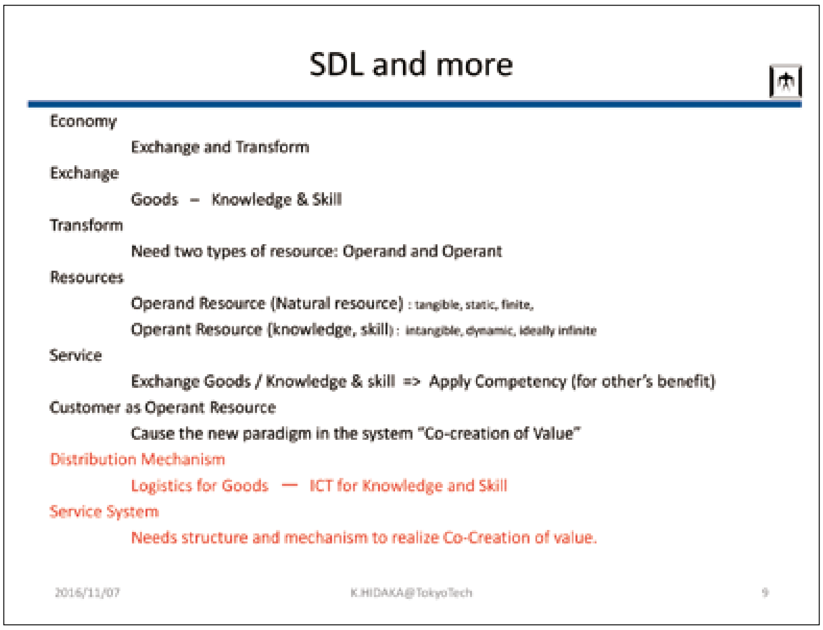


About the transformation, this is operand resource, this is the operant resource, and operant resource makes operand resource impact the operant resource and make some effect. Operand resource examples are land, animal life, plant life, minerals, anything that is visible, tangible, and static. Operant resources, then are our skills, competencies, and knowledge. Previously, our economy was based on the exchange of the operand resources; now, however, our economy is based on operant resources, which may indicate a new type of transformation.

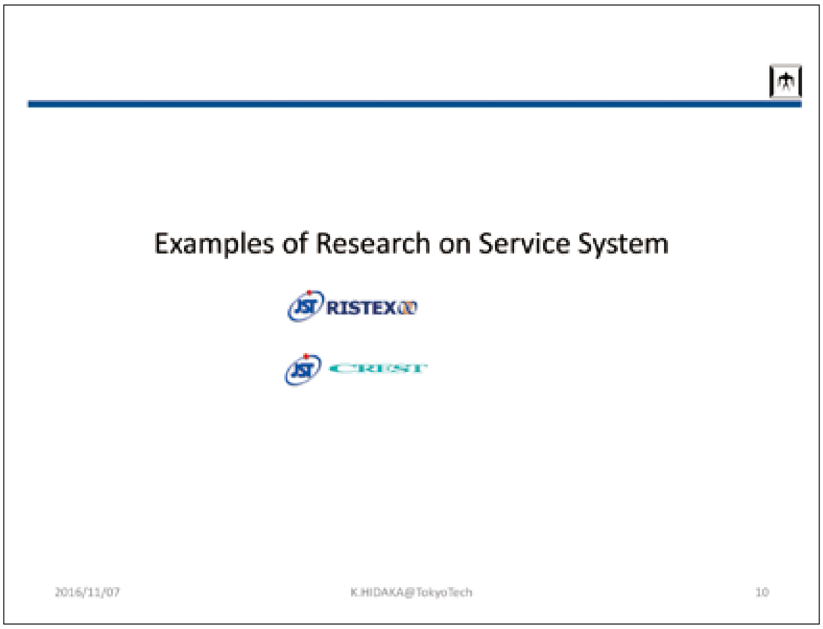
The point from the service science standpoint is that a customer can be a resource, whereas previously an operant resource was only captured by providers or enterprise companies. A customer as an operant resource is a significant point that has resulted in the co-creation of value so that customers can contribute value creation as a resource.



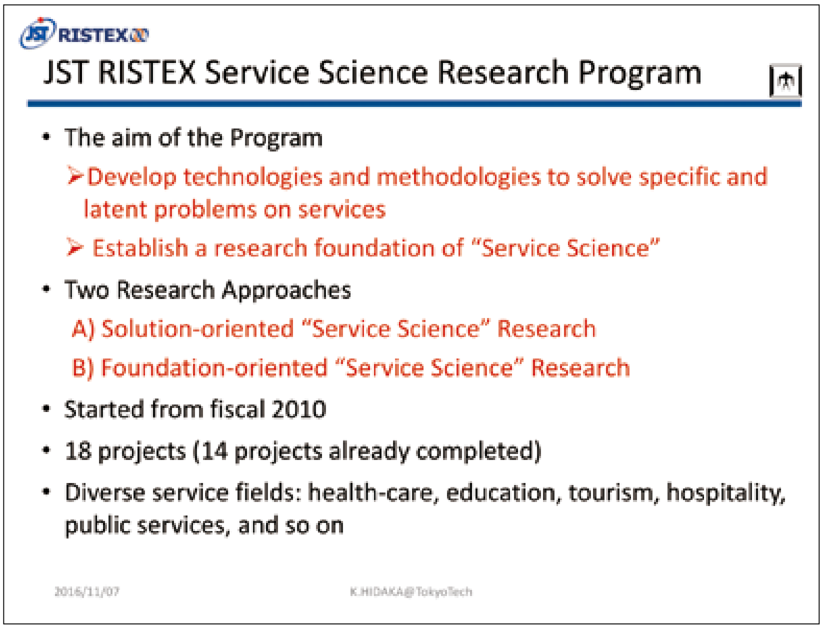
Customers of an operant resource have created a new paradigm which is co-creation of value, and services are an application of competencies. This is a significant foundation of the current service science discussion, according to Hidaka.



He goes on to state that economy is both exchange and transformation, wherein we exchange goods or knowledge/skills, and that transformation needs two types of resources: operand (i.e., tangible, static, finite) and operant (i.e., intangible, dynamic, infinite). Service can sometimes mean simply competency for other's benefit with only the exchange of goods and skills through applied competencies. The customer as operant resources cause a new paradigm in the system and co-create value. We need logistics for goods delivery, and ICT for knowledge and skill. So in this view, ICT is a significant vehicle of operant resources.

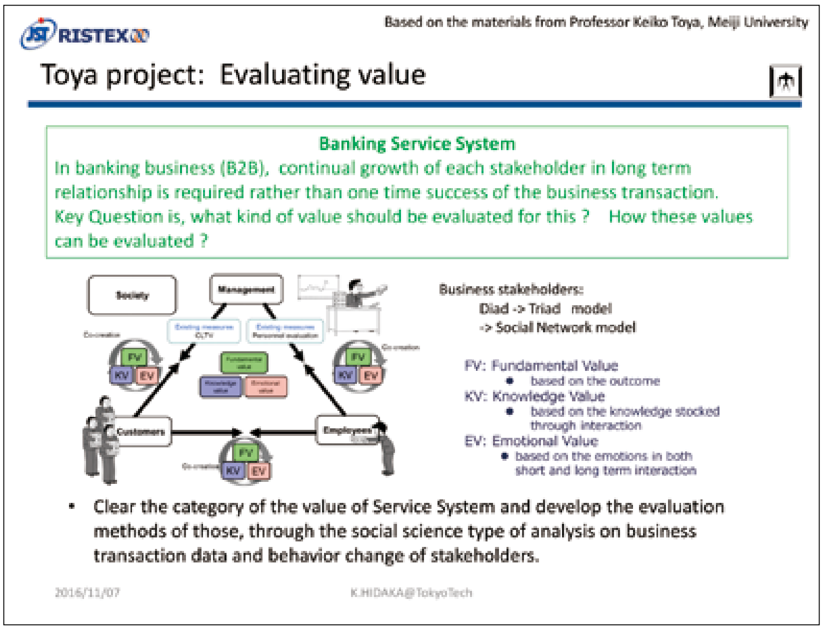


JST has organizations such as RISTEX and CREST, the former having several programs focusing on the service sciences. Hidaka goes on to share some examples for summit attendees.

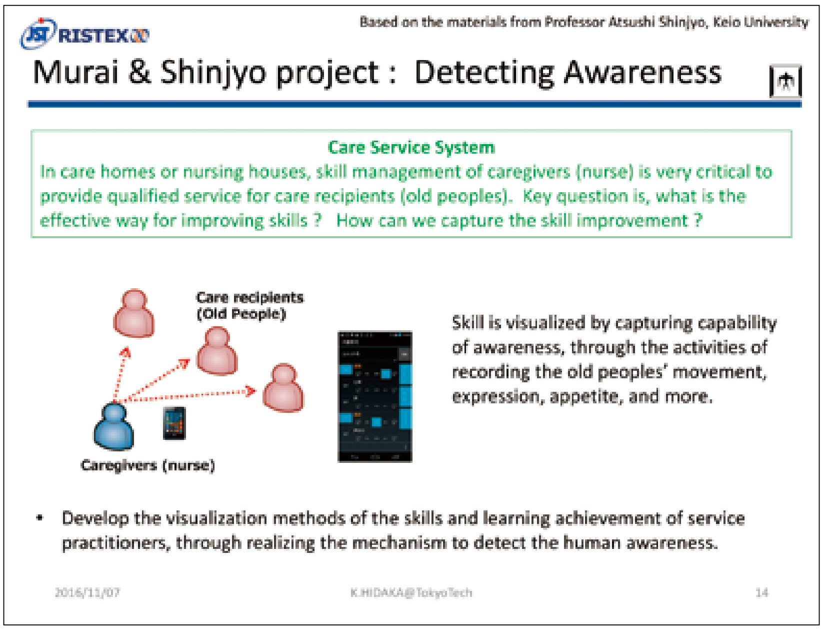


He first covers JST RISTEX Service Science Research Program, which aims to develop technologies and methodologies to solve specific and latent problems related to services, establishing a research foundation of service sciences. It started in 2010 and currently has 18 projects.

	Project Name	Project Leader
FY2013	Empirical Research on Co-creative Skill E-learning Service with Visualization of Experience Value	Hajime ASAMA
FY2013	Construction of foundation for smart social service systems, creating secure and safe community through the advancement of emergency medical care	Tomoki HAMAGAMI
FY2013	A method for the transition to value co-creative service by enhancing provider's competency and receiver's literacy	Yoshiki SHIMOMURA
FY2013	Service System Categorization based on Value Creation Models and Design Theory of Service Mechanism	Nariaki NISHINO
FY2012	Development of adaptive service model with co-creative design under dynamic environment - Application into restaurant service -	Toshiya KAIHARA
FY2012	Museum Experiences and Service Science	Kumiyo NAKAKOJI
FY2012	IT-enabled Novel Societal Service Design	Hideyuki NAKASHIMA
FY2012	Development and practical application of a "human resource development and evaluation service" based on on-site evaluation of quality of care by using IT platform	Jun MURAI
FY2012	A co-creation measurement for financial services: scale development and validation	Keiko TOYA
FY2011	Quantitative Valuation and Demand-oriented Provision of Irrigation Service	Toshiaki IIDA
FY2011	Realizing Multilingual Communication Environments based on Service-Oriented Collective Intelligence	Toru ISHIDA
FY2011	Analyzing Fundamentals of Japanese Creative Services and Its Application to Global Service Enhancement	Kiyoshi KOBAYASHI
FY2011	Research on Patient Satisfaction with Medical Care Services in Consideration of 'Benefit Delay' Effect	Kazuhiro FUJIMURA
FY2011	Research on the Service Science of actualizing Altruism-driven Society: focusing on the suicide prevention activities	Yasuo TATEOKA
FY2010	Innovation for Service Space Communication by Voice Tweets in Nursing and Caring	Naoshi UCHIHIRA
FY2010	Visualization and Support of Value Co-creation at Industrial Clusters by Service Systems Modeling	Kyoichi KIJIMA
FY2010	Architecting Service with Customer Participation Based on the Analysis of Customer Experience and Design Processes: Sophisticating Tour Design Processes as a Case Study	Tatsunori HARA
FY2010	Context Management Approach to Service Value Co-Design Model	Yoshinori FUJIKAWA

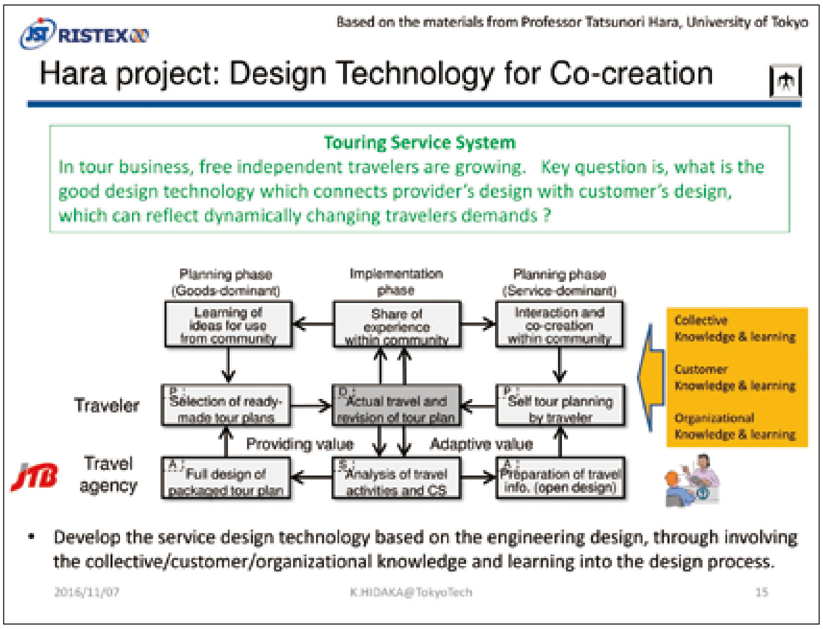


The first example of one of these projects is the Keiko Toya's project, which is related to banking service systems. In banking service, continual growth of each stakeholder over a long-term relationship is required rather than the one-time success of a single business transaction. As such, what kind of value should be evaluated for this type of relationship, and how can these values can be evaluated? Her project identified value categories within the service system and developed evaluation methods for these via a social sciences analysis of business transaction data and behavior changes among stakeholders. Toya's project defined three types of values and developed evaluation mechanisms for each of these three values.

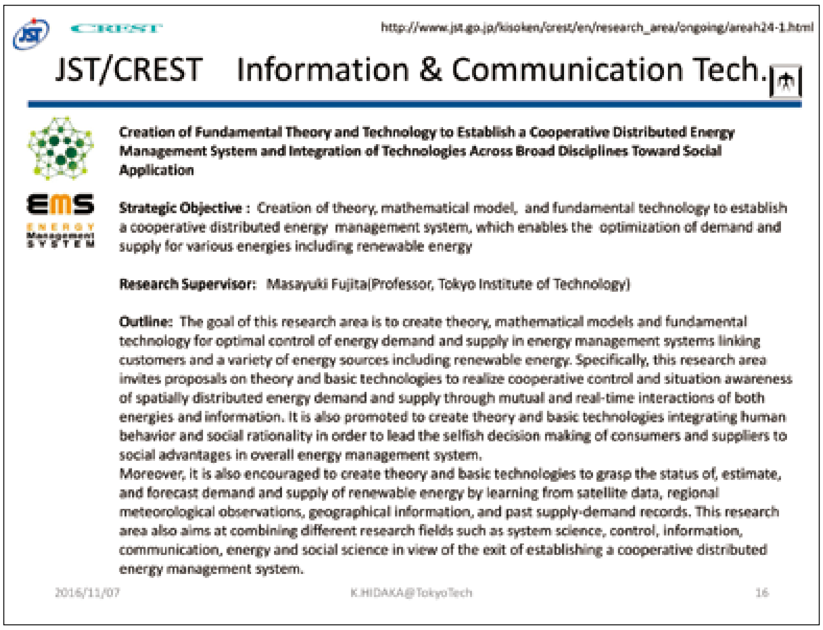


The second project example was initiated by Jun Murai and Shinjyo of Keio. Their main focus was detecting human awareness focusing on the care service system. Whether in-home care or in nursing houses, skill management of caregivers such as nurses is critical to providing qualified services for care recipients such as the elderly. The key questions of their project asked: “What is an effective method for improving skills?” and “How can we capture and measure this skill improvement?”

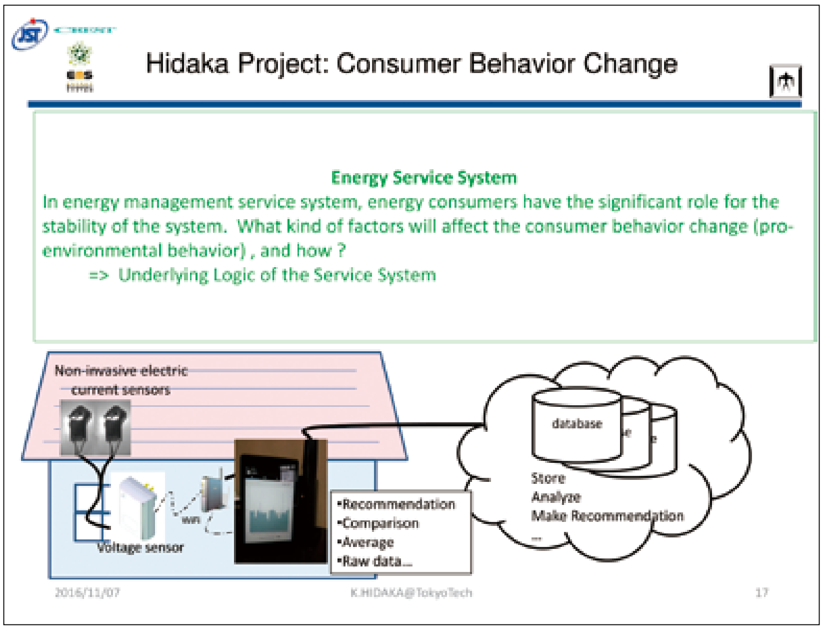
They developed a visualization method for skills and learning achievement of service practitioners through realizing a mechanism to detect human awareness. Their system was developed using smartphones, through which caregivers could record the elderly patients’ movements, expressions, appetites, and more. Through this they were able to capture the human awareness of these people and use the information for skill improvement.



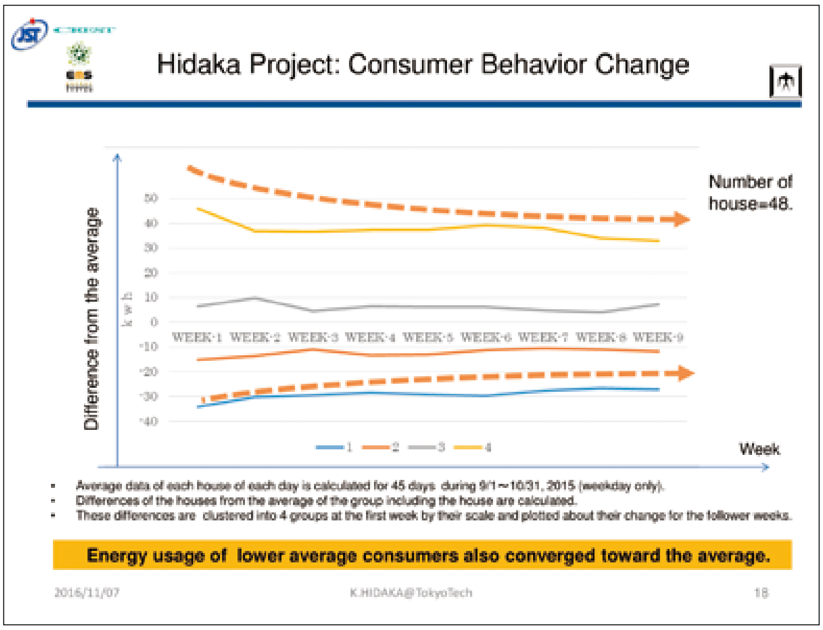
The third example involves the touring service system and is related to some common design methodologies. In tour businesses, free independent travelers (i.e., their customer base) is growing. The key question from this project was: “What is good design technology that can connect a provider’s design with a customer’s design, which can reflect, dynamically, changing traveler demands?” They developed service design technologies based on a foundational engineering design through improving the collective customer/organizational knowledge and learning into the design process.



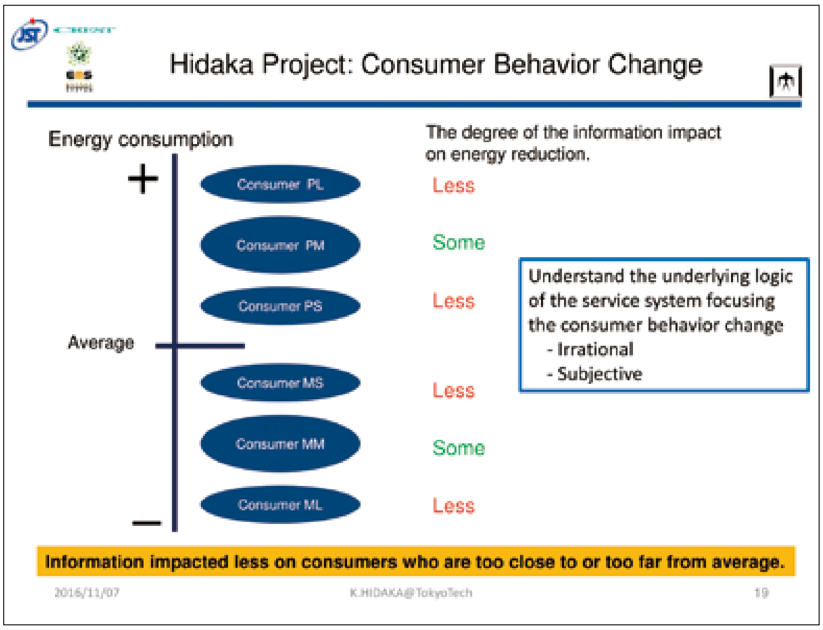
Hidaka then shared details of his own project from the JST/CREST program's information and technology areas, specifically related to energy management.



This project focused on consumer behavior changes within the energy management service system. Here, energy consumers have a significant role of stability regarding the system and what kind of factors will affect consumer behavior change and how. Hidaka and his colleagues developed a consumption monitoring system for energy consumption data of households to capture the data and provide insights and analysis on some of the information.

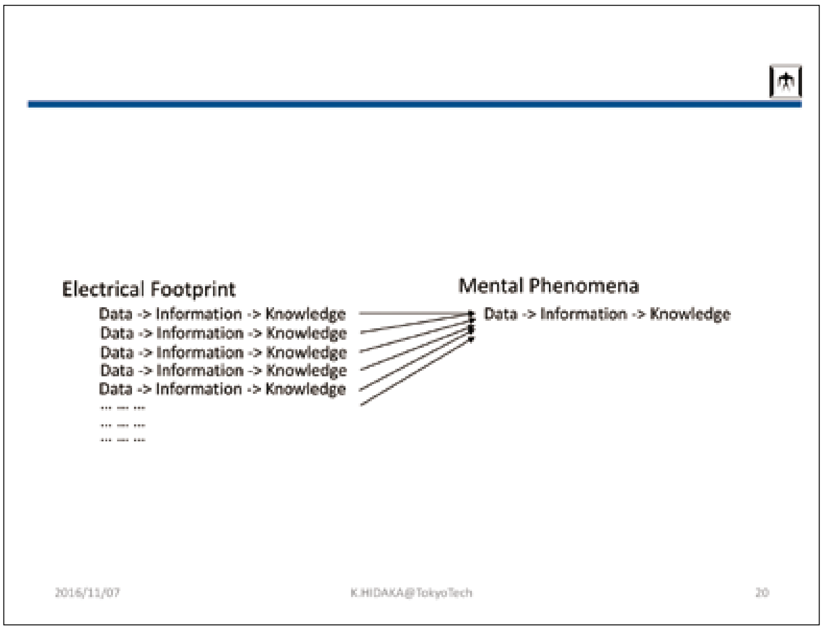


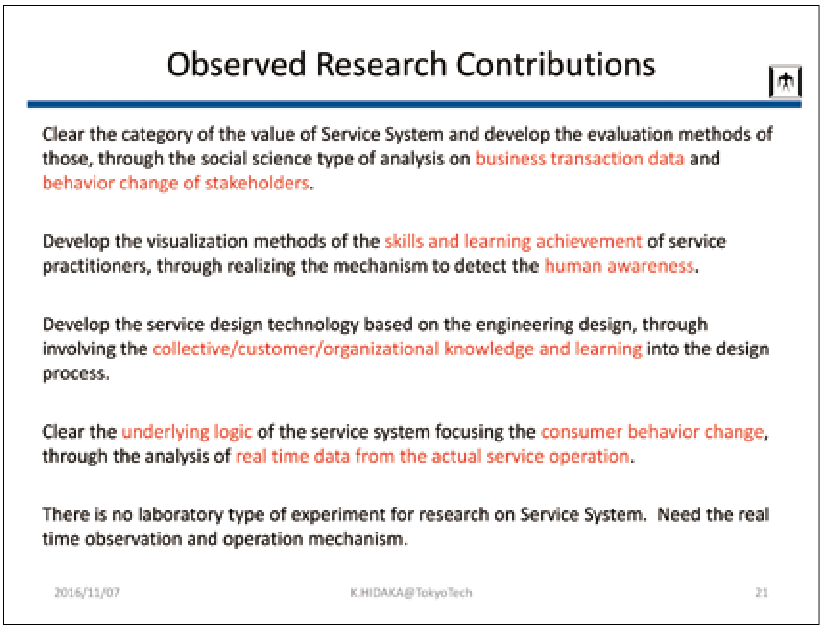
He reveals a timeline, slide from the project that shows some of the consumption data, with the average in the center. A yellow line and gray line show upper average customers, while a blue line, red line, and orange line show customers who consume the energy less than average. Analysis of the data show that the upper average customers going decreasing, but that lower average customers are going up. This results in a stable average.

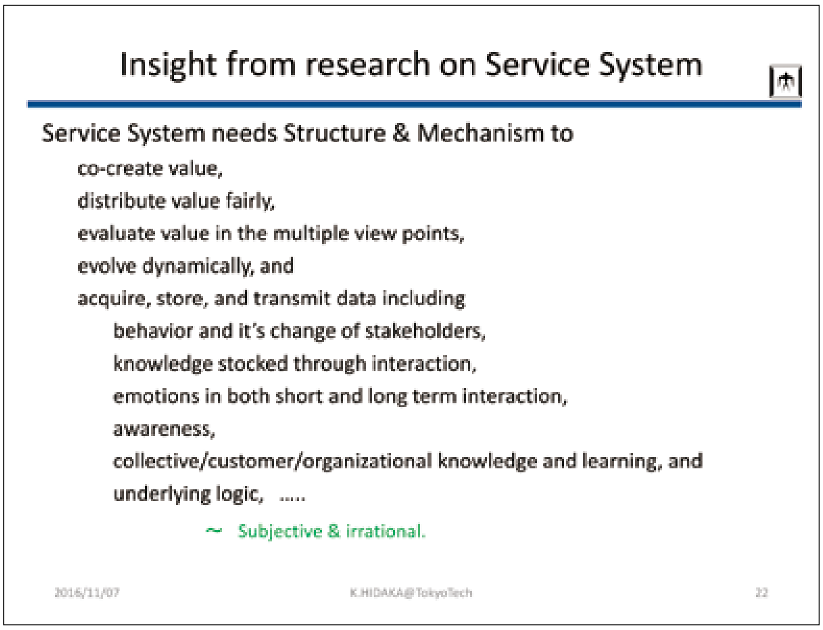


Hidaka also described the six cluster of customers within his project and how they each respond differently to provided information: customers very close to the average and customers very far from average were two groups that did not respond to the given information, so the insight would be that information impact is less on consumers who are too close or too far from averages.

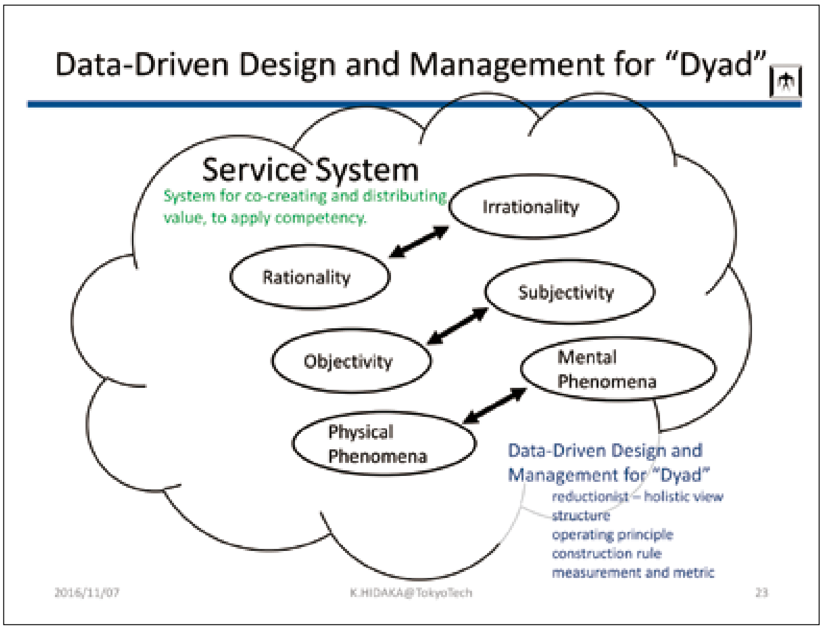
There are many electrical footprints that can be followed within IoT, and by using them, we can make deductions about mental phenomena.







Hidaka and colleague's project included business transaction data and behavior changes of stakeholders. Based on their observations, previous research projects or discussion about the SDL, they devised service system needs, structure, and mechanisms aimed at co-creating value and distributing value fairly as well as were able to evaluate value from multiple viewpoints and evolve dynamically (e.g., what this system needed to acquire, store, and transmit).



In conclusion, Hidaka believes that "dyad" design principles are needed for the service system in order to best create and distribute values and to apply competencies within the system. Within the system there were pairs of conflicts; for example, rationality/irrationality, objectivity/subjectivity, and physical phenomena/mental phenomena. Previously, the team had designed a system focusing just one side, but within the service system and this particular project, a dyad approach was needed to cover both types of actors. A data-driven design and management was decided up for the dyad prior to discussing structure and mechanisms.

Hidaka summarized his speech by referring back to Jim Spohrer and other members' discussions at the summit who spoke about multidisciplinary concepts and "T-shaped" individuals, but he admits that this is a difficult area of study because often it covers only some human attitudes, where a more system-based type of approach might enable people to think more about the dyad and addressing conflicting concepts and data points.

6. Impact Session

Yukiko Horikawa:

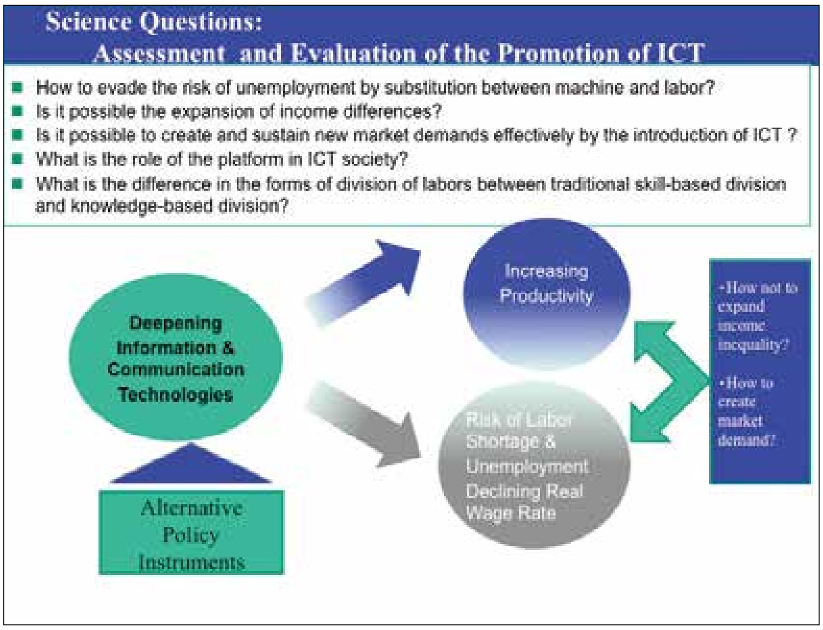
As the first speaker of the Impact Session, Yukiko Horikawa from ATR's Intelligent Robotics and Communication department discussed the social impact of many of the technologies and ideas covered earlier during the summit and stated that her goal was for this session to have more of a discussion format. The key points of her speech focused on obstacles for the future, preservation of privacy, and societal issues such as regulations.

She introduced her panel for the session as Professor Kuroda, Principal Fellow, CRDS, JST, and Emeritus Professor of Keio University, who will speak to a historical point of view while considering economical potential such as economic discrepancy caused by the technologies. In addition, she introduced Dr. Alexandra Medina-Borja from the U.S. who is a Program Director of Engineering at NSF, who will speak to the smart human-centered service systems of the future and the sociotechnical hurdles to achieving these systems. The speaker following was Director Hagita from ATR Intelligent Robotics and Communication Lab and serves as a research supervisor of the CREST project. He will speak about robotics technology as well as his CREST, particularly focusing on ethical, legal, and social issues. The last speaker for this session was Attorney Mr. Kobayashi of the Hanamizuki Law Office. He practices civil cases and also handles legal checks on security and the safety of surveillance cameras and network services and spoke at this summit about autonomous vehicles and related pragmatic legal issues.

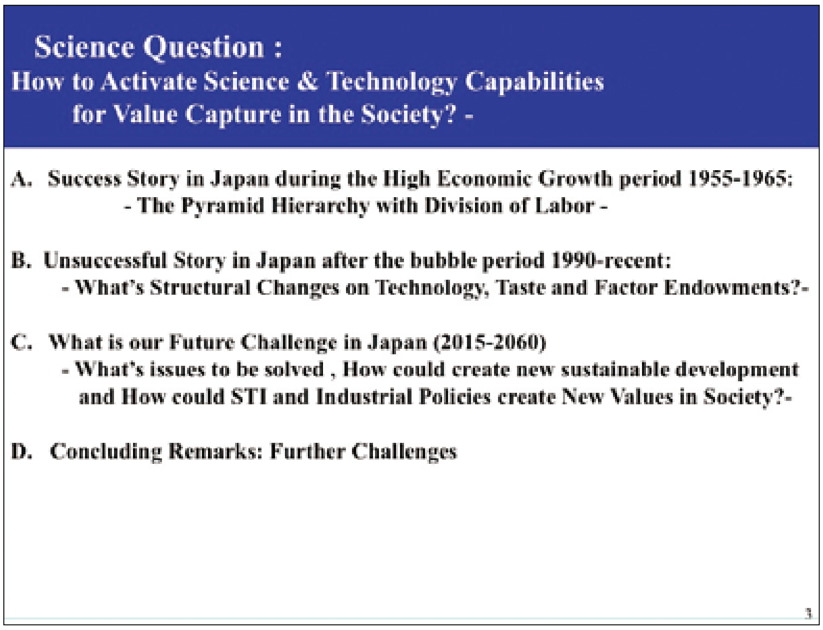
(1) Economist's Point of View: IoT and Its Impact, Masahiro Kuroda, Professor, Principal Fellow, CRDS, JST

As an economist, Kuroda based his discussion at the summit on the impact of ICT and AI, from the viewpoint of an economist, but not a natural scientist. The majority of the members of CRDS are natural scientists; therefore, he has received solid and engaging input from them, to build on his technological focus and expertise. Theory of economics currently has not considered carefully the relationships among science, technology, and economy, instead taking a consolidated level view of growth and changes of the total factor of productivity at the macro as well as the industrial sector. But unfortunately, for scientists, such a consolidated view of the productivity measurement due to the progress in science and technology is not necessarily their natural specialty.

Kuroda became interested in how to link knowledge of economics with natural sciences and technologies. He embarked on a project three years ago with Professor Iwano about measuring the impact of the progress of the information, and communication technologies on the economy and the society. He went on to elaborate it on this partnership.



In Japan, since the economic bubble burst at the beginning of the 1990s, the stagnated economy has been continuing for almost 25 years. The important issue, then, is how we can create new demand, how to realize scientific value-capability, and how to create societal values through the technology of today. For these objectives, we have to know how much and what kinds of knowledge about technology and sciences will be required to do so. He highlights fears about machines that will take over human jobs, the expansion of income differences, and how we can effectively introduce knowledge about ICT and IoT in the market. He proposed that the first step is to make an effective platform that considers the viewpoint of the new design in the division of labor, which is an important concerns of economics. Within the ICT society, the division of labor must be considered through a new lens, as it may actually expand in the future of the ICT society through the internet-network system. Kuroda referenced Professor Babbage, the “father of computers” and Professor at Cambridge University in England. Babbage wrote about the economy of manufacturing and discussed the division of labor that could serve as inspiration for building the current platform.



Following this introduction, Kuroda focused first on how to activate science and technology capabilities for value capture in society.

When Kuroda began studying economics in 1960 upon entering university, it was right in the middle of Japan's high economic growth. During the 1970s' and the 1980s, however, the economy gradually slowed due to the stop of the unlimited labor supply from the indigenous sector and the upraising of the energy prices. The circumstances of Japanese economy in the 1970s and the 1980s were completely different from the situation in the labor and capital markets as well as the states of technology and the energy and tastes of consumers at the 1960s. He recalled his first experience in 1969 with the IBM 1620, which took the place of "manual computers" that he and his colleagues had been using prior for mathematical calculations. Even though the IBM 1620 was a very small computer, it was much faster than manual calculation.

A. Success Story in Japan during the High Economic Growth period 1960-1975:
- What's circumstances for the industrial policy and How to manage it? -

"No more the stage of the aftermath of World War II"
White Paper on Economies, 1951

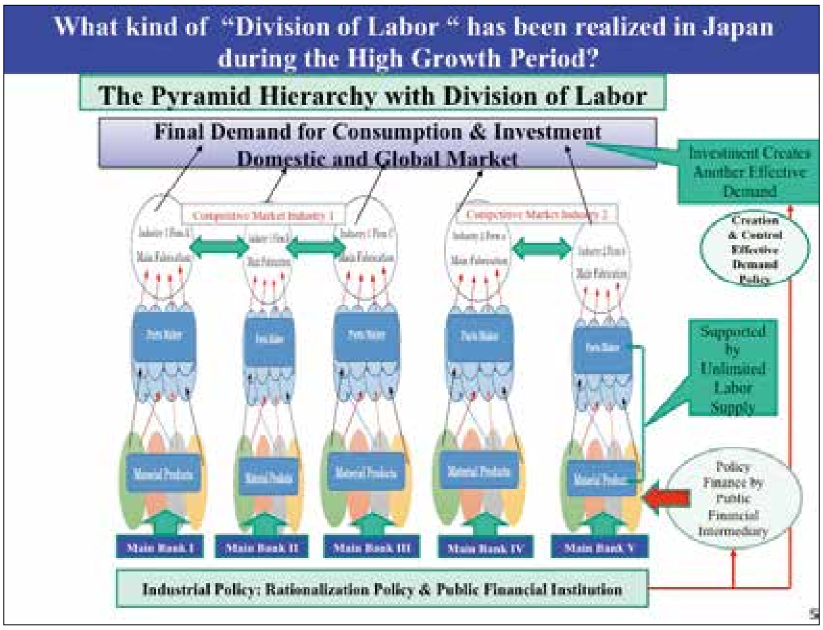
Source of Average Annual Economic Growth(%)

	1945-1950	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975
Real GDP	9.4%	10.9%	8.7%	9.7%	12.2%	5.1%
Labor	n.a.	n.a.	2.4%	0.8%	1.3%	-0.3%
Capital	n.a.	n.a.	4.0%	5.3%	5.4%	3.7%
TFP	n.a.	n.a.	2.3%	2.4%	5.5%	1.7%

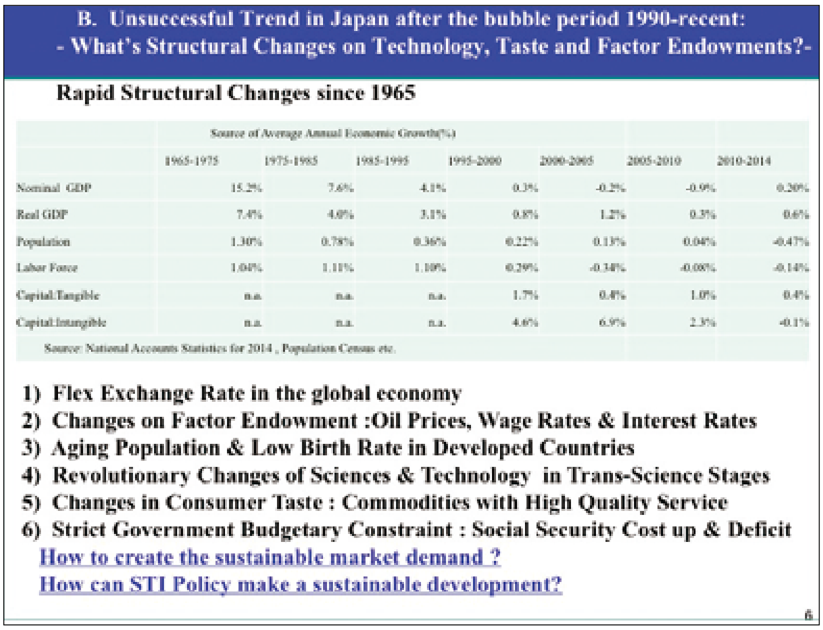
source :Yutaka Kosai, Age of High Economic Growth Period, 1984

(1) Unlimited Labor Supply from Agriculture to Manufacturing
(2) Government Industrial Policy
a) Production Priority System
b) Industry Rationalization Policy: the Exceptions to Tax Laws Acts for Heavy Manufacturing Promotion, Export Promotion.
c) Balanced Budget Fiscal Policy (1948-1965)
d) Financial Investment Funds by public finance
e) Investment for Infra-structure
f) Borrowed Technology for Mass-Production
(3) Increasing Domestic Consumer Demand for Durable Goods

At the time in Japan, the high economic growth period, annual GDP growth rate was almost 10% on average and the labor supply was nearly unlimited from agricultural sectors to manufacturing. During the 1960s, the labor force in the manufacturing sector increased by 9 million totally, in which the half of the labor was due to the spilled-over labor from the agricultural sector. Also in the 1960s, many industrial policies were positive and successful, as was the priority production system, industry rationalization policies, the financial investment funds by public finance, and investment for infra-structures. It is an important macroeconomic perspective during the high economic growth period that even in the positive governmental fiscal policies and financial policy, there could have been continuing to maintain the balanced governmental budget until the beginning of the 1970s. We could say it was one of the typical examples of the success story in the Keynes-style effective demand control policies and industrial policies. Creation of the effective demand in the market by positive fiscal policy and rationalization by the industry policies have been contributing to realize the Pyramid Hierarchy with Division of labor in the Japanese market.

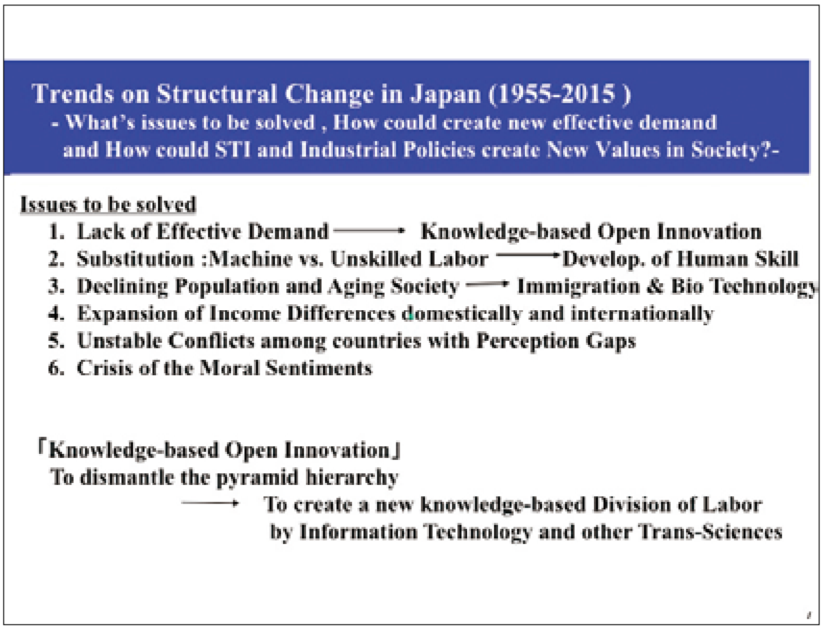


The industrial system in Japan, which was built in 1960s, is a pyramid-type hierarchical division of labors, wherein each industrial sector is composed by several competitive groups. Each group is structured by vertical relationships including material supplier - parts makers - publication makers - sales trader and on the bottom they are supported by the main "bank" financially. This pyramid-type division of labor is consistent with the concepts put forth by Adam Smith. Kuroda said that the pyramid-type division of labor built in the 1960s has efficiently contributed to realize the high economic growth in Japan as a system adapted to the situation of the time.

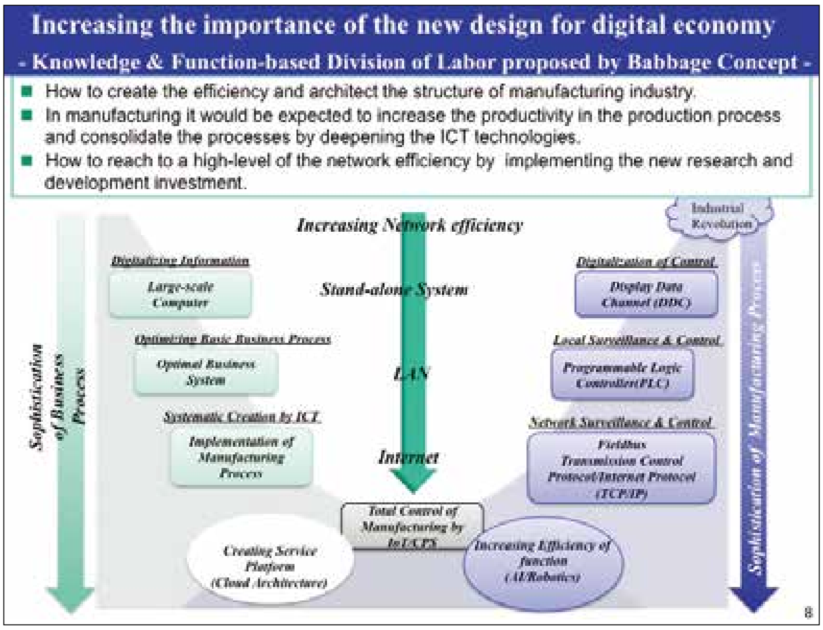


In the 1970s, however, the circumstances surrounded the economy were completely changed rapidly. With the change from a fixed exchange rate to a floating exchange rate in 1972, gradually the labor force has been truncated and the wage rate has increased rapidly, in tandem with an aging population and lower birth rate within the younger generation. There was no expectation of the labor market situation of the unlimited labor supply like that in the 1960s. Also we experienced the tremendous energy price upraising since the oil shock in 1974. On the other hand, consumer taste also changed about that time. All households had been satisfied with necessary durables enough qualitatively and they want to focus on the commodities with high quality service. After the bubble burst, demand on the consumer side gradually slowed and the investment demand on the producer side stagnated. On the other hand governmental budget had to be requested to support the aging population for the social security. Social security cost was increasing rapidly and government budget was stagnated with the big deficit. The government was obliged to throw out Keynes-style aggregate demand control policies. On the other hand, science and technology progressed very rapidly during the latter half of the 20th century. But unfortunately such merit of the progress was difficult to introduce to the market, because of the inflexibility of the Japanese system of the economy and the society.

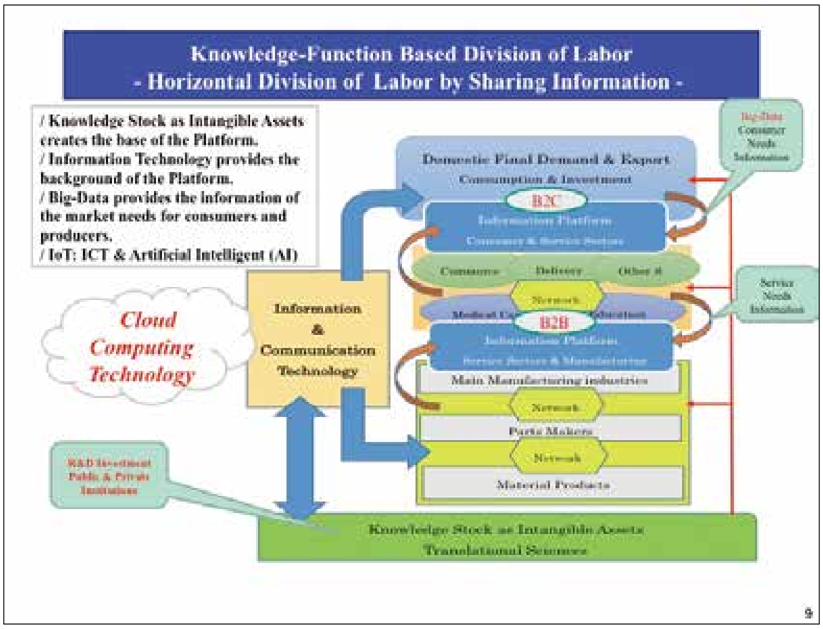
In such situations Kuroda emphasized that issues to be solved are how we can create the sustainable effective market demand and how STI and industrial policy can create "New Values in Society". He proposed the "knowledge-based open innovation", in which society can dismantle the pyramid hierarchy of the division of labor and create a new knowledge-based division of labor by information technology and trans-sciences.



6 Impact Session

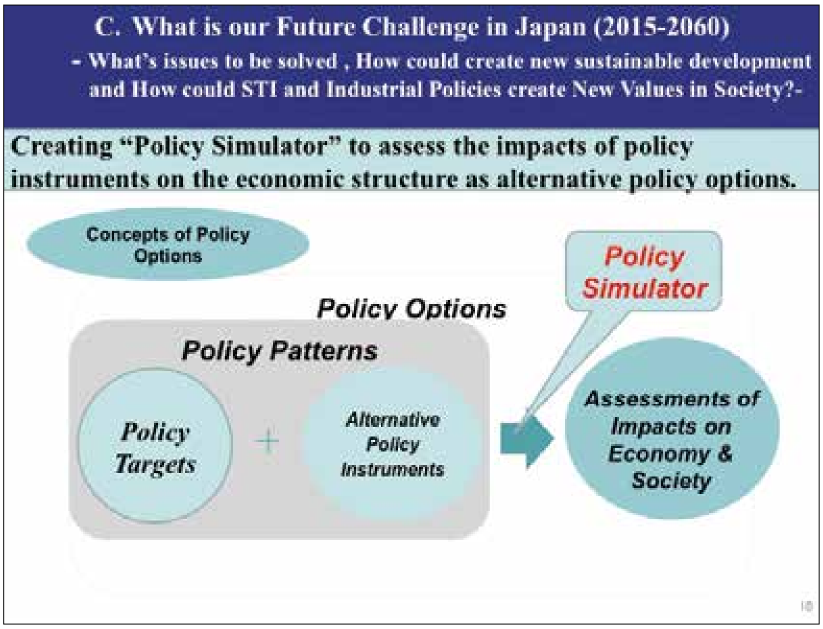


The notable progress in information and communication technologies since the middle of 20th century made a society expectation to encourage the changes of business models and the sophistication of the manufacturing process itself. If we could design on the system of the society, this kind of technological progress expects to have enormous impact on the economy. But unfortunately the merit of technology development could not create the effective advancement of market so rapidly on its own, so far, because of the lack of the appropriate policy inducement.

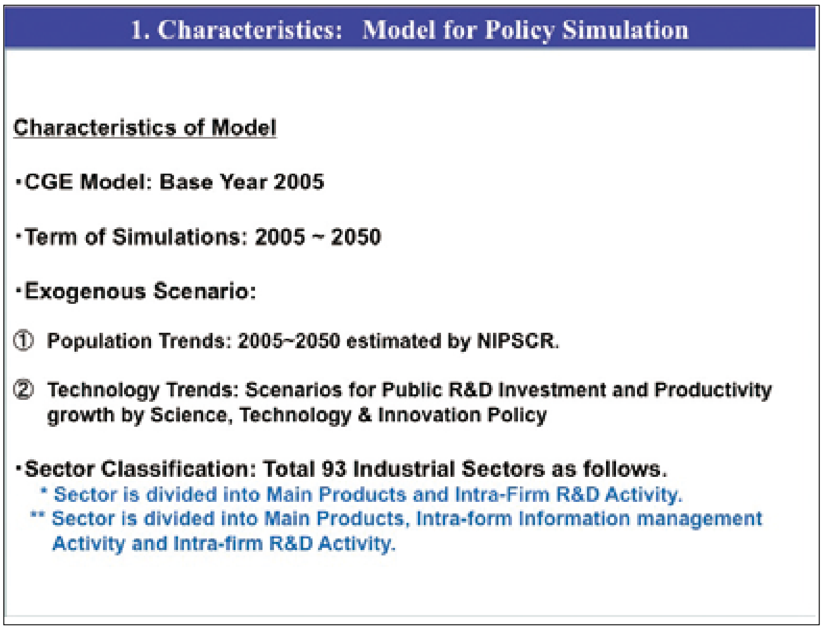


Recent technology has revealed a necessity to change societal systems themselves, away from the pyramid type for processes and the division of labor. Within the field of the sciences, information technology has too much impact on all branches through the innovative changes on experimental methodology in sciences. Each science is deepening itself and linking to others on its discipline; for example, all of the fields of sciences like bio-sciences, energy, environment, and material sciences are all linked each other and exchanging their knowledge among sciences. There is a multilateral and interdisciplinary need within the development of the sciences themselves, and also a need to address how the business side tries to link with scientific knowledge. We need to create the platform in which the knowledge in each science can be exchange. The knowledge created in the science platform has to contribute to the innovation on B2B or B2C platforms on business. Platform on the businesses is very important to activate their activities on business with exchanging information among B2B and B2C. This is completely different from the division of labor in the 1960s and beginning of the 1970s. On the new type division of labor in society, a platform makes a role to exchange the specific knowledge and information among the members horizontally, among various fields of sciences as well as between B2B and B2C.

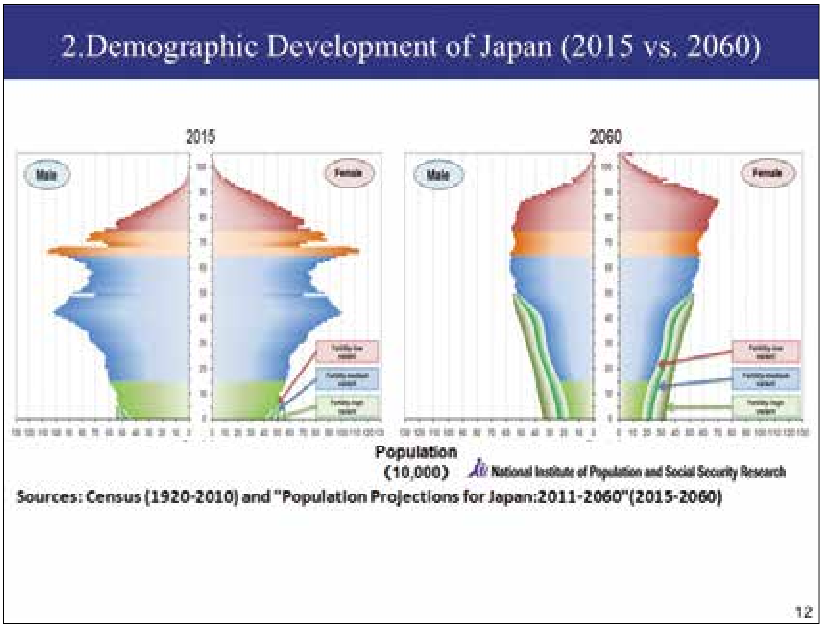
Our problem of the policy design is how to choose the appropriate policy design among alternative policy menu, by which we can create the platform with the new knowledge-based market design horizontally.



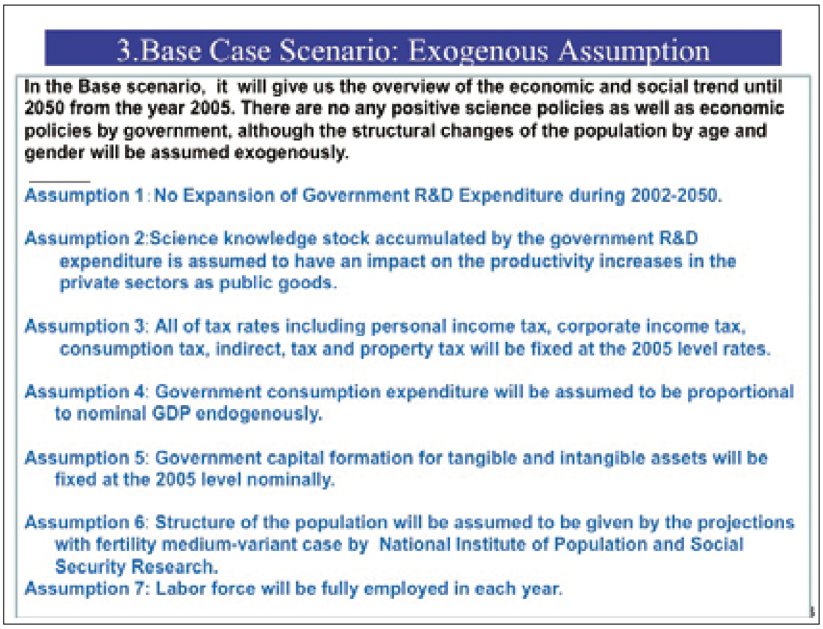
In order to select the appropriate policy design among alternative policy menu, we try to create "Policy Simulator", by which we can assess the impacts of alternative policy instruments on the economic structure as policy options. Here, Kuroda introduced to attendees at the summit a policy simulator model, which is based upon a computable general equilibrium model of the Japanese economy. Policy simulator is expected to propose the assessment of the impact of the alternative policies on the economy and society. It might give us the quantitative suggestions to choose the appropriate policy among alternative policy options.



He try to depict the impact on the economy by alternative scenarios of the government R&D policies as policy options during the periods 2005-2050. All of the parameters in the model were calibrating in the base year 2005. Population was completely exogenous in this model, and technology trends were exogenously given by certain scenarios.

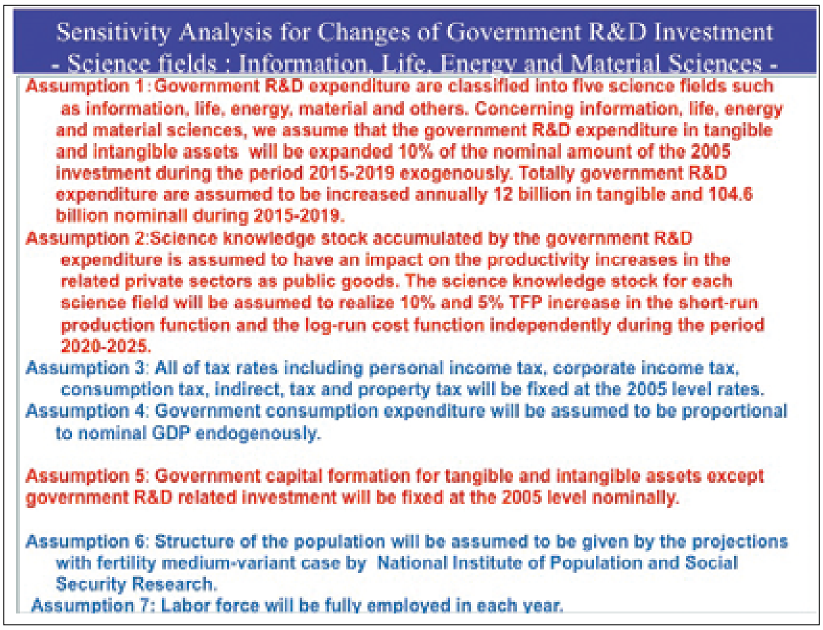


Also, the demographic development of Japan with the population forecast by the Institute of the Population and Social Security is exogenously given during the periods 2005-2050, commonly in all of cases including the base-line. Data show that the population has decreased in Japan and that it is, overall, aging gradually.



Base-line case as scenario is what he calls “the most miserable scenario of the Japanese economy from 2005 to 2050,” wherein there is no expansion of productivity through technology or investment of R&D (privately and by government) and no expenditures related to consumption and investment by government. Based on this scenario, he tried to draw the base line of the economy in the future as a bottom line scenario. The real GDP trend could be a good indicator in the macro level in order to compare the various impacts among alternative scenarios of policy instruments. The labor market as well as the financial, commodities, and service markets are influenced with the level and the trend of GDP. Here he focuses whether alternative economic policies on government R&D investment by differences in the level and the fields will have differences on economic growth paths and which policies will be a key to avoiding a new stagnation.

In the base case, trends are stagnated continuously, and the level of the GDP in 2050 still reveals no economic growth comparing the real GDP level at the base year 2005. It is showing a miserable growth scenario, as mentioned before, in which all of the exogenous policy variables except the trend of population are fixed as the level in the year 2005.



In the model, R&D expenditures by government are divided by fields such as information technology, life sciences, energy, and others. In each science field some amount of investment by government is assumed to be provided in order to promote the technology progress. In the base line scenario, the level of the government R&D investment was fixed in all of the science fields at the level of the year 2005. We try to give alternative scenarios in the level of the government R&D investment by each different fields of sciences. As an assumption, the model provides a 10% increase in investment from 2015 to 2019; after that, productivity increases within each sector. At first, the scenario is showing the increasing trend of real GDP during the periods 2005-2050 due to the increasing investment of the ICT field, as shown in the figure. A 10% increase of the R&D investment of the ICT field by government during 2015-2019 is not promising, but at the real GDP in 2050, it will have the impact of about ¥7 trillion, 1.3% increase of the real GDP in the base case scenario in 2050. Continuously, he tried to give the same scenario in the science fields of life, energy, and material sciences, in which 10% increase of the level of R&D government investment during 2015-2019 is assumed separately.

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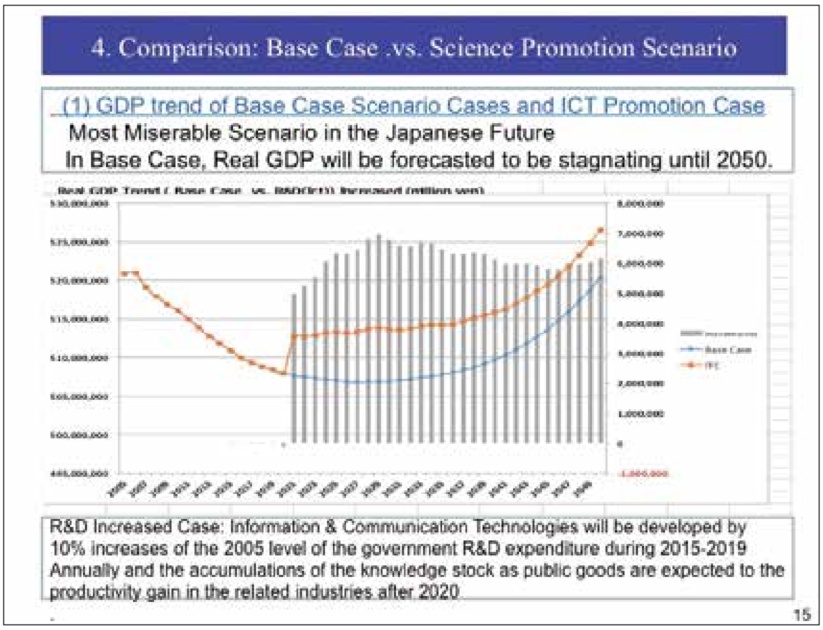
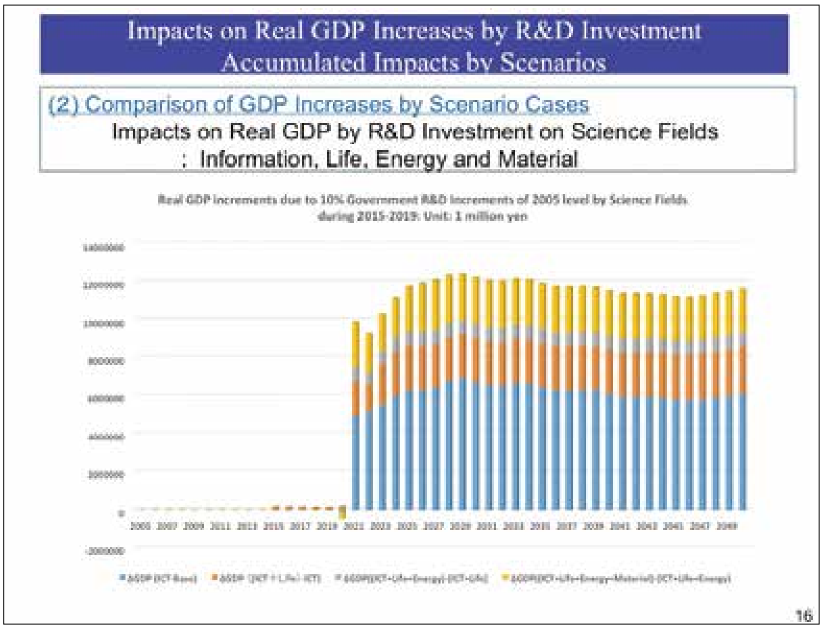
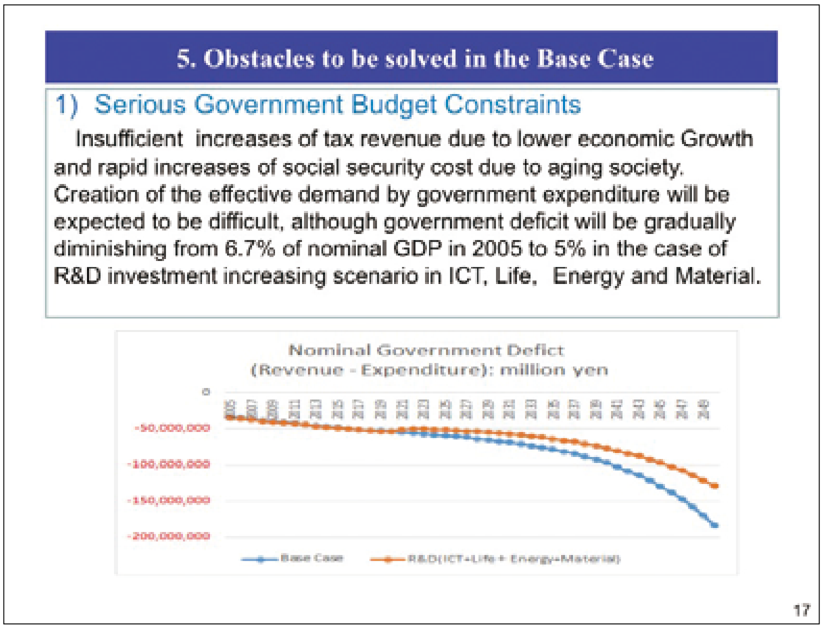
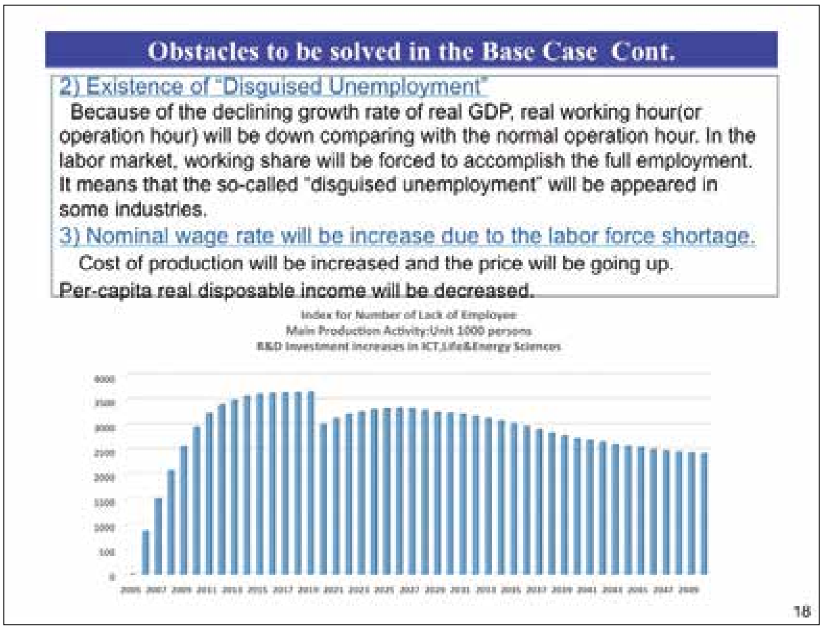




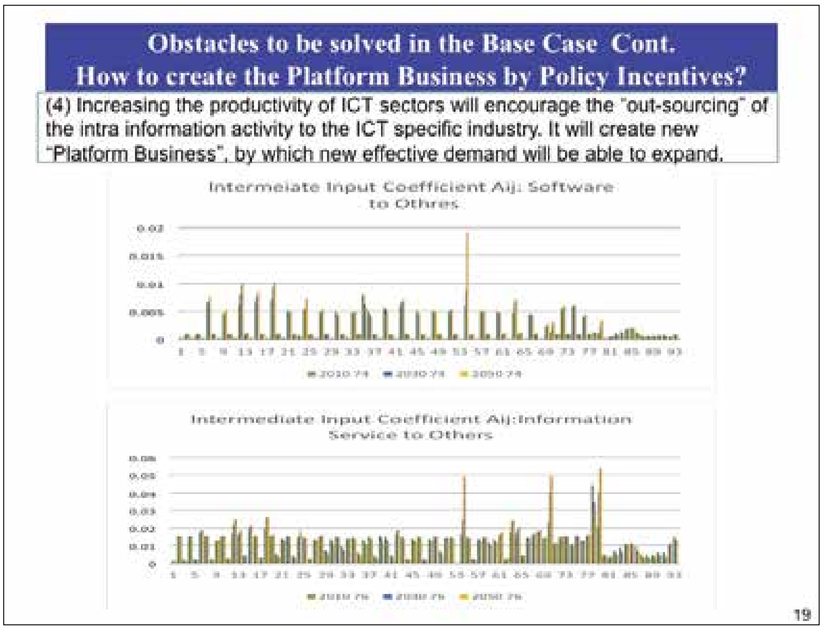
Each impact reveals the differences in the network or spillover effect of productivity among the industrial sectors, but ICT impact is the most significant. Although they are simple policy scenarios, it can show the various views on the economy in the following important points.

First point is concerning on trends of the government budget constraint. Insufficient increases of tax revenue due to lower economic growth and rapid increases of social security due to aging society will be a big constraint on the sustainable development. In the base line scenario, the deficit in the government will be increased continuously. Even in the case when technology is improved and economy growth is up, the budget and deficit are still significant negative issues.

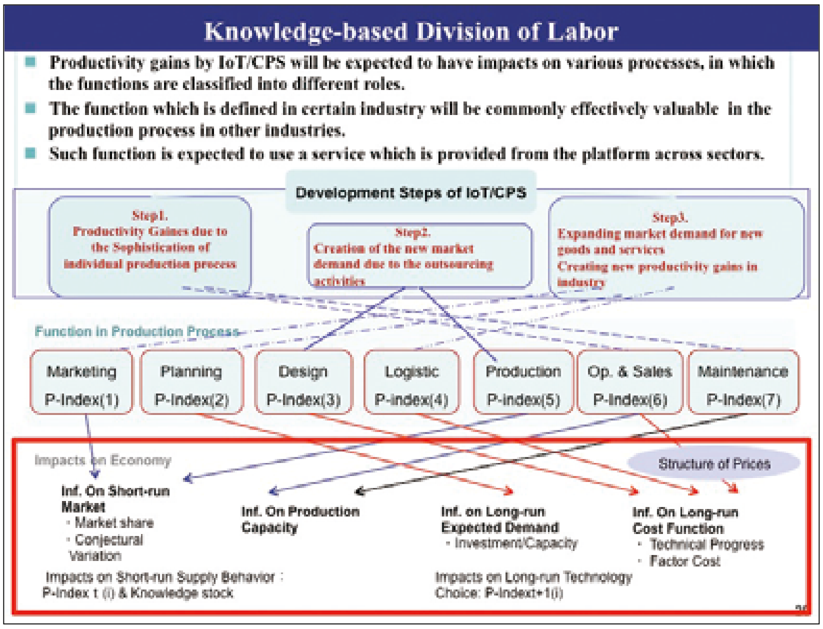




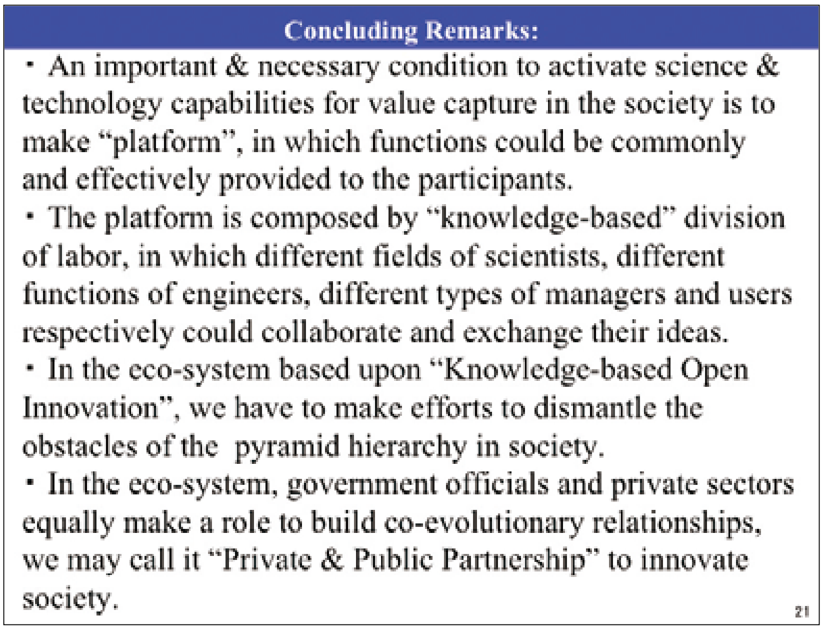
Secondly in each scenario it was shown that unemployment is up and the visual provided to attendees demonstrates the necessity of the working share in the society in order to realize 0.0% in the unemployment rate. Regardless, unemployment will be a significant problem in Japan.



Finally, he showed, in his next slide, that increases of the productivity of ICT sectors will encourage the "out-sourcing" of the intra information activity to the ICT specific industry. It will create new "Platform Business", by which new effective demand will be able to expand. Information technology can make a platform and increase the efficiency by the division of labor. If government would try to encourage to outsource the intra-ICT activity to the professional ICT industries across industries by policy, in which it means to encourage making platform for ICT activity by the functional concentration of ICT activity and promoting a division of labor among sectors.



When it comes to consider the ICT impacts on the process of the production in each industry, there are many different functional impacts, such as marketing, and planning, designing and trading functions of the business. Essentially, the function itself is not specific in certain industry, but a kind of the function is commonly used among the different industry levels. Such function is able to use efficiently in the platform, in which the function proposed in the platform can be used commonly among the members of the platform. The influence of ICT progress impacts part of the function, which is correlated to all industry sectors.



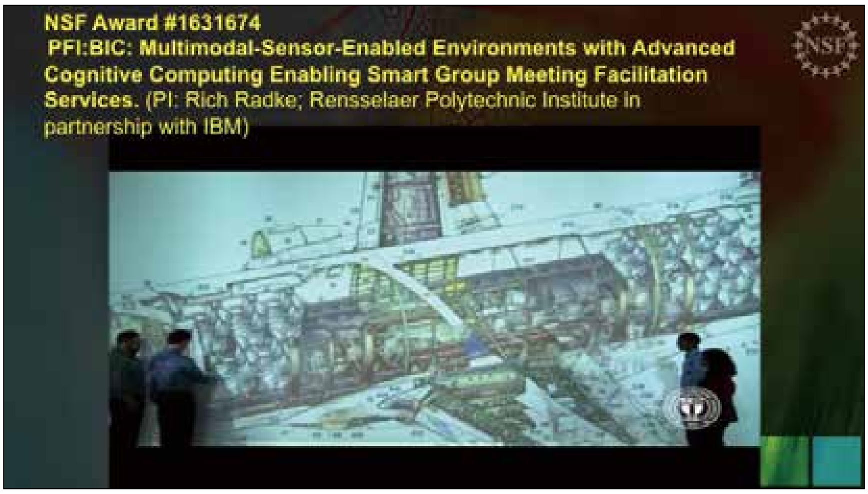
Finally, Kuroda states that an important and necessary condition to activate science and technology capability for capturing value in society is to create an effective platform that can, in some way, serve as a function of the process. Ideally, this platform will be composed of knowledge-based sectors, an appropriate division of labor, and people from different fields of the sciences as well as engineers and other types of managers. These individuals could then collaborate and exchange their ideas with one another. Within academia at the university level, a similar platform is also needed, though one that is multilateral and interdisciplinary, to encourage knowledge-based open innovation. This could help to dismantle the obstacles inherent in the pyramid types of hierarchy in society.

(2) Smart Human-Centered Service Systems of the Future, Alexandra Medina-Borja, Program Director, NSF

Dr. Medina-Borja is the Program Director in the Directorate for Engineering at the National Science Foundation (NSF), whose first trip to Japan was in 1993 for the government-sponsored Ship for the World Youth program, which had among its objectives to ensure solid relationships of the program's attendees, who had aspirations to become future professionals in other countries. Her participation in that program and then her speaking at the summit, she says, is why she considers herself a success story of that initiative.

She explains, during this session focused on the impact of Society 5.0 and smart services/smart society that at the NSF, they always talk through the projects that they fund; for Medina-Borja, the program that she manages is related to partnerships for innovation, building innovation capacity in the smart service systems, and is the only division in the group that funds translational research. While some other divisions are becoming interested in smart cities, her division is the only one that has a prescribed mission to fund smart services in partnership with industry.

In order to understand the impact of this future smart society, she states, we first need to know what we have today, and she posits that the projects in her program will be in the market within five to ten years (though longer if they involve a medical device, and less if they are software-related).



All of her examples discussed at the summit are projects that result from partnerships between her group at the NSF and industry. Her first example, Multimodal-Sensor-Enabled Environments with Advanced Cognitive Computing Enabling Smart Group Meeting Facilitation Services, involves a smart environment that facilitates meetings such as the current summit. But within that environment's ambient intelligence, it could mediate between presenters and attendees, take notes, and other tasks to facilitate an engaging event.

(Video presentation)

Her example is accompanies by a video by Rensselaer Polytechnic between Rich Radke from the NSF and IBM (the industrial partner). The video content imagines how a large "cognitive immersive environment" could facilitate and enhance collaboration in a group meeting. Prior to the hypothetical meeting, the cognitive environment has an agenda of who is scheduled to attend. As participants enter, face recognition technology matches them to the agenda and checks them in.

In many large meetings, not everyone knows each other, so the cognitive immersive environment tracks the participants with an overhead camera array and records who is standing where. It can use information such as social media posts to determine participants' interests and identify commonalities between people who might not know each other yet. In this way, the environment can be an "icebreaker" before the meeting starts, a time during which participants can learn something new about each other without having to individually initiate the interaction.

When the meeting starts, the environment already knows the content agenda as well as the participants and their roles, and even the meeting notes from a previous related event, if applicable. Speaker recognition and natural language understanding can help the room

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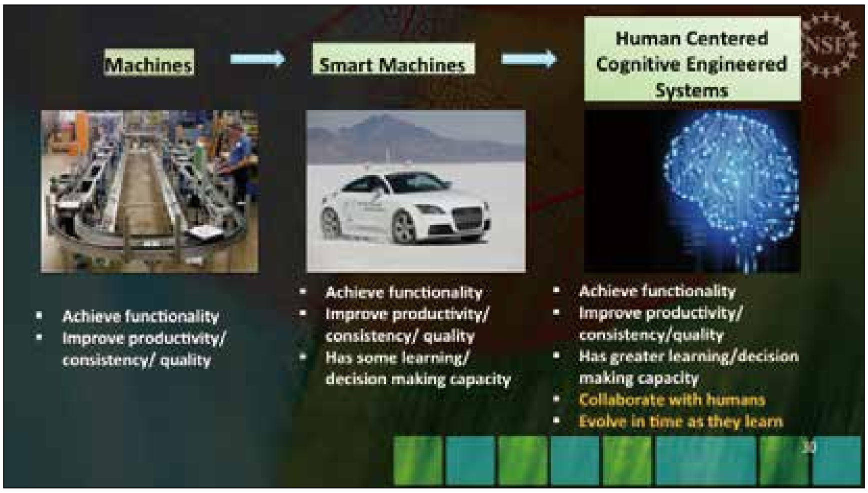
determine whether action items from the previous meeting have been accomplished and to keep track of new tasks for any necessary subsequent meetings. Tasks are automatically pushed to participants' mobile devices and to-do lists according to their roles and skillsets.

The environment also keeps the meeting on track and knows which participant's input is needed for each agenda item. At the end of the meeting, the organizer and participants immediately receive an email that contains a generated summary for their records. Such immersive environments enable groups of people to simultaneously collaborate in ways that would be impossible using a single monitor or single human host. Complex visualizations and technical data can be shown on a large scale and interacted with using natural gestures. Participants can share data from their personal devices for everyone to see, or the room may generate new data/analysis in response to queries or statements made during the meeting.

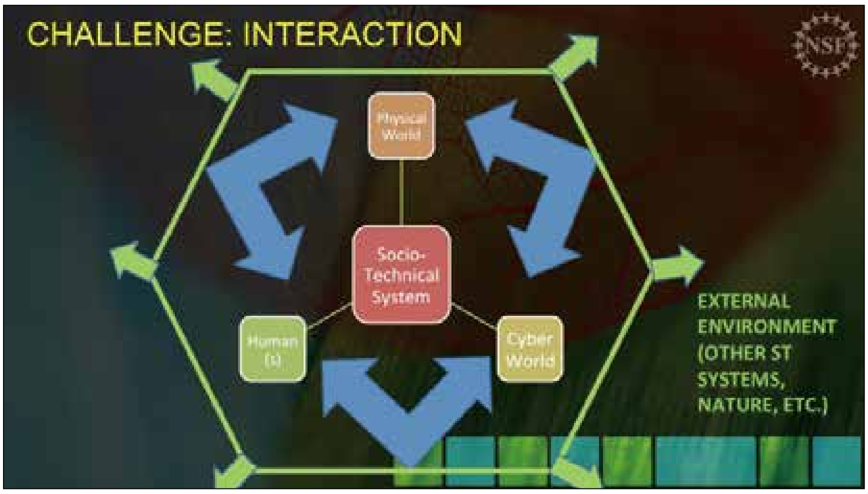
In the coming years, Medina-Borja believes that we will realize the vision depicted in Rensselaer's Cognitive and Immersive Systems Laboratory, combining research from computer science, computer and systems engineering, cognitive science and varied application domains to create human-aware environments. However, she qualifies that such an environment is still in the research phase and may take five years for even a pilot program.

One of the key challenges to this becoming a widespread reality, however, is privacy concerns (i.e., a machine knowing where you're standing, having access to your profiles and interests), though she does state that all projects that NSF funds that would require human subjects are required submit to their institutional review board materials for the protection of human subjects. During the research period, people "opt in," but once the service is in place, then it becomes a societal issue and even a private sector issue; for example, an employee's boss currently does not know what each employee is doing in meetings, but if a cognitive immersive environment becomes the norm, then they will be able to access much more detailed information about their subordinates.

In the very near future, smart artifacts and spaces will be able to intelligently interact with humans. The space will co-create value for humans, to which NSF states that "humans will become the space," and the object/artifact will become a de-facto service provider. These kinds of sociotechnical systems have human components as well as physical objects that have a type of intelligence, and then interfaces on which parties (humans and machines) can exchange information and interact in new ways. As such, it will expand the concept of service system.



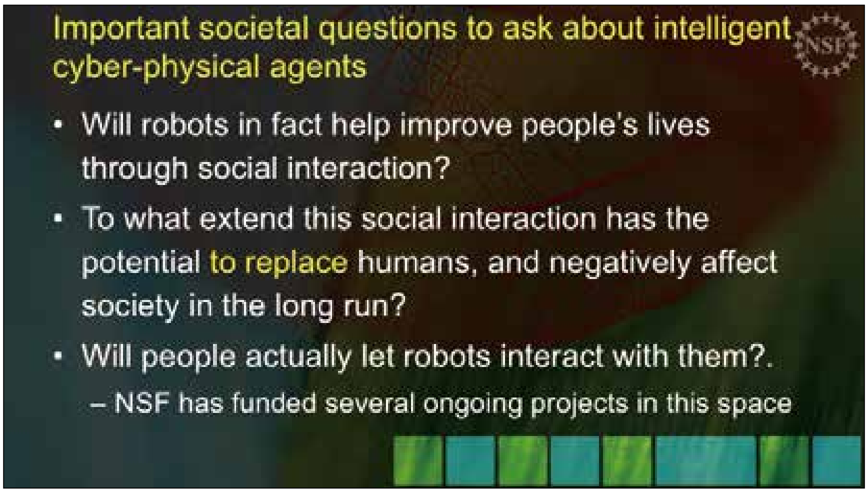
Medina-Borja then presented a visual that shows how we have evolved from simple machines to smart machines, but also how we are heading toward human-centered cognitive engineering systems that will collaborate with humans, not seek to replace them. Successful research will propose how the system can help me as opposed to replace me.



She then discussed how the key challenge of these new smart systems is interaction, using a visual of a sociotechnical system between the physical world, a virtual world/cyber world, and humans. Arrows on the visual show interactions across all elements of the sociotechnical system and of the system with the environment. The ethical and security challenges are considered to be “within” the arrows of the interactions.

According to the NSF Computer Science Database’ list of awards over, more than 2,500 of them over the last three years included variations of the words “security safety networks,” “safety of network,” “safety of cyberspace,” “safety of sociotechnical systems,” etc. This indicates that there is a lot of fundamental research in trying to make systems safe, but that there are also challenges in the fundamental research for these systems to fully realize a place in the future. As such, interdisciplinary teams are going to be necessary to hone and refine interaction to ensure the safety and viability of these systems.

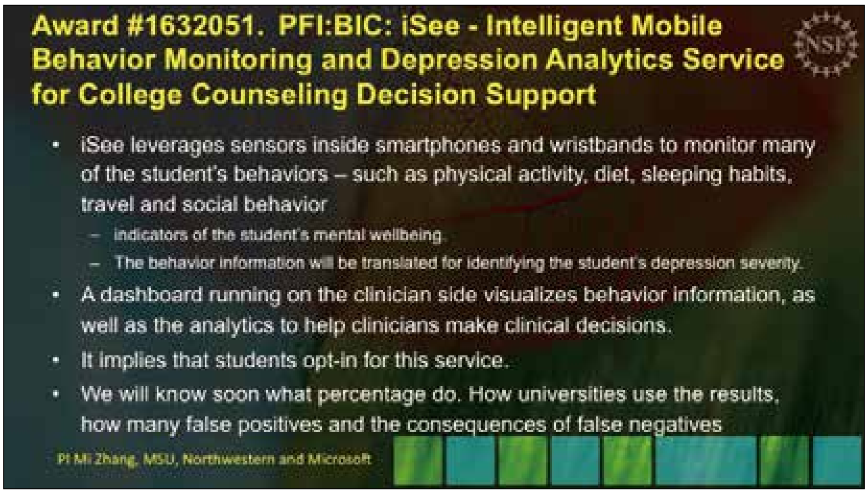
When it comes to ethics and privacy, Medina-Borja states that sometimes the NSF makes sure that their paperwork is in order to begin the research but that they defer worry about what will happen with policy until later, because if they went into research the other way (worrying about external factors first) then "nothing would have been funded." She equates it to someone having cancer who is given two options: radiation or chemotherapy. Both will be uncomfortable but it's the benefit-cost analysis that makes the decision (i.e., radiation is bad for your health but it is better than dying). Likewise with some of the issues surrounding smart systems: there is a risk but also we need to weigh the benefit.



She provides a slide to attendees that contains important social questions about intelligent cyber-physical agents, such as whether robots can improve people's lives and if people actually want to interact with robots. Let's say that people do want to interact with these mediators: Will there always be an inherent fear that will they replace human-human interactions altogether? She stated that we can almost see the beginning of this in current society: people in restaurants looking at their phones as opposed to having a conversation with the person across the table.

One of the aforementioned awards that Medina-Borja spoke about with attendees was on Affordable and Mobile-Assistive Robots for Elderly Care out of the University of Pennsylvania in the U.S. by Mark Yim and a robotics company. Yim stated: "The only way robots can be commercially viable is if they serve a real need in an appropriate manner. Having the real context of working with elders in the eldercare facility is critical to getting the robot design to be effective." His project centers on robots that have physical flexibility to, for example, hand a glass of water to an elderly person without crushing the glass, or covering them up with a blanket without causing physical harm. The robots also seek to learn behavior patterns of the patients/nursing home residents via a cognitive system, so that they will learn whether the person is thirsty or cold and bring the appropriate item to them, so that human nurses can focus on other tasks that robots cannot perform.

The project also studied whether or not elderly people would like to interact with the robot, or whether they might be afraid of doing so.

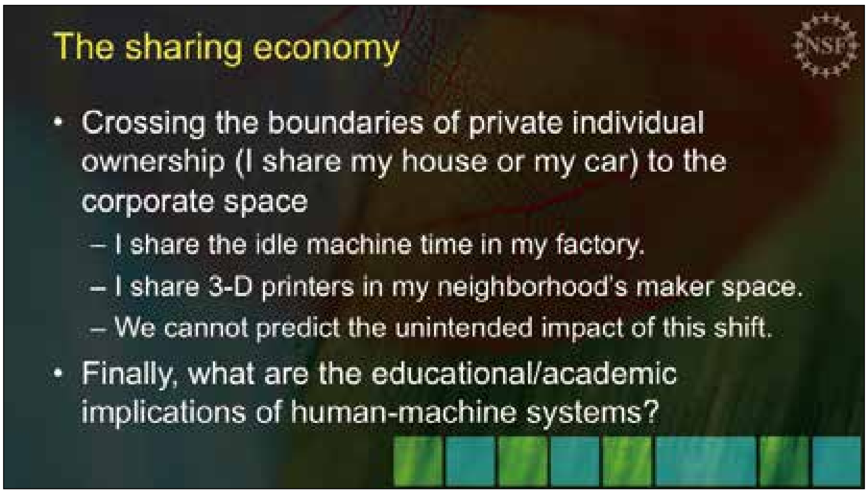


The second awarded project that she discussed was out of Michigan State with Microsoft and focused on using sensors in phones of college students to gather data on the increasing trend, particularly in engineering students, of depression during the first years of college; in some large engineering schools, there has been an increase in suicides as well. In looking at how to you prevent this, researchers entered a partnership with Microsoft for an "opt-in" study into these trends. One of the more significant flaws in this study, though, is that people are opting-in to a study about behavior, and in such cases, researchers often question if the patterns they see in the study are real patterns.

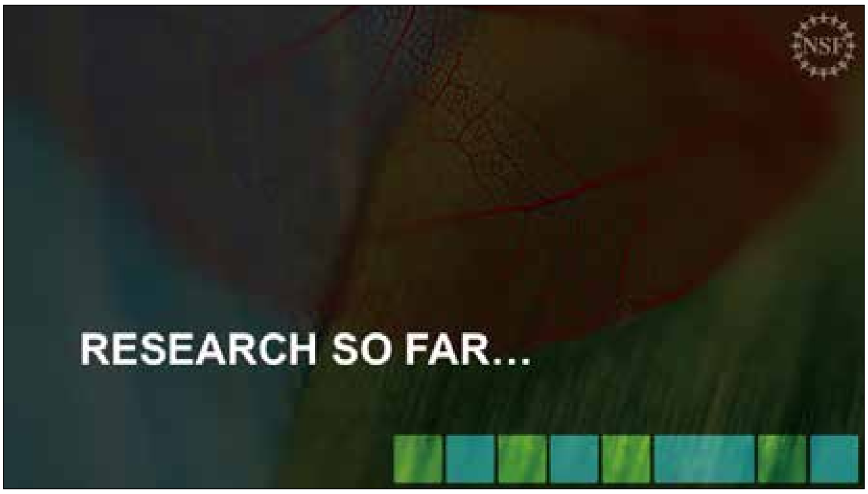
They are also collaborating with Northwestern University, which is a well-known researcher in depression, and hope that this combination of people will return significant results. One of the forward-thinking concerns is about the actions that university counseling offices might take if (when this is deployed in a real-world situation) they feel that a student is at risk of suicide. Are they going to send him or her home because of liability issues? In addition, what will happen with "false positives" or, worse, even false negatives from this data when, again, used in the real world? So, Medina-Borja states that it is a good step to fund research for this, but to make it usable, there are a lot of issues that need to be resolved first.

She then moved into a discussion of economic disruption by showing attendees a timeline from a report by GE that shows human progress from the industrial revolution to the Internet revolution and then predict that we are heading into the industrial Internet revolution.

She noted that many of the projects that NSF is funding could end up being disruptions in the supply chain because of manufacturing changes; for example, what if we could design and print our own shoes at home, rather than having them made in low-wage countries and needing to buy them from a store?



She noted two related projects funded by NSF that are complementary and involve translating the sharing economy (e.g., the concept of Uber and Airbnb) to manufacturing facilities, so the ownership of the machines, especially those that are very expensive, can be translated to a “makers movement,” wherein people who have ideas and want to not only print but actually produce other things can do so.

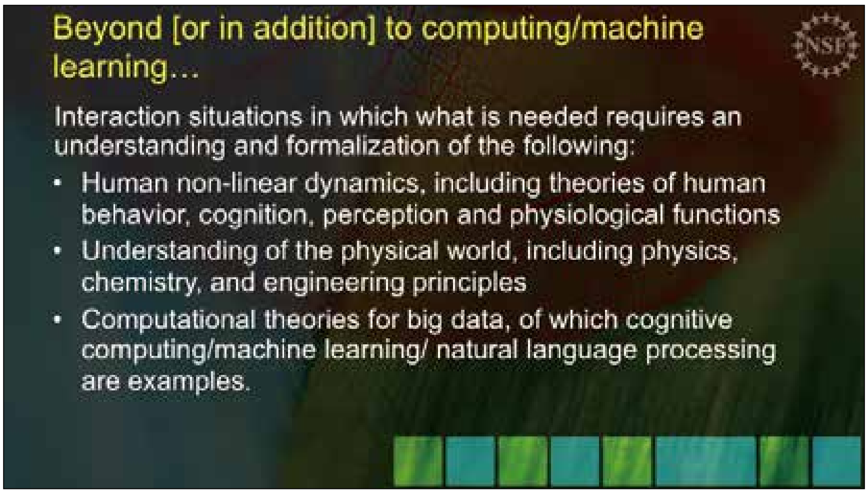


One of these two projects is out of Georgia Tech and is a consortium that is working on algorithms that match a company or factory that has specific machines (not 3D printers but other manufacturing and assembly machines) with someone else who wants to use them, and creating a work stream agreement there. The consumer base, then, would be the decentralization of service demand for these machines.

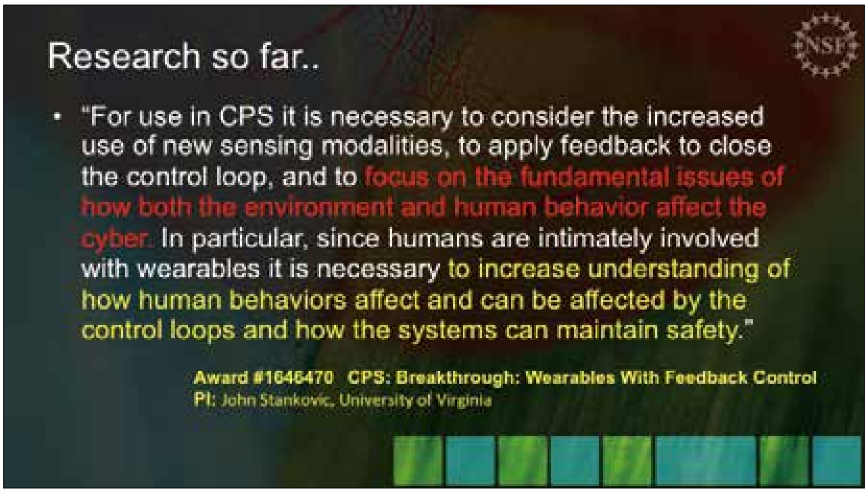
The other complementary project is out of Purdue University and called the MakerPad, which claims that any design can be translated into CAD and be printed. To use the above example, designing a shoe and sending them to print. If MakerPad is successful and joins with what the first project group is doing at Georgia Tech, in the future (at least simple things) that today we purchase from places like China could be translated into people's homes or a neighborhood/regional printer, thereby disrupting the supply chain.

Following, Medina-Borja spoke to summit attendees about socio-technical research challenges that relate to topics outside of ethics and the safety.

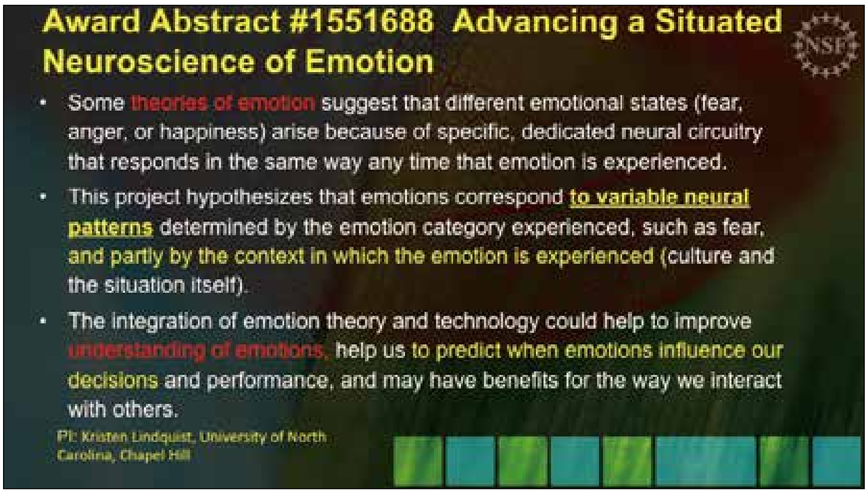
She used the example of autonomous vehicles to discuss the challenges of “cooperative control”: Human drivers, on a rainy day, are likely to be more apprehensive and careful than usual, and human passengers in a self-driving car on a rainy day may still feel more apprehensive than usual. What happens, then, if a family of deer is in the distance in the second scenario (riding in a self-driving car)? The car probably already knows that that there is at least an object moving toward the car, and (depending on how good the algorithm) might even recognize it as a group of deer, but a normal human reaction may be to want to take over control of the vehicle. AS such, cooperative control is an important consideration in some AI research. Similarly, the car needs to know that the passenger’s heart rate is up and contain algorithms that can react to that (similar to what McDuff’s discussed earlier at the summit). She notes that this will involve a mix of three things: the physical world (where it is raining), a cyber-physical object (the self-driving car), and a socio-technical system (wherein the AI algorithm can detect human behavior cues).



The formalization of interaction between these systems will result in human non-linear dynamics, including theories of human behavior, cognition, perception, action, and physiological measures. The latter (physiological measures) is something that is currently advanced—understanding physical work—but it is the combination and the interaction between all of these things, and the computational combination of them that requires further research.

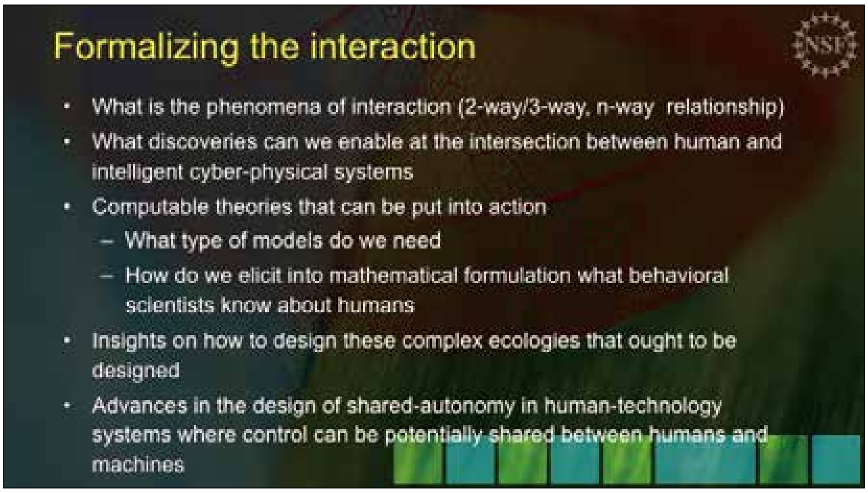


As additional examples, she found three other projects: one in computer science, one in social and behavioral sciences, and one in engineering. The computer science example was the CPS program out of the University of Virginia that involved breakthrough wearables with feedback controls and focuses on the fundamental issues of how both environment and human behavior affect the cyber arena, to increase the understanding of how human behaviors affect and can be affected by control loops and how the cyber systems can maintain safety.



The behavioral sciences example involves the neuroscience of emotion; for example, there are different parts of your brain that activate when you are fearful, happy, etc. The part of your brain that activates is context-dependent, so if someone feels fear because they see a deer and are in an autonomous car, then a certain part the brain is activated, but if a person is in a spooky place then the part of the brain activated is different, even though the emotions are similar. As such, for those researchers who want to have sensors that measure electrical activities in the brain, then this type of neuroscience is important, because these projects seek to predict when emotions influence our decisions and performance.

The engineering example involves control and dynamics toward developing fundamentally new dynamic models for cooperative control algorithms and decision-making.



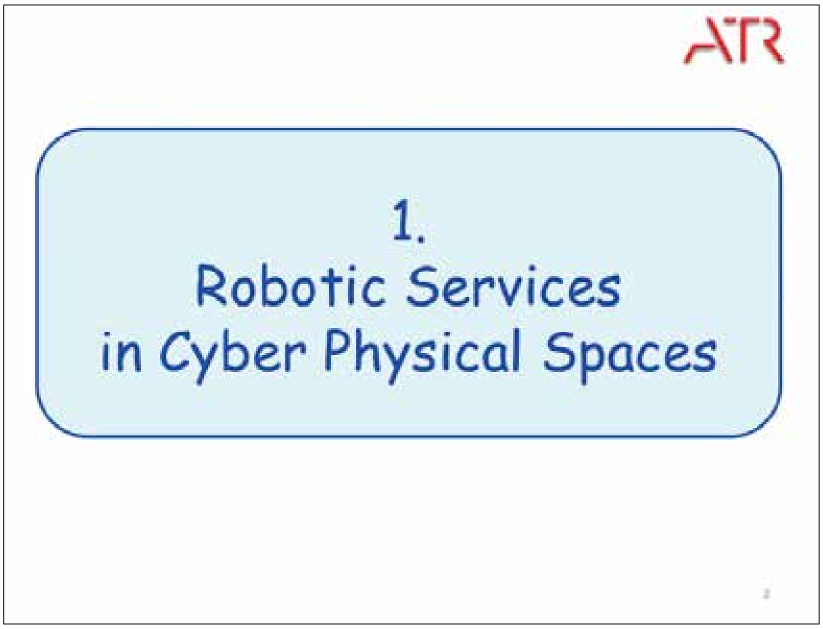
Medina-Borja concluded her discussion by positing that, if these three researchers could work together, the issues involved in her autonomous vehicle simulation, for example, could probably be solved in only a few years.

Formalizing interaction, then, will be key to future research, as will convergence, rather than being simply “interdisciplinary.” A deeper integration of knowledge, tools, techniques, and modes of thinking (particularly modes toward current societal problems) is required; until we have that, she stated, NSF will be siloed. Going back to the discussion about “T-shaped people,” she stated that people have to be deeply involved in what they do also have to be able to collaborate.

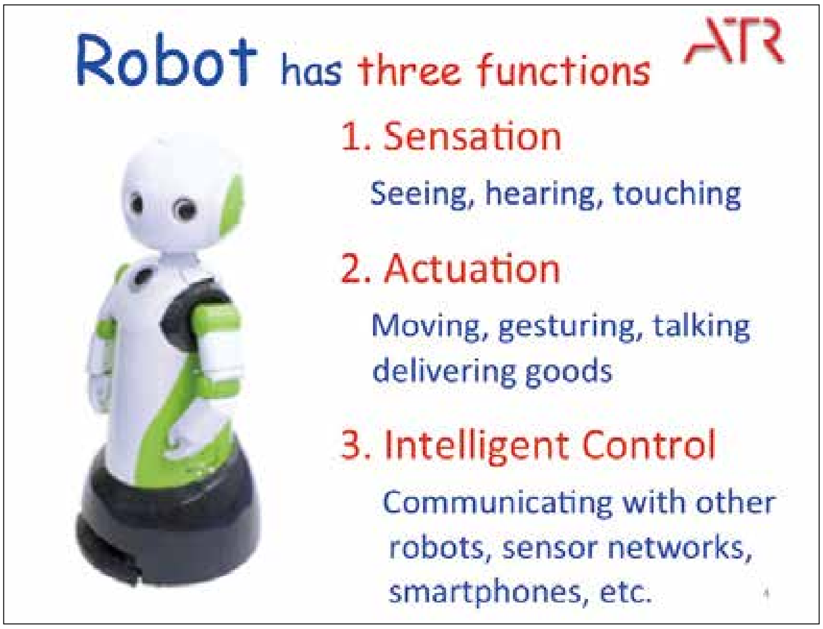
(3) Intelligent Systems Creating Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration, Norihiro Hagita, Director, ATR Intelligent Robotics and Communication Laboratories

Nori Hagita's speech at the summit focused on robotics and the societal impact of intelligent systems, as well as how robotic services development requires ethical, legal and social challenges and how the JST CREST Research Programs can help to create a "situated services" society in the near future, ideally as part of the U.S.–Japan Research Collaboration projects in partnership with JST and NSF.

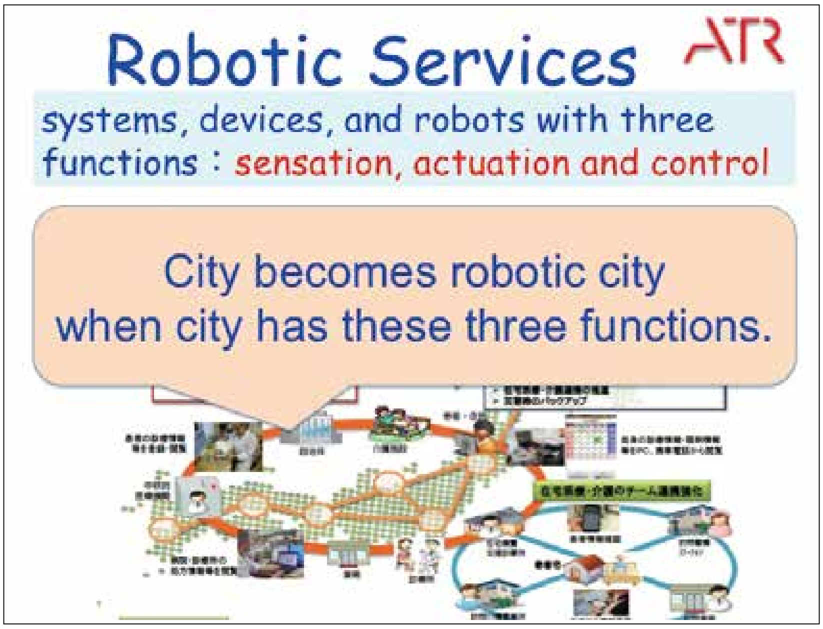
He references Nordfors' speech about disrupting employment to create new types of work to combat unemployment, particularly among specific groups.



The cyber-physical space is a new type of space; as such, we have to create new types of jobs.

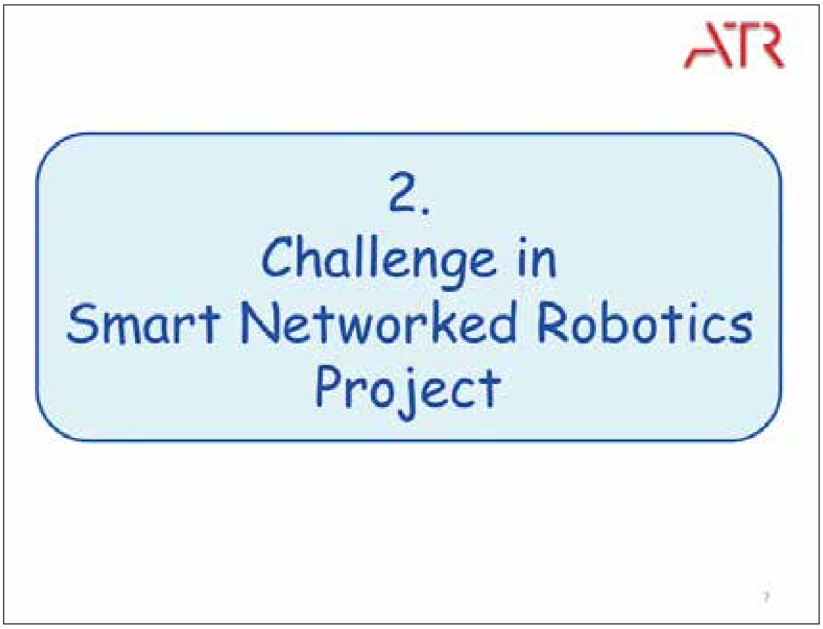


Within robotic services in cyber-physical spaces, robots have at least three functions: sensation, actuation, and intelligent controls between sensation and actuation.

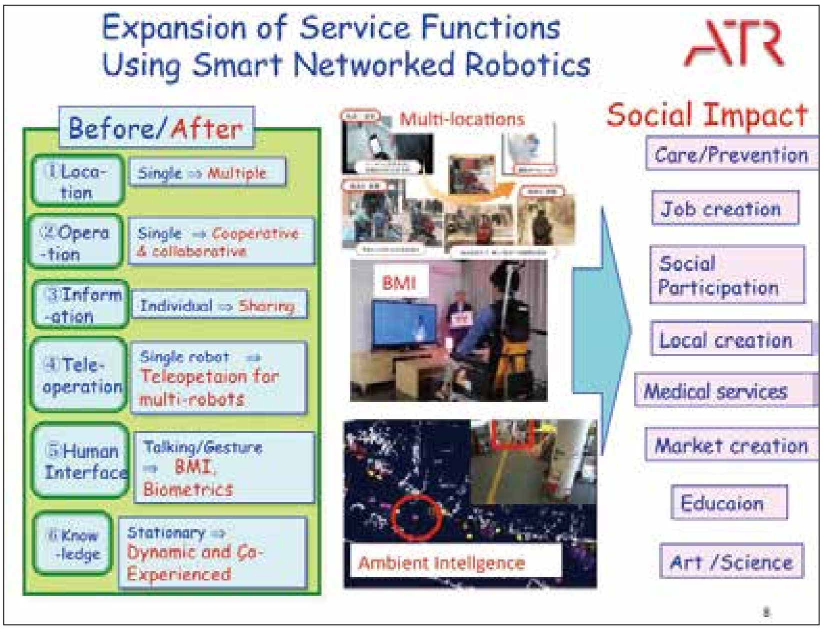


If these three kinds of functions could be applied to an entire city, then the city could become a robotic city. Many studies are already focusing on “smart cities,” so these cities are benefitting from the sensing function; following, some venture capital companies are focusing on new types of business, and after that, hopefully, new types of employment can be generated.

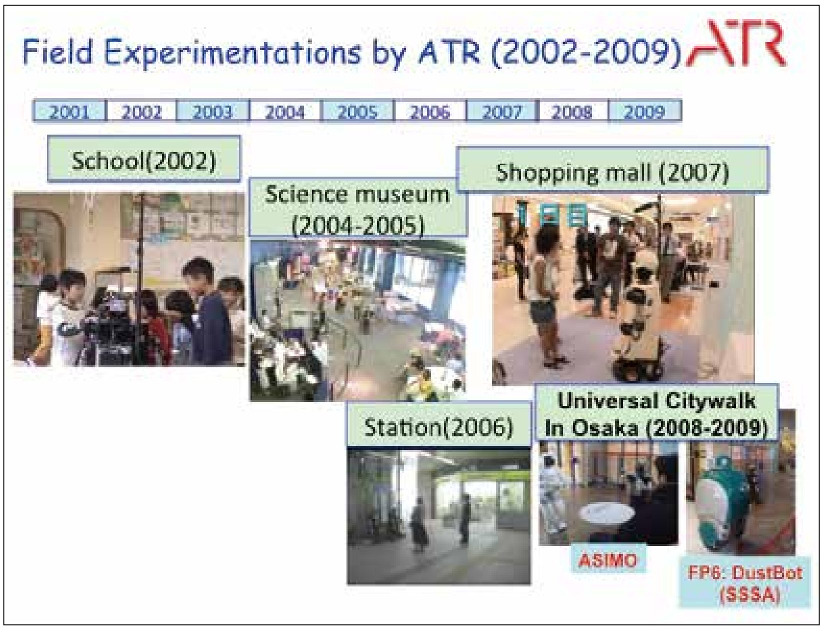
At his company, ATR Intelligent Robotics and Communication Laboratories, Hagita has been working on robotics services for 15 years, including field experimentations.



For one such project, he received funding from the Ministry of Internal Affairs and Communications (MIC).

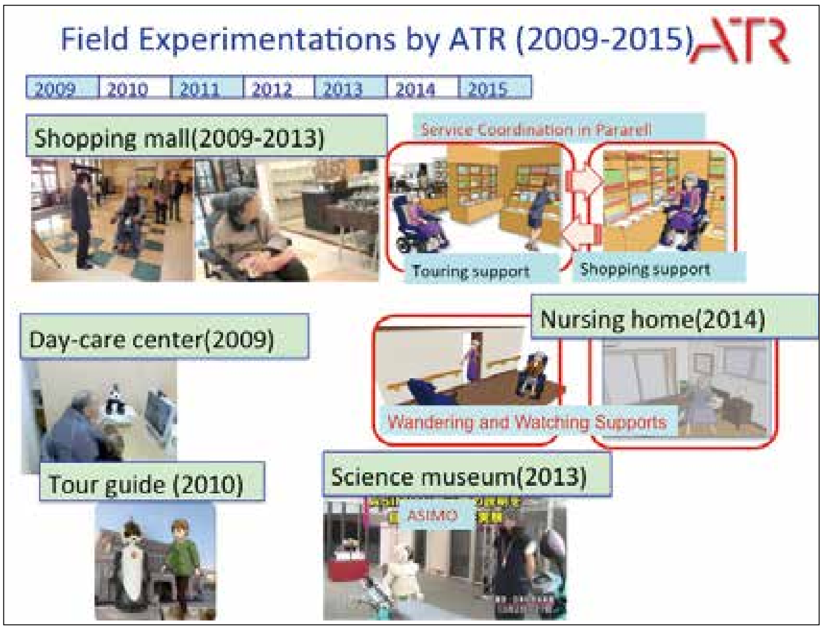


This case investigated how to expand service functions and coined the phrase “Smart Networked Robotics” to reflect the concept of the new ideas and new research.

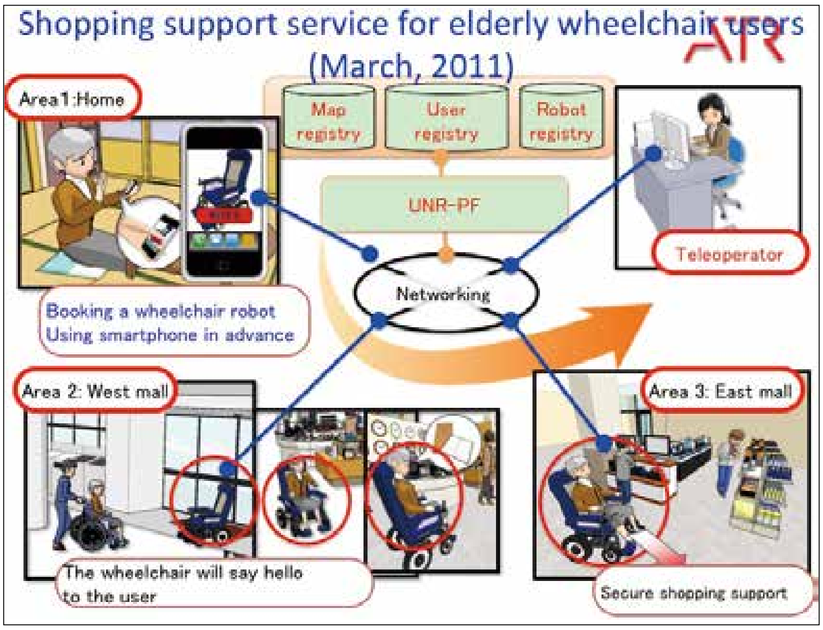


Hagita has been engaged in field experimentations from 2002 to the present, including bringing robots to elementary schools, science museums, and shopping malls. He also collaborated with Yuichiro Anzai, the President of the Japan Society for the Promotion of Science.

He also often collaborated with FP6 in the European Union, and Scuola Superiore Sant'Anna - The BioRobotics Institute (SSSA) just collaborated with ATR on work in certain towns in Peccioli, Italy, to have special signs and designations for robots and vehicles.

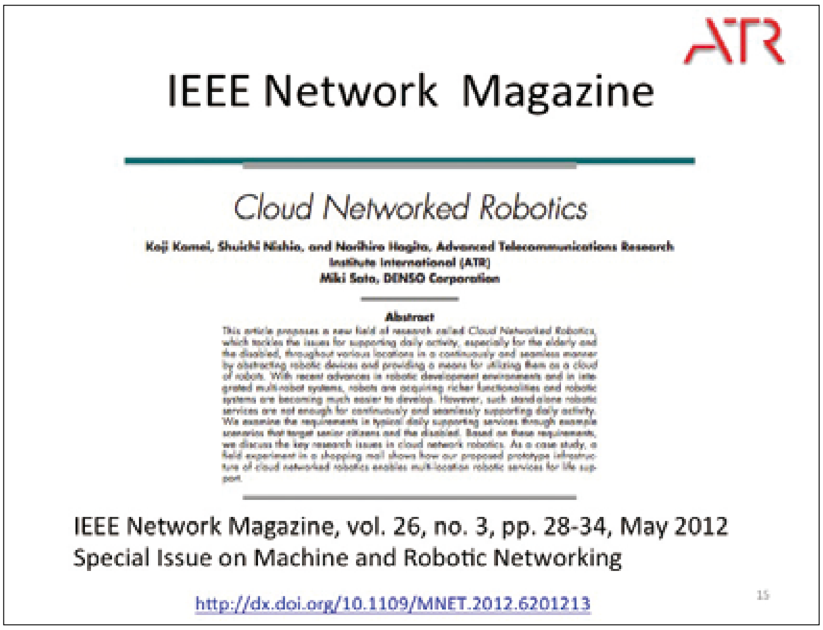


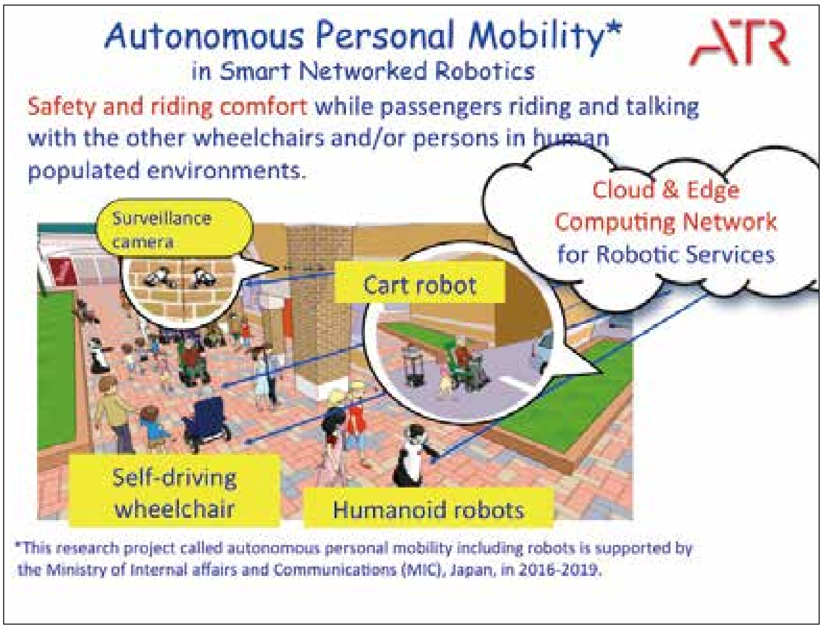
He is still working on securing governmental funding to do field experimentations in shopping malls and nursing homes, ideally in collaboration with ASIMO; however, he did refer to current collaborations with Hideyuki Tokuda (who spoke earlier at this summit) that focus on autonomous personal mobility, such as side-by-side walking with autonomous wheelchairs, and directed attendees to see his work in IEEE Network Magazine.



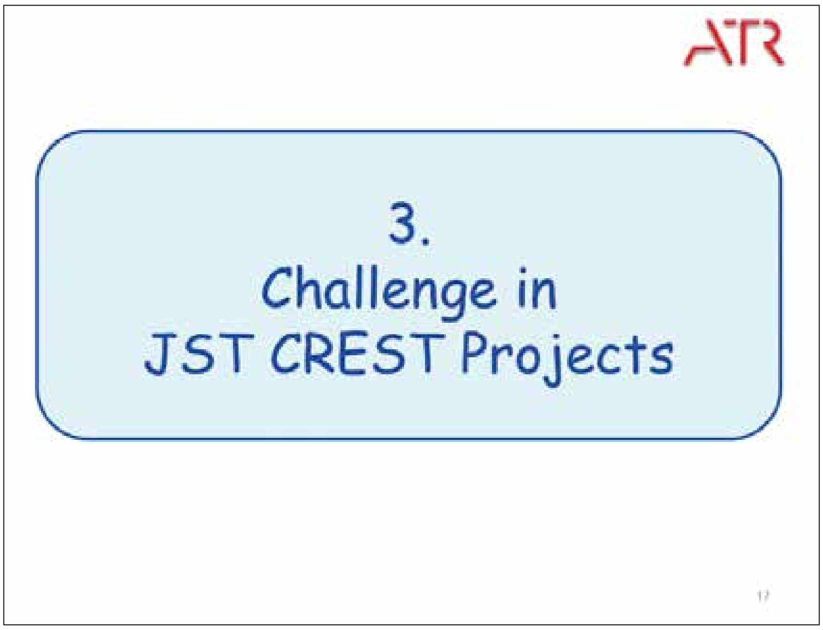

Shopping support service
for elderly wheelchair users
Using Ubiquitous Network Robot Technology
ATR Intelligent Robotics and
Communication Laboratories


Robotic services for AAL
(Field Experimentation in 2009-2013)
Shopping support
Active hearing
Cloud Networking
Health care
Touring support
Community building support
Life support research project in Ministry of Internal Affairs and Communications
in Japan. ATR, NTT, Hitachi, Toshiba, and NEC in 2009-2013



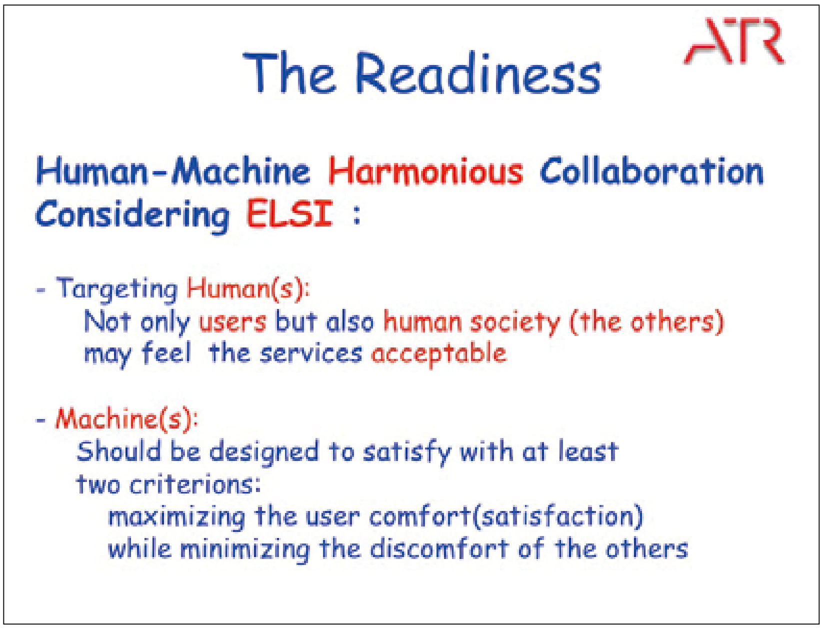


6 Impact Session



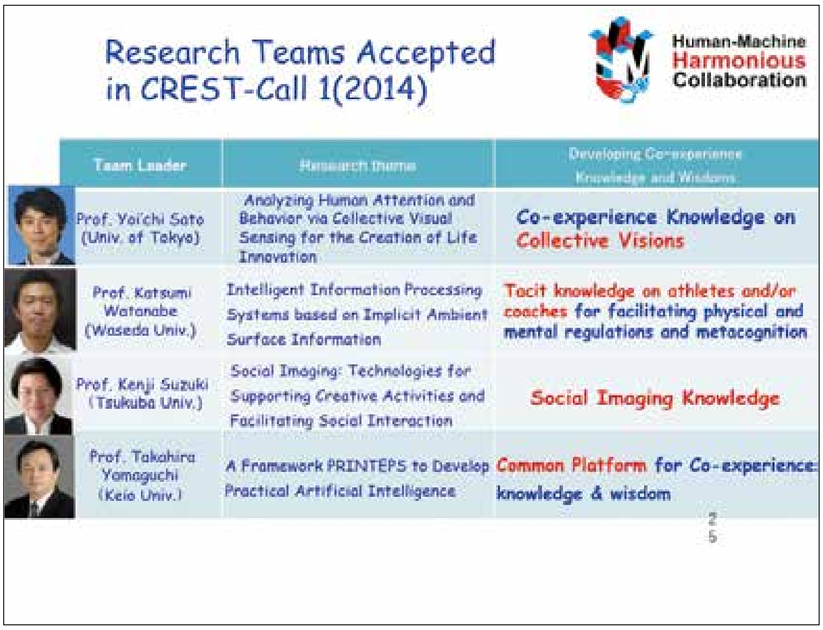
He next moved onto a discussion of the challenges inherent the JST CREST projects, using a project for which he was the supervisor: Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration.

Harmonizing, he stated, is very important because it can generate a new kind of market if a situated service society is also in place, using the co-experience knowledge and wisdom that can result from human-machine harmonious collaborations.

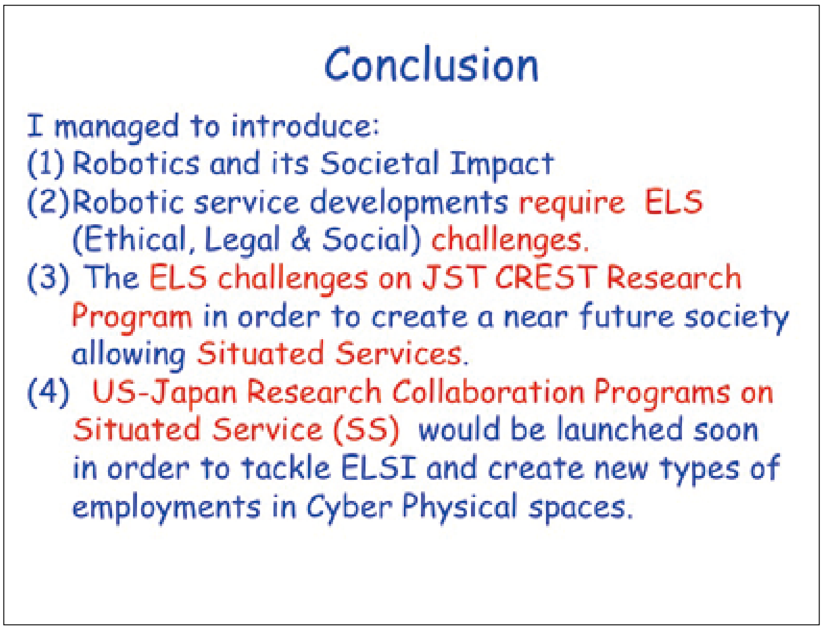


To be ready for human-machine harmonious collaboration, we have to consider ethical, legal, and social issues (ELSI); for example, humans as users as well as human societal impact in general. In Hagita's case, following field experimentation, he learned that not only the users (most studies focus only on user acceptance), but also human society in general may feel that the service is not acceptable, and this general acceptance might be very important to enabling such services not only in the physical world (robots) but in the cyber world as well.

For example, Pokémon Go, even though some bus drivers were trying to play while driving the bus, there are other amusing stories related to this gaming experience. But there are also cases that we saw during field experimentation that revealed how some children were getting "lured" to Pokemon sites and then were at risk of abuse. As such, projects and experiments also need to consider how to remove some of these dangers.



For his CREST project, Hagita accepted eight research projects that he considers "ELSI challengers." The ELSI challenge is aimed at creating a co-experience knowledge and wisdom as well as the collective vision in a public space or even in surgical operation situations. The aim will be to combine these data to develop a common platform for this co-experience of knowledge and wisdom that also considers ELSI.



In conclusion, Hagita summarized his topics of robotics and its societal impact and how development of this innovation requires consideration of ELSI challenges in order to create a new future society that contains embedded robotics services. His current project is the first stage of wisdom computing (of which Iwano spoke earlier at the summit regarding its three stages). He is also hopeful for more U.S.–Japan research collaboration, not just on individual projects but a broader program on situated services to be launched soon. He believes that this would create new types of employment in the cyber-physical space.

(4) Attorney's Point of View – Fear for Autonomy, Masahiro Kobayashi, Attorney

Masahiro Kobayashi, the last speaker in this Session, discussed with attendees about the issue of smart societies from an attorney's point of view.

He began by asserting that internet technology makes a society smart, and a smart society brings great benefits to humans; however, technology may not always be welcomed because it can have both positive and negative effects. In other words, technology has risks of abuse even if it has been developed in goodwill.

He believes that there are two important reasons why technology should be regulated by the legal system: to protect human rights, and to ensure that development of technology is not inhibited. Striking good balance, however, is difficult work.

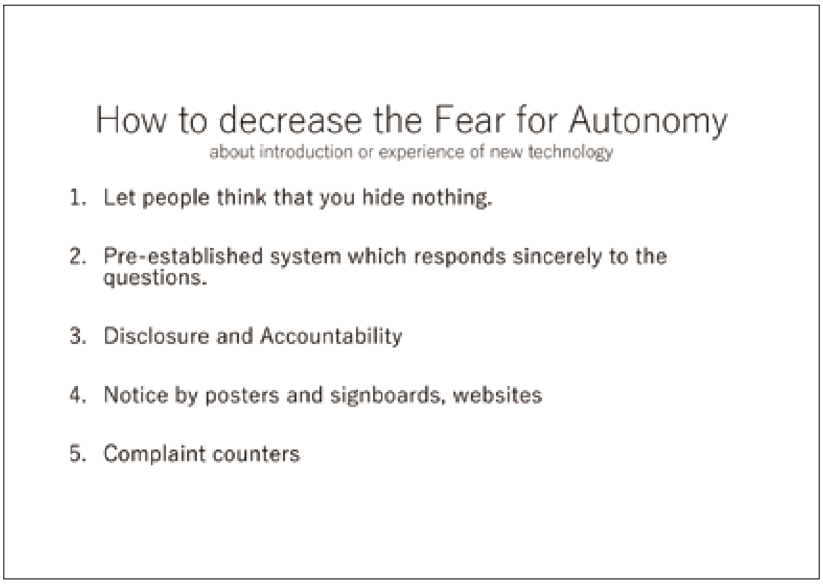
One of the biggest issues occurring when we create a legal system around technology and smart society is what he calls “fear for autonomy.”

In the fall of 2013, a public institution set up 92 digital video cameras at Osaka Station in order to capture the faces of all visitors and gather data on their migration patterns. The number of people who visit Osaka Station is roughly 800,000 per a day, so this trial would have become an important milestone to show how arrival points and face recognition technology can work together, as part of a Big Data processing technology.

However, this trial was rejected by human rights groups as well as the Osaka City Council, which stated that the institution could not take photos of the visitors.

What they could do was take photos of only those people who volunteered to participate. In spring 2014, Kobayashi was asked to provide a legal assessment for the institution. From an attorney's point of view, this trial had problems regarding the right of privacy, though this was not its fatal flaw, as hundreds of video cameras were already set up at Osaka Station for years before this trial to help human security guards catch thieves, identify and locate missing children, and to assist the physically challenged, injured, or sick, yet no one had complained about this.

Kobayashi could not understand why machines were not allowed to perform a similar action that humans had already been doing. He believed the antipathy to be irrational and emotional, rather than logical, so he created the term “the fear for autonomy.” As mentioned, security guards could already track some visitors from inside a monitoring room, but the proposed new surveillance system would make it possible to monitor the behavior of hundreds of thousands of people every day. The ability of the new surveillance system (it may be called “the God’s eye” or “Monster’s eye”) would obviously have been far superior to that of human visual surveillance. It would contain “intelligence” but would not be able to “think” or control the data it would be receiving. This, posits Kobayashi, is the reason why people feared the autonomous system.

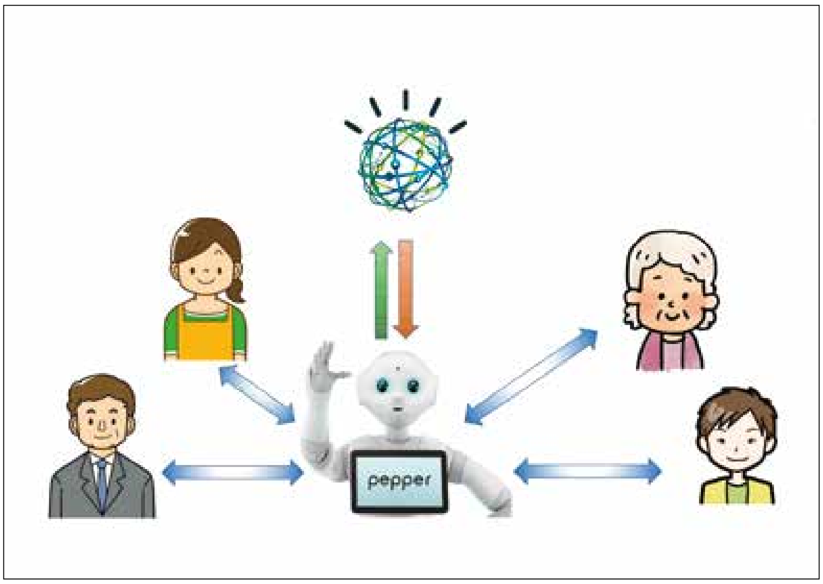


In 1968, Stanly Kubrick, a famous filmmaker described “fear of the autonomous” through one single image of red circle of one lens in “2001: A Space Odyssey”. According to Kobayashi’s experience in introducing new technology to society, only complying with laws is not enough to enable the technology to be welcomed by people. Rather, full transparency is key: to let people think that you have nothing to hide. This requires a pre-established system that can respond sincerely to people’s questions. It involves disclosure and accountability. Essentially, a thorough and appropriate marketing campaign is needed, and should include website(s) and ways for people to file complaints that are then quantified.

TECHNOLOGY & PRIVACY

Communication robots in houses

In a smart society, robots can be part of households and communicate effectively with families.



Private communications could be automatically uploaded to the cloud through robots, analyzed by artificial intelligence, and then downloaded back to the robot. Then, millions of conversation data could be stored in the cloud. And then what if a police detective could get conversation data from the cloud when he thought the son of a family might be suspected of a crime? Does this essentially mean that robots are like “bugging devices” in every household? This is the fear for autonomy.

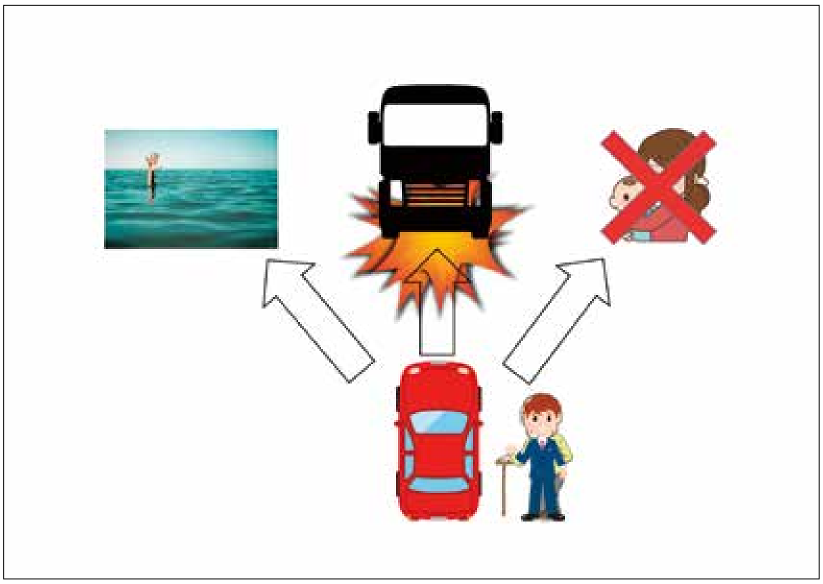
The establishment of Privacy Commissioner System

German; 1977
Canada; 1982
United Kingdom; 1984

Japan; 2017
But it is insufficient

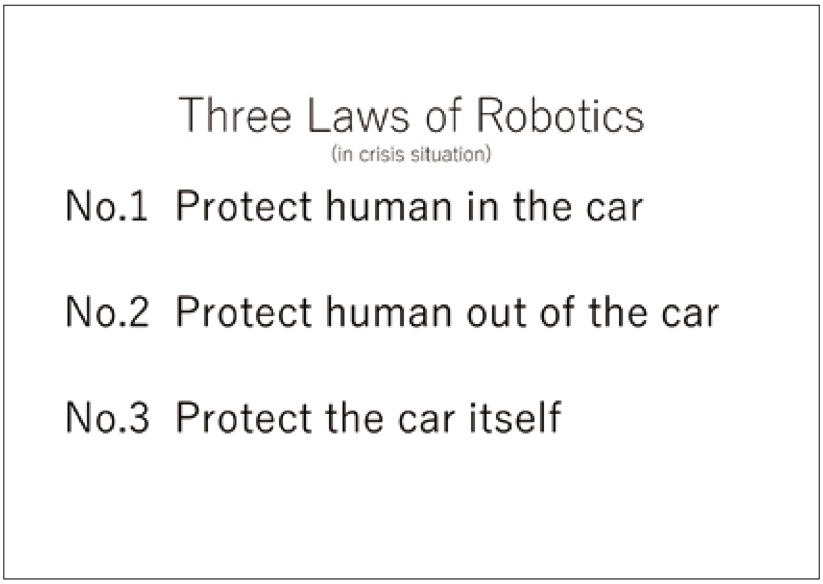
http://www.soumu.go.jp/main_content/000150899.pdf

The harmonization of privacy and technology is one of the areas in which changes to or a new legal system is most needed; however, Japan is about 30 years behind Europe, Canada, and the United States. For example, these countries established the Privacy Commissioner System between 1977 and 1984, but this system will not be implemented in Japan until 2018. While a Privacy Commissioner of Japan would not be given supervisory authority for other government agencies, these agencies have the greatest amount of personal data that could do the largest damage if leaked or used illegally.

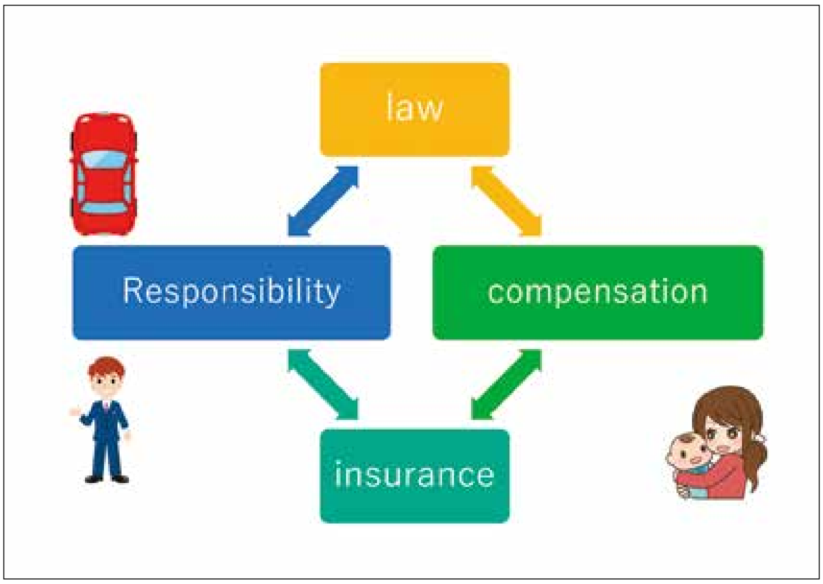


When we think about the legal system around self-driving cars, many people have fear for the autonomous. For example, what if a young man is riding in an autonomous car along a cliff-top road facing the sea. Then, a big truck veers over from the opposite lane. If the car went straight, it would result in a head-on collision. If it turned left, the car would jump into the sea. If it turned right, the car would run over a young woman with a baby. Which move should the car make? Would the answer change if the passenger in the self-driving car was an 85-year-old man instead of a young one?

This is, of course, as philosophical question without a single correct answer; however, artificial intelligence must not define a set of value priorities for human lives. A young man, an old man, a mother, children, a criminal, or Nobel Prized professor: AI should not be programmed to choose who should die or who should live. Therefore, humans have to make the rules and courses of action for autonomous cars, and all makers of these cars throughout the world have to conform to the same rules of priority because this disunity would make it impossible to predict the behavior of the cars (i.e., if Toyota cars go right, Nissan cars go left, and Honda cars go straight, then protection is impossible).



What, then, should be the rule of priority? Kobayashi thinks that the first principle rule should be to protect the humans in the car, the second principle to protect humans outside of the car, and the third principle should be to protect itself. He actually believes that these will be the first three laws of robotics in the real world. According to these three rules, the autonomous car should jump into the sea when empty, and it must protect the 85-year-old man even if it hits the young woman with a baby.



Who, then, compensates the young woman and her baby for their injuries? In the proposed model of law, no one is at fault when no defects are found in the car. As such, Kobayashi thinks we should establish an insurance system to compensate for damages caused by autonomous cars (outside of defects). Potentially, the government could obligate the owner of the car, have him or her sign a contract and carry insurance, and then the owner's insurance company would pay this compensation on behalf of the owner. If there is a defect in the car, the insurance company could claim all or part of the compensation to the manufacturer.

Kobayashi wraps up his discussion with two more issues about fearing the autonomous. One is an autonomous labor management system that could evolve the rational distribution of working hours. Artificial intelligence could create a perfect shift table that could eliminate standby time; however, this shift table may reduce salaries, because laborers currently get paid not only by working but by waiting. Efficient outsourcing systems could enable retirees or stay-at-home parents to earn some income by teleworking, but again, their income may reduce others' income, because if the size of the market is the same, an increase in workers can result in the decrease of working time for other laborers.

Second, the autonomous stock exchange trading system could be disrupted by artificial intelligence systems reading newspapers; public, corporate, and government documents; and every tweet all over the world and analyze them to help humans decide whether or not to buy or sell stocks. Kobayashi is not referring to the current international discussion that seeks to limit high-frequency trading systems but rather a more exclusive system. A lot of human traders could be fired.

Computers, he believes, will dominate the financial market, but this is risky, because no one will be able to understand the algorithm that artificial intelligence obtained by deep learning, which means that humans will be unable to predict a future stock market crash.

Today, intelligent technology has obtained great power to change the world, similar to the shift in 1945, when physicists put to nuclear technologies to practical use. This is a heavy responsibility.

7. Panel Session

Moderator Yassi Moghaddam,
Panel: Yuichiro Anzai, Daniel McDuff, Norihiro Hagita, Kazuo Iwano, David Nordfors, James Spohrer, and Hiroto Yasuura

Yassi Moghaddam closed the summit by moderating a panel discussion with the speakers—Yuichiro Anzai, Daniel McDuff, Norihiro Hagita, Kazuo Iwano, David Nordfors, Jim Spohrer, and Hiroto Yasuura. The exchanges have been edited for clarity.

Prior to turning over the panel to questions from attendees, Moghaddam noted two things that stood out to her during the summit: comparisons between Japan and the Silicon Valley ecosystem and then (a question for Japanese colleagues) about how this is viewed in Japan. Is it something that entrepreneurs in Japan feel comfortable with?

Yuichiro Anzai:

I bet the Japanese point of view is to amalgamate the Japanese traditional cultural ways of modesty with innovative ways of the United States and its West Coast. No one has experience with that, so there is no current solution. I admire the ecosystem of the West Coast, but just copying that will not be possible here nor should it be considered the way to go.

Norihiro Hagita:

Yes, the Japanese way of accepting failure as a part of success only applies to research, I think. Older researchers/Japanese professors are always thinking about doing the basic research and lack experience regarding the innovation stage, but young students and assistant professors are now gaining experience, little by little, about new types of ecosystems that will be generated in Japan. Currently, though, almost all professors focus on the research and research funding.

David Nordfors:

Well, maybe I can address this a little bit from the Japanese perspective and from the Silicon Valley perspective. Being a Swede, I would say that Sweden is both geographically and culturally somewhere in between Japan and the U.S. Silicon Valley. In this summit today, we have not seen very many venture capitalists around or angel investors. We have seen speakers from a lot of large companies, and this is something that is pretty similar to what happens in Sweden. When I was a research funder/innovation funder in Sweden, if someone from university with an idea about cellphones, for example, the first thing we would say would be, “This is a great idea about cellphones! You should go to Ericsson and they will help you develop it.” And in Silicon Valley that is the last thing you want to say, because you want to develop a startup first until Ericsson comes along and begs you to let them buy it. So, in this way, the innovation ecosystem in Silicon Valley is antagonistic toward large companies. You do not want to put together your entrepreneurs with large companies right out of the gate, and getting corporate venture capital is often the kiss of death, because no other big company is going to buy you if one big company already has a stake in you. So, this is one thing that I think is a big difference.

Another thing that is a big difference is just in the shared culture, and it is a kind of personality difference. Ichak Adizes wrote *Mastering Change* in the 1990s which said that there were four personality types you’ll see in the workplace: one is the entrepreneur, the other is a fixer, the third is the administrator, and fourth is the integrator. Adizes describes the different personalities and talked about what “yes” and “no” means when coming from each of them; for example, when the doer says yes it means yes, but when the entrepreneur says yes it means perhaps, and when the entrepreneur says no it means no.

So, often we see conflict between the entrepreneur and the administrator, because the administrator says, “But you said yes to do this!” and the entrepreneur says, “Well, it seemed like a good idea at the time.” I think that is where you have a difference. In Silicon Valley, it is always the entrepreneur with a vision who is the CEO. If you go to the Swedish system, it is often the administrator, actually, the one who guards policy and who rules with the help of policy, and it is pretty much an administrative culture. I noticed in Sweden that when you come with a new idea when inside an organization, everybody is very quick to shoot it down, everybody wants to immediately tell you why this idea does not work.

This is almost impolite in Silicon Valley. If you don’t have anything to gain by shooting somebody down, let them go on with their idea. Even if you don’t believe in their idea, just let them go with it and say “Great idea!” Maybe they succeed and then you will be their friend. I don’t think one can change the culture here, unless it is done very slowly. Sweden is changing it slowly, but I think that what you need to create is what’s inside your organizations. You need to create isolated bubbles that are protected by very senior directors who can hide these inventors and “entrepreneurs” from division directors who probably want to kill their ideas as soon as they feel they are stepping on toes. You also have to have a good exit mechanism for them as well. I can go on talking about this forever, but I think that ultimately you need to protect your entrepreneurs and you need to find solid ways of protecting them, so that they don’t get eaten alive when they succeed.

Norihiro Hagita:

Fortunately, our CREST project has a philosophy and vision for startups where the basic research and the startup are inseparable and focus on sustainable goals. For example, focus on the commercialization for certain startups or convergence for certain others, so new types of commercialization or products will be generated based on specific visions.

Hiroto Yasuura:

I also served as a leader of the sakigake project at JST, which involves young researchers. I currently have 18 researchers, and requested of them the following three tasks. First, write a scenario of how to make your idea acceptable to broader society, and this was the basic requirement of the proposal. Second, every summer I took them to Silicon Valley to show them the real battlefield; and third, I made an appointment for them to meet with the Kasumigaseki in Japanese government (another name for the Japanese government bureaucracy). Forging relationships with policymakers is very important, because society must be changed and they are the ones who can help us do it; as such, I make it a priority to facilitate discussions between researchers and the Kasumigaseki.

Kazuo Iwano:

Yesterday we discussed the relationship between the science and technology community and society. I think we should also discuss how we can be professionals and forward our objectives toward making a good impact or influence on society. As professionals (engineers, researchers), we have to think about how we can make an impact or how we can create new pathways within society. Startups might be one solution, so I think it is a kind of a basic standpoint to be a professional. Every talk at the summit today addressed relationships with society, which means that we (and other engineers and professionals) are required to partake in social responsibility. I think in Japan, back to your question, and young people’s feelings about this relationship to the society is rapidly changing, so many people are eager to do certain kinds of startups, whereas our older generation is more traditional. In order to make an impact on society, our generation thought it would be through large companies like IBM or Mitsubishi Corporation, but nowadays this has changed, because as David mentioned, I think there is a wide variety of components within an ecosystem, and so I think situation is changing.

Yassi Moghaddam:

Excellent. Thank you so much. That is actually a good segue to my next topic, wherein we will talk about how society is changing in the context of smart service systems and how "design thinking" is a core part of the research that is being done, because certainly we see that in the conversations regarding smart service systems. Any comments from the panel?

Hiroto Yasuura:

Yes, I think that is a very important issue, and I have proposed a five-layer model of the society, where the top layer is society itself, the second layer is service that needs to be implemented society, the third layer is the products related to the service, the forth layer is technology for the products, and the lowest one is science. So, in a traditional approach, scientists discover basic concepts or new phenomena, and engineers, for example, implement the systems for production, and then products are created and introduced to the market. People believe that products are the economy, but situations are changing in this century, and service is just as major of a player and products are now just tools. We are now thinking about what kind of society we really want to see implemented: what kinds of services are required, and then what kinds of products do we really need. So, we have to merge various fields and people have to collaborate with each other.

Yassi Moghaddam:

Actually, I know IBM has heavily invested in design capabilities. Would you like to say a couple of words about that, Jim?

James Spohrer:

Phil Gilbert is our Vice President of Design at IBM, and in addition to honoring distinguished engineers at IBM, we now have a distinguished designer level and I think our partnership with Apple is relevant to the importance we are seeing in design. I think, to me, from a service science perspective, we can see impressive design in virtual worlds these days. There are a lot of games that are very well-designed in terms of keeping the players engaged, and I think that also shows a little bit of societal risk when you design things that can become addictive. So, I think our science of design has gotten very, very good, almost to the point of not always serving the best interest of individuals.

The other thing about design is that if you are a parent and you are trying to design experiences for your children, you don't necessarily want everything to be easy for them, because that will spoil them, and life has hardship as well as good experience. So, I think that is one of from a service science perspective, you have to be very wise I think about how you design things so that you don't just design them to be too easy or addictive, you have to design them to be such that you are actually helping people cope with a broader range of experiences.

Yassi Moghaddam:

My view about that is you are designing ecosystems, not just one thing for the user, and this requires a balance.

Yuichiro Anzai:

When we think of what design is and how that word is used, we are using that term in the fields of architecture, engineering, manufacturing, and art and it means that design is a human activity that requires thinking about many different kinds of elements and their relationships, and also who will use the designed products. The designer needs to predict how the environment will change during the use of that product. In this context, we can say that service is a design. So, if we think of smart services, it means a kind of service based on advanced ICT technology and, essentially, design based on ICT.

David Nordfors:

Design thinking has two key elements. One is rapid prototyping and the other is empathy within a diverse team. So think about it like this: If you are a monoculture and people share the same language and you operate in a space of shared language, the formality makes is an efficient, winning strategy. If you are a diverse team, however, with only a small bit of common language together, formality is going to keep you in that small overlapping space, which is stifling. But if you have empathy and can work informally, then you can give each other support but also disagree constructively, making it possible to leverage each other's differences. In this case, a diverse team that is held together by empathy can cover a much larger idea space than a homogeneous team that works efficiently with formality. Another factor is that you must be able to let go of something that you decided yesterday, which is also difficult in a formal culture. So, I think design thinking represents here the entrepreneurial culture and is an excellent exercise for people in Sweden and maybe even Japan to engage in, aimed at discovering new relationships on the team.

Daniel McDuff:

I would just like to add that some of the examples we have seen in the presentations of success stories are companies that have leveraged the network as their most valuable resource, so Airbnb and Uber are examples of using the network to design their products. As such, in order to build on what David said, you have to let go of some of the control and trust that this network is going to be able function within the constraints or parameters that you built into the system to make it stable. We are even seeing that there are companies now that are using the network for their innovation, so they're essentially outsourcing innovation. Within a large organization—and this is where I will disagree with David—I don't think you can put innovation in a pocket; rather, it has to be throughout the whole organization, and this model can work in large companies. If the innovation is a small pocket that is hidden away, it's likely to die, and we are seeing larger companies now outsourcing innovation, essentially allowing startups to do their innovation for them by leveraging the network, and there are some very innovative companies in China doing that.

Yassi Moghaddam:

The examples that David mentioned, which I have seen, are actually piloting with small teams and showing success before exposing their practices to the larger team.

David Nordfors:

Since I was addressed here, there is something I call the "entrepreneur's dilemma." It goes like this: If someone tries to introduce a new idea within a traditional organization, no one is going to know what the person is talking about, but they certainly will know who is the troublemaker. Once an idea has been accepted and embraced, nobody is going to remember who came up with the idea, but everybody is going to remember who was the troublemaker. So, you have this entrepreneur who is fighting with an idea and everybody says to the CEO, "Why are you giving this guy money, he is not doing anything valuable," and then it turns up somewhere in the company and, hey, this works, and then they say, "This is important stuff, we can't let a troublemaker head that," and then off it goes.

I think this is very important. First, it is difficult in these cultures that celebrate large organizations to have open innovation. I think that you have to try to find ways also for entrepreneurship to be accepted by finding a balance among the bosses (and then maybe the entrepreneur becomes a boss themselves one day) or I think that the CEO has to have even an informal organization, maybe some pockets, for lack of a better word, to put away these innovators and be able to count on them. I've seen division directors come to them and say, "This belongs to me," and then the entrepreneur must have a gracious exit somewhere to go on with something else. I have also seen that the intrapreneur created something valuable and was severely punished for it and basically lived with a scar for the rest of their career. This happens in Silicon Valley very often, because when I tell this story there, everybody starts laughing, because all creative people that have worked in big companies have either had it happen to them too or someone they know. I don't know if it happens often in Japan. Somebody is nodding over there, so you must have been the boss.

Kazuo Iwano:

I also have questions about innovation and also policy and legal issues. In order to be innovative, you have to break the barriers of traditional custom; however, the speed of change of technology and the speed of change of customs or laws are totally different. So, how do you manage in Silicon Valley and/or in startup companies?

David Nordfors:

Actually, I was just thinking about a model that could work that was developed by a good friend of mine, Dan Maydan. He built a company called Applied and he had a special method for keeping his large company innovative. He took an idea that he thought for sure was going to be the future and he bet massively on it. He built a new house, found half of the new people from existing employers, and then the other half were his employees, to whom he gave startup incentives. And that usually worked. Of course, his senior VPs were outraged him because they felt that they were the ones responsible for all of the earned profit and yet here there new teams were getting startup incentives. But he managed to crank it around a few times and that apparently worked. And then he made a mistake somewhere down the road and then he was out, but I guess you should never sit forever as a CEO.

Hiroto Yasuura:

I tried to start an Uber-type service in Japan two years ago and of course that was a test case. The Japanese government was so restrictive of our service and systems that my partners decided to stop our experimentation. So, how do you break through such kinds of heavy restriction? I mean, even in the EU you have many such restrictions, so maybe David, you have experiences in Stockholm?

David Nordfors:

Yes, there are many restrictions, and there has been a culture in Sweden of that. The first thing you think about if you have an idea is how do we do this without breaking the rules, and then you think about which part of government can I go to help me, which is not a common way of thinking in Silicon Valley. In Silicon Valley, of course, it says, we will do it even though it is forbidden, and if they come after us, we get a good lawyer, and if it works then we win. I don’t know if the latter is good advice for Japan because you have such a cohesive society. You would pay a huge social penalty if you started encouraging that. So, you kind of have to find your own way, and one way I guess is to test it in other countries. But if you want to apply it within your own culture, Jim is talking about testbeds, which can be something that works. Actually, I was leading a project at Vinnova, the national agency for innovation systems, and in its first round we built a bi-national research program with Israel and had a testbed for cellular applications far up north in Sweden where they not only had all the infrastructure technology, they also had 5,000 profiled users. So, we said we wanted to run testbeds that included people and technology so that you develop the user scenario and the technology simultaneously. Now, I don’t know how well the testbed actually worked, but it is the Swedish way of thinking and I think that maybe can work in Japan if you establish large enough testbeds.

Yassi Moghaddam:

Yes. And I think what I have seen in the U.S., which is a very special case because there is a lot of autonomy at the local and regional levels. As such, people take advantage of that and work with more liberal city governments and regional governments.

Sunil Narumalani:

That is very true, and is one of the things that we were talking about, where it is the smaller and mid-sized cities that have a lot more of the autonomy to be able to execute new operations and new technologies. One of the examples I use is Chicago, where the Mayor actually has that autonomy to say that he wants something done. Yesterday, David, you and I were saying that the Mayor has both administrative and executable capacities to be able to do that and it is less so in more structured societies.

I also want to go back to what Iwano said about the societal impacts, and I think Alex also will agree with me. At NSF, when we fund projects, we look at two things: intellectual merit, which is probably the biggest factor that we consider if we want to provide funding for a project, and then also the broader impact, which is becoming an increasingly important part of any proposal. And that is where the societal impacts are going to be. Of course, if you look at it from a U.S. perspective, we look at broader impacts such as diversity and STEM education, even if it is something small like a project for a student. The broader impact on the science of that field is also considered, so I think it is a pretty broad spectrum, as far as the impacts that we are looking at, but it is ultimately designed to improve society while at the same time, improving the science.

Yassi Moghaddam thanked the panelists and then opened the floor for questions from summit attendees. These are noted with (Audience) for the person asking the question, and then the speaker's name is listed prior to the response.

Hideo Setoya from Tohoku University (Audience):

I would like to make one comment: The tendencies of people on legal matters is very different in Japan compared to the U.S. In Japan, if something is not written in law, then we must not do that, but in the United States, if it is not written in the law, then you can do that. It is a very big difference. I would like to ask one question. I learned a lot from today's discussion on AI and the IoT, technological trends and the business, and also social acceptance issues. I would like to ask you, if these trends were to be adopted in developing countries and also less developed countries, do you think it would deepen the divide between the developed countries and less developed countries, or would they help each other "catch up"?

Norihiro Hagita:

I think Professor Yuichiro Anzai gave us something on this during his talk about commoditization. Depending on the commoditization, time, power, or capability, it is very important to put these new products into new societies.

Hiroto Yasuura:

I have one experience to use regarding developing countries as a testbed of new technology. This case is a medical system combining ICT and telecommunications. Very few medical doctors stay in rural area of Bangladesh, so nurses often carry various tools in one box—or a portable clinic, as we call it—and go around to villages to check the health of the people. If a patient is found who is in danger, they start communication with a doctor via Skype or similar. So, there is no need to move the patient from the village to Dhaka City. But under Japanese law, this would be impossible because they are not allowed to engage in that kind of medical behavior. But this kind of the technology is very useful for African countries or Southeast Asian countries, meaning that we can use technology and, in new ways, directly apply it to a developing country. It is a very, very good idea and these countries would be a very good testbed and, also, a big market.

Kazuo Iwano:

Thinking of a developing or underdeveloped country, that notion in itself is a kind of westernized view, isn't it? Speaking from the aspect of Wisdom Computing, we have been discussing the value of society: value to which a society aims or value that a society will adopt. In that sense, language structure or the kind of culture that is present in a developed country needs to be reinterpreted from other perspectives. Then, we have to understand what kind of style that future services should be. That is my thought in addition to Professor Yasuura.

Yassi Moghaddam:

Yes, that is an excellent point. The service has to be designed for that place and those people.

Sunil Narumalani:

Just to add to that, I am a geographer, and when I looked at the map that Daniel shared during his speech about how information flows across the globe, and we saw the density in the United States, we saw it even in India and East Asia; however, Africa was very light, hardly anything there, and that is a resource that can help modify our thinking about social and economic conditions. We know that there are certain countries exploiting Africa for certain resources, and there is also the issue of them leapfrogging technologies. Like in India, for example, when landlines began to be replaced straight away by cellular technology. So, in looking at some of these situations, there is a potential in these countries. Another interesting statistic I read a while back is that when we talk about population growth in China and India, eventually it is going to level out somewhere in the middle of the century, and the real population growth is actually going to happen in the African countries. This is something that I personally feel has great future potential, in terms of technology, smart cities, and connectivity.

Yassi Moghaddam:

Yes, those are excellent points. But coming back to Japan, Society 5.0, and cognitive computing, when we look ahead to, say, 2035, how are we interacting with our cognitive mediators? What media are we using, and are we using it and/or is it distributed in the same ways that it used to be?

Daniel McDuff:

Well, I hope it is not cellphones. I was in the southwest a few years ago and the amount of people that were staring down at their palms when they were in an environment with thousands of other really interesting people was depressing. So, I think the form factor will change for sure. I think what is going to be revolutionary is how much these devices know about us. I think it can seem intimidating but also it has huge potential. At the moment, we have resources to access information around the world, and, indeed, information *about* the world, but we can't access a lot information about ourselves. And I think that is where things will change, because ultimately if we want to change things about our well-being, about our health—we want to be more productive, etc.—we need to understand more about ourselves and not just the world around us.

James Spohrer:

I think Professor Anzai's presentation had a statistic about how many people will have wearables that are Internet connected, didn't he?

Yuichiro Anzai:

Yes, about 91% by 2025.

James Spohrer:

Exactly, so I am pretty bullish on that as well. I think that is going to be a big opportunity.

Yuichiro Anzai:

For communication on those types of devices, I think one perspective is going to be telepathy. We have already collected some MRI data, and from those kinds of data we can roughly infer what people think. So, sending those data to other people, we can at least think of communication without any device, without any speaking or hearing. Also, these devices are enhancing our communication abilities, particularly for disabled people, and we can think of new devices to enhance our abilities to communicate. Lastly, we only have 24 hours in a day, and human beings are basically serial information processors, though of course we can effectively compute. Serial computing or serially speaking, hearing, and inferencing for only 24 hours at a time is a limitation. When considering parallel thinking and just one person's mind, that is not considered much in technology, but what if we could have some sort of time-sharing system in our mind. At least in Japanese culture, women are doing that all the time, every day, with taking care of children, preparing food, and working as well, things like that. They are doing different tasks virtually in parallel, so that is sort of what we consider with parallel thinking. I don’t know how to do it, how to build innovative technologies with that, but it could be significant in the future.

Kazuo Iwano:

I actually have a question to Professor Anzai. You talked about parallel thinking; however, when you consider such thinking, what do you think about individuals’ identity? I think in 2035, the concept of identity might be completely different than it is today. Could you speak to this a bit?

Yuichiro Anzai:

I don’t want to get into details of philosophical issues, but identity is, of course, the consistency of the human mind. We have been talking about the legal system at this summit regarding, for example, automated vehicles and traffic rules for them, but that is still a sort of physical incidence. What if the AI system tries to control our decision-making and emotional experience? It’s already been done by recommendation technology, for example, by some companies. I think humans need to make a real effort to control AI systems, and in that process for the future, I hope that we can keep our identity to ourselves, and that is what I can answer to your question. I am afraid that AI could eventually control our minds, which is a scary thing, but I bet that human beings can overcome that worry by thinking seriously about the enhancement of our inference abilities. In that process, I think that we can include how we can retain our own identity.

David Nordfors:

Yes, I think that now we have tools to achieve so much, so maybe it is time to think a bit more about what we *want* to achieve. Is it pretty much about maximizing the means? We attain means to get even more means. So, I think when we talk about STEAM or THEMS, the latter of which includes the humanities, that we should also include spirituality. I think we need some of it in Silicon Valley! There is a strong tradition in Eastern philosophy about accepting the phases of life and embracing the imperfection of humanity, and I think that somehow when we have great means to change things that maintaining ideals to try to achieve perfection will actually be one of the worst ideas that we can have in that situation.

Yuichiro Anzai:

A group of researchers stated recently that Yoga, Wabi-Sabi, and Japanese or Eastern kinds of cultures have been able to be observed by MRI as part of brain research technology. I think that in 10 or 20 years, much will be revealed about the impacts of Eastern culture on science.

David Nordfors:

I think the motto should be to never settle for anything less than imperfection.

Hiroto Yasuura:

I have a very simple question regarding the culture issue. Several Japanese presenters at the summit showed the figure of a robot as a humanoid but no figure of human-like robot from U.S. presenters. Is there a cultural reason for this?

David Nordfors:

Well, I have been thinking about this actually. If one looks at the traditional picture of wise men, like holy men, it just strikes me that in the Eastern tradition, the wise men are often loners. They turn away from others to find harmony inside themselves. Thinking of western culture, wisdom is often more about seeking communication with others, or establishing a relationship. And I think we had a discussion about that because in the culture here, people believe there is a common soul, so you almost can connect with others by turning inwards. You can't do that with more diversity, like in the U.S., so you have to seek outwards. My favorite philosopher is Martin Buber, who talks about "I-Thou" and "I-It," which I try to implement now in economics. I think maybe that this can explain how, in the west, wise men would like to have information technology to help us to connect with other humans. There is no meaning in becoming friends with a robot; for example, the preference for match.com (technology) that is a way to meet others (humans), instead of having a very nice robot that is like a friend.

Alexandra Medina-Borja:

Yes, so it is a cultural thing. There has been research in human-computer interaction, such as what should the faces or general appearance of the robot be, and one thing we found is that resembling humans in the west is less appealing, with the exception being if it is "cute." I think that for children or the elderly, it will be okay, but in general, the western view is that robots are really just machines that can move. I do believe that robotics in Japan is more advanced than robotics in the U.S., though, so that is the other part. My researchers don't have the robots that you have.

Yassi Moghaddam then ended the current discussion to ask the summit attendees if they had any additional questions.

Makoto Yokoo from Kyushu University (Audience) :

Do you have any idea about how to change the minds of Japanese policymakers to introduce ideas that could help all of this technological innovation? For example, what about a frequency auction, trying to allocate the right to use radiofrequency for cellphone makers by auction. This idea has proved to be very good in microeconomic theory and all OECD countries, except Japan, who use that type of auction. Why hasn't Japan tried to adopt that idea?

Daniel McDuff:

I think it starts from how innovation happens. One of the things I liked the best about the Media Lab is that there were law students, political science students, technologists, designers, and unless you can speak the same language, it is very hard to convince someone to change the way they do things. And so as much as the environments in which technology is developed can be infused with people from other disciplines, as we saw today—I thought it was fascinating to hear a lawyer speak about these issues—I learned things that I haven't thought about and now I feel more informed to speak about that topic. And I think the same goes for policy, but it is a long-term thing, it doesn't happen overnight. I don't think there is an easy fix.

David Nordfors:

There is one way to change a mindset and I will use the example of a program that I ran that actually got me into the United States. Everybody reads peer review articles and shares stories with their peers, but journalism is what goes across the whole country. As such, we identified journalists of a certain stakeholder group in the innovation ecosystem and started a program to introduce a new discipline or school of innovation journalism that was horizontal. So, we found self-identified journalists who wanted to be innovation journalists and learn how to tell the story about how technology business and policy interact, and to create stories that all stakeholder groups can read and see how they interact and it also becomes a catalysis in national discussion.

We gave the journalists something similar to postdoc grants, the largest grants that were being given to journalists at the time, actually, and then we took them over to Silicon Valley and they spent a lot of time practicing in newsrooms like CNET, TechCrunch, etc. And then we had a program for them together at Stanford, comprised of people from six countries, and I think that while you will find it difficult to measure results, you will notice these results because the journalists will then come home and have a network with other journalists in Silicon Valley, sort of a network among themselves, among people with different ways of thinking. I think that this will feed the culture with a new narrative and they will become catalyzers.

Yassi Moghaddam then asked one last question: If the panel could share one book that they would each recommend on related topics of course.

James Spohrer:

I have so many books! I like to read books, ideally about one a day, so I would have to say Pedro Domingos' book *The Master Algorithm* is a must read if you are interested in machine learning. The book I read on the plane over here is about co-creating humane organizations and sociotechnical design theory. Another book that came out around 1995 from Stanford by Kline is *Conceptual Foundations of Multidisciplinary Thinking*, which talks about how the sociotechnical system design loop is accelerating and it gives a framework for creating

T-shaped people. I guess we didn't have chance to go into blockchain very much today or material science, but Professor Anzai's predictions there, such as a 3D-printed car by about 2025, are not far-fetched, as there is already a design for that at MIT for a 3D-printed car that they have actually demonstrated. And think about a car that folds up after you get out of it and follows you into the building and rides up in the elevator. It is superlight and can transform itself into a personal robot to help you in addition to being an energy system. So, I think when we start considering the future, even 10 to 20 years from now, probably the best way to think about it, is that we need to think more about how to include younger people in these types of discussions, because my sense, when I talk to these younger people, is that their thinking is in some ways quite a bit further along than ours. I haven't found a good book on that yet.

Yuichiro Anzai:

Adam Smith's book titled *Moral Sentiments*, because I am interested in human interaction and that book refers not just to economy but the moral sentiment of people and that should be based on economic negotiation and marketing. That is a classic, and we can gain many insights from that kind of book.

David Nordfors:

Well, you could read Facebook. Honestly, I have a mild form of ADD, so I actually don't find it comfortable to read books. My dirty secret is that I got my Ph.D. in physics without reading books, though I did write one, *Innovation for Jobs*. Other than that, what I do is I kind of read snippets here and there and then I kind of connect them in my head. I have lots of friends on Facebook from varied disciplines, countries, and forms of thought, so, I like to say that I read a "salad" of good stuff, such as recommendations of articles and so on that come from friends. And I think the mix is very stimulating.

Daniel McDuff:

So, I am going to say the book Rafael Calvo on positive computing, because it talks about lots of ideas and I think it is really important to keep in mind that the way we design technology, it is an active choice to design in a positive fashion. Take Facebook, for example. We can design addictive technology that is very useful for certain purposes, but is that the most positive thing we can design in terms of helping people? Again, coming back to wellbeing, I believe it is the most edifying and helpful thing for people.

Hiroto Yasuura:

I am recommending a book titled *Decision Science*. It is currently in press now, in Japanese. At Kyushu University, we are just now making a new science field of this same title, Decision Science, and the book will be translated in English next year.

Norihiro Hagita:

Out of digital technologies, in my case, I would recommend *The Last Journey of Buddha*. Even as death was approaching for him, he still he gave many people advice and inspiration. Sometimes we think about the philosophy of the vision for business and research and, I think, Buddha's wisdom has a place there.

Kazuo Iwano:

It is hard to pick one, but I think 15 or 20 years ago when I began to think about IT and society and how we can make societal impact, at that time I read Freeman Dysons' book *Future of Technology* and I was impressed at the time.

Yassi Moghaddam thanked the panel members and the audience, and ended the panel discussion at this point.

8. Closing Remarks

The final stage of the summit was the closing remark by Kazuo Iwano, who explained how they named this symposium as a summit, because in order to create new policy (e.g., IT policy), researchers and industry experts should come together and discuss how to shape the future. In addition, the creators of and speakers at the summit believe that this new wave of technology and its related policies should not be "top-down"; rather, everyone should contribute to creating new ideas or new directions. This was the third such summit (but the first international summit with ISSIP), which followed the first about Wisdom Computing and the second about Reality 2.0. This summit focused on new services, the future style of services, societal impact, and ethical and legal considerations. His hope was that the summit resulted in not only new ideas and inspiration, but in new relationships and networks as well.

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Cognition as a Service (CaaS): A Service Science Perspective

Jim Spohrer, IBM Research
spohrer@us.ibm.com
November 7, 2016

Abstract

This paper will provide an introduction to the cognitive era of computing, in which cognitive capabilities from natural language and video understanding, machine learning, and decision support with explanations and levels of confidence become broadly available as part of cognitive solutions in the cloud and on personal devices such as smartphones. This summary will cover the basics of what everyone needs to know about building, understanding, and working with cognitive systems in their personal and professional lives - including the progression of cognitive systems from tools to assistants to collaborators to coaches to mediators, trusted to perform some interactions on behalf of the user. IBM transformation to a cognitive solutions and cloud platform company will also be discussed, including IBM Watson on Bluemix, as well as other industry trends.

Body

In the year of my birth, the history of modern Artificial Intelligence (AI) began with great optimism in at the Dartmouth Conference of 1956 (Vardi 2016). However, the quest for machine intelligence has proven far more elusive than the founders of the field foresaw. Sixty years of ups ("AI springs") and downs ("AI winters") have passed. Today, optimism has returned, but signs of over enthusiasm about the level of AI capabilities, such as chatbots and natural language dialogue, are also apparent (Braun 2016). There is even a dawning realization that smarter machines directly lead to Intelligence Augmentation (IA) of individuals, which may soon give some individuals, who are so inclined, the destructive power reserved only for nations some seventy years (Turbo 2016). This is a troubling thought.

Nevertheless, nations and businesses are locked in a competition to see who can first fully harness the power of AI in the cloud and on smartphones, producing Cognition as a Service (CaaS), to augment the intelligence of their citizens and customers with IA capabilities (Spohrer and Banavar, 2015). Yet building cognitive systems is still very hard, and is likely to remain so until the challenge of commonsense reasoning capabilities is resolved. Commonsense reasoning entails a seemingly infinite number of little, obvious facts, such as birth dates occur before death dates for people, which are effortlessly applied by adults in diverse contents, and yet no smart machine has fully mastered this ability so far. It is commonsense reasoning that allows people to play the game of twenty questions with children, and while there has been some progress, again it is restricted to narrow game domains (see for example 20q.net).

As the competition heats up, investments by large corporations (Amazon, Apple, Facebook, Google, Microsoft, IBM, Samsung, etc.) as well as venture capitalists are rising (Spohrer 2016). Some corporations already make their cognitive service offerings, from speech recognition to image understand and machine learning, freely available to faculty and students around – for example IBM Watson on Bluemix (Spohrer 2016). Furthermore, USA has funding programs to develop smart service systems, and in Japan work has begun to explore the development of investment into wise service systems (NSF 2014; JST 2014).

The benefits of cognitive computing (AI + IA) are potentially enormous (Spohrer 2016). Once commonsense reasoning is solved, building digital cognitive systems in their personal and professional lives will be much easier. Over a decade or two, cognitive tools, assistants, collaborators, coaches, and mediators, trusted to interact on our behalf will be developed. This will require digital cognitive systems that have models of the world and tasks (commonsense), as well as highly accurate models of themselves, their users, as well as institutions, laws, and cultures.

As businesses compete to be more efficient, some are concerned that the rate at which these capabilities (cognition as a service) destroy jobs may be greater than the rate at which new jobs are created (Vardi 2016). Comparison with other technologies such as automobiles impact on society shows that far fewer employees are needed these days to create far higher valuations of top companies (Vardi 2016). The growth of productivity, wages, middle class jobs, and gross domestic product grew together for decades, but in the last decade a decoupling has been observed in aggregate national economic data (Vardi 2016). There are even alarming trends in suicide rates of white males in the USA (Vardi 2016). The signs of growing wealth inequality, and evidence that high inequality leads to slower GDP growth of nations are also being observed in data (Vardi 2016).

And yet building cognitive systems (AI + IA) remains very hard (Spohrer 2016). Over the last decade, most major IT companies have announced chatbots or natural language conversation systems, but few have proven truly successful with customers who are used to natural language conversations grounded in commonsense reasoning with other people (Braun 2016). In spite of the marketing hype that goes unrealized in practice, slowly and steadily progress is being made. The promise of cognitive systems in healthcare, education, government, finance, transportation (driverless vehicles), retail, and other industries is gradually being realized, as machine learning, big data, Internet-of-Things (IoT), and smartphones mature (Domingos 2015). In the USA, drivers and teachers are two common jobs held by middle-class Americans, and AI is poised to have a major impact on these two types of jobs over the next ten years.

What does wisdom look like in this cognitive era? Will a universal basic income (UBI) be required, or policy that allows nations to print money coupled to some form of technology deflation index (TDI)? Will the promise of eldercare for an aging population be realized, or will nightmare scenarios be realized through intentional or accidental acts? These debates are being help now. Our science for advancing technology seems significantly ahead of our science for advancing policy. Will cognitive systems (AI + IA) be required to advance policy to keep up with advancing technological capabilities?

To advance policy, perhaps a science is needed that rethinks the nature of competition and collaboration for civilization from first principles (Spohrer, Kwan, Fisk 2014). Service systems are value co-creation systems that dynamically configure resources of people, technology, organizations, and information. Service science studies the evolving ecology of service system entities, their capabilities, constraints, rights, and responsibilities, as well as their value co-creation mechanisms and capability co-elevation mechanisms. The measures of productivity, quality, compliance, innovation, as well as sustainability, resilience, and equity are areas of study in service science. Wisdom is not yet well understood, but an emerging area for future research within the global service science community. ISSIP.org is a non-profit professional association working to advance service science and prepare future-ready T-shaped adaptive innovators, with depth and breadth.

As the capabilities of service system entities increase from individuals to cities to nations, reaching super-power levels, the challenge is moving from smart to wise service systems (Medina-Borja 2015; Demirkan et al, 2015; Iwano & Motegi 2015).

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Innovation For Jobs (I4J): The People-Centered Economy

David Nordfors, Co-Founder I4J
david@iiij.org
November 7, 2016

Abstract

This paper will provide a very brief introduction to Innovation For Jobs (I4J) and the people-centered economy. Today, businesses and governments focus on a task-centered economy, and growth of the economy and GDP (Gross Domestic Product) through productivity improvements, which make businesses need less people as employees. The focus of the people-centered economy is growth through people needing each other more. The people-centered economy grows when people see more value in each other.

Body

The IIIJ Foundation is the non-profit organization running the i4j Innovation for Jobs Summit, an exclusive network of global thought leaders, aiming to disrupt unemployment. The Co-Chairs and Co-Founders of the i4j Summit are Vint Cerf, father of the Internet, and David Nordfors. The first i4j Summit took place in 2013 and then took on the form of a virtual think tank. In 2015, i4j decided to go from thought to action, giving birth to an "innovation for jobs ecosystem."

Of the six billion people who are of working ages, one third don't work. One quarter have jobs, and the remainder want a good job. Of the quarter that, only about one in six of them are engaged in the work, and one in three dislike their jobs and are actively disengaged. With this state of affairs, the GDP of the world is roughly $100T. By changing from a task-centered economy to a people-centered economy, we conservatively estimate a $200T global economy.

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ICT Impact to Society and Education

Hiroto Yasuura, Kyushu University

Abstract

ICT (Information and Communication Technology) is the driving force of innovation. Thanks to rapid progress of ICT, we have got extremely large computation power and data handling abilities with very low cost. Now, we are redesigning all social systems and services based on ICT. All social systems in modern cities are coming to be managed by Urban Operation System (Urban OS), which combines various data and information in the social systems. One of the most important social service is education. Education will also drastically change by gathering, storing and analyzing personal learning records as big-data in near future.

Introduction

ICT has made unusual progress in the human history. In the last 5 decades, we got extremely large computation power and data handling abilities with very low cost. The ratio of cost per performance was improved more than 10^{15} times. For example, A super computer of 30 years ago is in your pocket as a smartphone and everybody can use smartphone service in everywhere with low cost. Our daily lives are supported by social information infrastructure based on ICT.

Resent trends of ICT are discussed by the following key words:

- Artificial Intelligence (AI): New technologies for analyzing data and discover information from the data.
- Inter net of Things (IoT): All of things with sensing, communication and computation abilities are connected to Internet.
- Big Data: Analyzing huge amount of data, we can find feature and characteristics of the various phenomena.
- Open Data: All data should be open to public and freely combined each other for social activities.

These keywords are used in national policies as well as their science and technology policies in many countries. One of the large and well-known examples of IoT policies is “Industrie 4.0” jointly developed by the German government / industry / academia. The goal is to connect all the machines in the factory via the network to digitize the whole process in the factory activities. It completely changes the style of the production process. Industrial Internet Consortium (IIC) in the US, which was established by major US ICT companies, AT&T, Cisco, GE, IBM and Intel, aims at digitalization of not only production processes but other social services such as medical services, energy services, etc. Chinese government has also presented the plan “Made in China 2025 (MiC2025),” which is the roadmap of manufacturing industries in China. It aims to augment Chinese industry in many aspects, and the key ideas include enhancement of innovation, quality/brand-power, environmental protection, etc. in the manufacturing.

In the 5th Science and Technology Basic Plan, Japanese government has proposed the concept of “Society 5.0,” where advanced ICT improves every aspect of our life including industry, economics, health, transportation, education, etc. The plan emphases the 5th social paradigm change, which follows "hunting and gathering society," "agrarian society," "industrial society," and "information society." Our society is becoming truly "Cyber-Physical System," which is the mixture of the real world and the cyber world connected by ICT.

Urban OS

More than half of the people are living in cities. Handling various problems in cities are one of the major and common issues of all of countries in the world. Using ICT, especially IoT technology, a huge amount of data on activities in a city can be gathered. Combining various data, such as traffic condition, electric demand, health care activities, event information, tourist information, public service activities and so on, the city government, industries and citizens can analyze them and provide solutions to solve problems in the city. In this meaning, the city management is an actual cyber-physical system.

For efficient management, we need a platform as operation systems in your computer systems. We call the platform, "Urban Operating System (Urban OS)". The similar concepts are proposed in some areas, such as UOS by Living PlanIT, City OS by Barcelona, Open Programmable City by Bristol. Society 5.0 includes the basic concept of Urban OS, and PCAST in US also mentioned the similar idea as City Web.

Providing Urban OS, we can implement future social information infrastructure on which everyone can participate actively in social solution development. For the implementation of Urban OS, we have to solve the following issues both technically and socially.

Society allows mixed utilization of cross-domain data.

People change acceptability of sharing their data and belongs.

In the COI program, "Creation of co-evolutional Social Systems," of Kyushu University, we are now working to design and implement an Urban OS and will apply it to Fukuoka city.

Education Data Science

Education is the most important social service, like health care. Digital revolution by ICT is also changing education. In higher education in universities, programing is a basic literacy of students and various electric learning tools are provided. E-learning and MOOCs (Massively Open Online Course) is now very popular and students can take courses any-time and any-where through internet. PCs and tablets are introduced in elementary schools and children uses e-textbooks. The technology has enlarged into the market of social education for citizens and professional carrier developments.

The change of education induces the change of principles, methodologies and tools of education, which are established and used over hundreds years. Active learning becomes a main stream of the current teaching style for students in connected age. Big data analysis of learning and teaching records are usable for improvements of learning and teaching ways of students and teachers, respectively. Learning records becomes important personal records like health records.

As a basic research area of the new education, an interdisciplinary science, called "education data science," should be established, which is a mutual intersection of Computer Science, Psychology and Cognitive Science. Education materials and methodologies can be improved by scientific ways based on big data analysis. Evaluation of education is also scientifically analyzed and not only outcome of the education but process of education can be also evaluated.

In Kyushu University, we started BYOD (Bring Your Own Device) policy for all undergraduate students from 2013, and have provided e-textbooks with e- portfolio and e-learning systems. More than 180 thousands learning records are accumulated from learning activates of students every day, and teachers are analyzing the records to improve their teaching style. The Learning Analytic Center is helping the teachers to their improvements as well as providing feedback information to students.

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http://coi.kyushu-u.ac.jp/en/
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How Artificial Emotion Intelligence Will Change Our Lives

Daniel McDuff, Microsoft Research

Abstract

The wealth of digital devices around us has made it possible to create systems that can sense and respond to human emotions. Facial expressions, voice tone, physiological responses and contextual information provide a rich picture of the emotional state of an individual. Furthermore, advances in machine intelligence, namely deep learning, have vastly improved the ways that machines perform on learning tasks resulting in new excitement about the potential of artificial intelligence. This combination of sensors capturing data from many modalities and models that learn accurate relationships between these inputs and meaningful outcomes means that is now possible to deploy devices that respond intelligently to human emotions in the real world – devices that have Artificial Emotion Intelligence (AEI).

These technologies will change how people interact with computers and presents the possibility of new applications that help improve our health and wellness. Below I will explain how everyday devices can sense emotional signals. I will discuss how intelligent digital assistants might use this information and how services might be changed and improved by understanding the emotional experience of customers. I will also highlight the social implications of this technology and how it might make us feel.

Emotion-Aware Devices and Services

Emotions play an important role in our lives, influencing memory, decision-making, communication and wellbeing. Non-verbal and verbal signals contain rich information about one's affective state, intentions and wellbeing. In social contexts, these signals are vital for effective communication and social engagement. In order to understand other people in everyday life, humans synthesize signals from multiple modalities (e.g. speech, facial expressions, physiology, gestures, language).

Ubiquitous devices are now equipped with hardware (cameras, microphones, motion sensors) that could be used to sense human affective states from these modalities (Zeng et al., 2009). Microphones and cameras are available on most personal devices and wearable technology could soon be ubiquitous. In addition, people are increasingly using voice and gesture controlled interfaces. Speech interactions are becoming more common in many contexts than traditional touch inputs.

Advances in machine intelligence, namely deep learning, have vastly improved the ways that machines perform on learning tasks. In some object recognition tasks machines are now performing at an accuracy level equivalent to that of humans. Models that can learn the complex relationship between sensor data and human affective states present the opportunity to create devices that have Artificial Emotion Intelligence (AEI).

Given the important role that emotions play in our daily lives there is much potential for devices that are “emotion aware.” Affective Computing (Picard, 1997) is the name given to the field of study concerning these types of systems that sense, interpret and/or adapt to human emotions. The field has developed from a vision in the late 1990’s to a significant research field with an IEEE journal and international conference (Affective Computing and Intelligent Interactions (ACII)) (Picard, 2010). In the early days hardware for capturing emotional signals was cumbersome and clunky but now the electronics we use in our daily lives has the ability to capture and process affective cues in real-time. There are also many companies commercializing forms of affective computing technology. Whether it is in facial expression (Affectiva, Noldus, Microsoft) or voice prosody analysis (Audeering, BeyondVerbal) there is a growing market for software that detects and helps draw insights from emotion signals.

Emotion-aware devices and services have a huge potential to transform the way that people interact with technology, from our commute to work (Hernandez et al., 2014) to the classroom (Woolf et al., 2010) to entertainment (Gilleade & Allanson, 2005). Intelligent assistants that respond to non-verbal cues, games and experiences that are “emotion-aware” and healthcare applications that can provide tracking and insights about emotional and behavioral patterns are all products or services that are likely to become mainstream in the next few years. Soon we will think that a lot of technology we use is outdated if it does not respond more naturally to the emotions we express.

Recently there has been enormous growth in the market for intelligent digital assistants. Siri, Cortana and Alexa are all services that are reliant on understanding users’ needs. If these systems were able to interpret emotional cues in addition to language they would have much greater power to offer appropriate advice and assistance. In addition, they may in future be able to provide help and support far beyond what is possible now – for example noticing when an individual is depressed and offering assistance.

In addition to changing the way that devices are designed affective computing technology has the potential to facilitate understanding of the impact of services. For example, what if it was possible to understand the emotional experience associated with a service and use this information to help improve how that service is provided. Companies are already regularly using facial coding to understand the emotional connection someone has with a brand through advertising copy-testing (McDuff & Kaliouby, 2016). It may be possible in future to “tune” services based on the experience of an individual and/or change how a service is provided based on real-time feedback about the feelings of customers. This could change the relationship between a service provider and consumers making it much more personal. There may be greater potential still in understanding how a medical condition and treatment is impacting a patient’s behavior in real-time through quantitative measurement (Valstar, 2014).

There are significant social implications for devices and services that can measure and respond to human emotions. There is the potential for a dramatic shift in how that people relate to devices that no longer appear to be impersonal hardware. Affective computing technology could serve a very important role in helping us understand others and ourselves.

Recording and analyzing physiological or behavioral information is a sensitive topic and there are many justified concerns related to potential invasions of privacy. This data is very personal and in many cases personally identifiable unless carefully processed to keep it anonymous. Therefore, it is very important that there is an open discussion about the appropriate social norms that exist around the use these data and also what constitutes misuse. Researchers and companies need to consider how to afford subjects the appropriate protection otherwise they will quickly lose their trust.

Conclusion

With rapidly increasing availability of powerful sensors on everyday devices and advances in machine learning it is not possible to design and deploy systems that sense and respond to human behavior and emotions. This has implications for intelligence devices and how we measure and understand consumer experiences in the real world. Emotionally aware devices offer the potential to dramatically improve our wellbeing and make our devices merge seamlessly into the fabric of everyday life.

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Micro Services and Innovative Organizations toward API Economy

Minoru Etoh, NTT DOCOMO

Abstract

API economy (application programming interface economy) is a concept which describes commercialization of API marketplaces where many APIs are listed and collected from different organizations. That concept technically sounds like SaaS (Software as a Service) or SOA (Service oriented architecture) though, it is unique to highlight economic scalability through monetization from industry's real demands. Someone might say "API economy is dead." due to lack of sufficient SLA or stable business continuity. Nowadays, microservices architecture is emerging to nurture innovative services to have greater agility, salability and availability, so as to create another type of API economy inside of an enterprise. Recent progress of cloud platforms and software development environments have enables that architecture as well as a group of small nimble teams. This talk covers a state-of-the-art service development approach, by taking Amazon Web Service and GE's IoT platform as examples.

Introduction

What is "API Economy?" For many innovative companies today, the term API Economy is vitally important. The concept represents the function of building a new integrated system by combining enterprise systems as "the digital glue that links services, applications and systems." Each company concentrates on assetization of data and know-how in the company and can acquire "Revenue Channels of Your Own Data" by providing it externally as Application Programming Interfaces (APIs). One example is Microsoft's Cognitive APIs. APIs such as speech recognition, image recognition, machine translation, etc. are provided so as to be associated with other services. By providing such an API infrastructure, it is now possible to implement mobile applications that do not have a server, and application markets providing various services for consumers are emerging.

This article will discuss related technology trends in terms of whether API Economy will become an important concept of cooperation between companies. As a result, we mention that we need not as a technology but as an organization, and furthermore as a sociotechnical system we need a mechanism to evaluate the output of "API = Organization."

API Bazaar Concept and its failure

As we move forward with API Economy, it will be possible for many companies to sell their respective APIs to the market (Bazaar) and advance the monetization. Mashape is the startup that was promoting that idea. In addition, there was Mashery, a startup that hosting service in order to make APIs easier to market. Apigee, a startup, has provided system development that provides the basic functions of API, security, flow control, and AAA (authentication, authorization, and billing). These are in early 2010s, but many of them are not successful as expected. TIBCO Software Inc., a global leader in integration, analytics, and event processing, acquired Mashery in 2015, Google acquired Apigee in 2016. Mashape made a pivot from an API bazaar provider to an API platform tool provider. Its open and democratic marketplace i.e., “Bazaar”) has been well-known though, its monetization thru APIs is not promising so far.

Why has the bazaar approach not been successful? Here are my observations:

Mixture of Wheat and Chaff. Some APIs are slow, buggy and unreliable. Others are marketing API users, not helping them.

No Need for the Bazaar from Killer API providers (e.g., Twilio and Stripe other than Amazon, Netflix, etc.).

Organized API Market and Innovative Organization

In fact, it seems the open market approach is suffering from the quality control, while big enterprise internal API usages are going well. Netflix is one of the most successful companies which utilizes its APIs seamlessly for both its internal service composition and external expansion together with third parties. Netflix engineers have obtained the fruit of “REST as API Lingua Franca”. The concept of Service Oriented Architecture (SOA), which consciously designs the system to loosely coupled and combines the subsystem API with the service bus concept, has been on for 20 years ago. It was practiced. SOA and the software architecture of the company that is currently successful are quite similar in appearance. The crucial difference is that software development is mapped to organization and culture. SOA is merely a technique of improving “Service composability and reusability” efficiency. SaaS (Software as a Service), which is a more scalable concept of it, is just SaaS is a software delivery method.

The concept/aspect of “mapping software development to an organization” is missing.

Conway’s Law and microservices

Marvin Conway showed an empirical law entitled by his name (1968) which says “Organizations which design systems are constrained to produce designs which are copies of the communication structures of these organizations. If you have four groups working on a compiler, you’ll get a 4-pass compiler. Or more concisely: Any piece of software reflects the organizational structure that produced it.” Thus any software is not free from the company’s organization and culture. It implies the productivity and scalability of software development depends on those. Many big net companies have been struggling from the optimizing the organization and engineering culture. Here is the concept, “microservices.”

Here are several reasons to make a small autonomous team.

Brooks’ law: a claim about software project management according to which “adding manpower to a late software project makes it later”.

Ringelmann effect: the tendency for individual members of a group to become increasingly less productive as the size of their group increases.

Tuckman’s stages of group development: the forming–storming–norming–performing takes time.

Let me show you a very interesting case which happened in 16th century in Japan, regarding the microservices concept. It is the story of a magistrate, Hideyoshi Toyotomi who becomes the ruler, Prime Minister of Japan later. Well one day, the wall of Kiyosu castle collapses due to the storm. His master, Lord Nobunaga instructs ordinance to repair, and the construction begins, but after 20 days or more there is no remarkable progress. When the fence that is supposed to defend the castle in sengoku period (the civil war period of Japan) is broken, the defense capability drops considerably. It is the mission of this repair project to finalize the fence construction in a short time and return the defense capability to the original. Hideyoshi shared this mission with carpenters and masons. Then, Hideyoshi, who narrowed down his wisdom, divided the fences to be constructed into 10 sections, and the craftsmen divided into 10 groups. Speed of repairing the section was compared among the 10 groups, so as to be competed, all the construction completed on the next day. It is a method called "autonomous construction by divided teams with competition"

Let's consider that construction as software development in 21st Century. The concept of "Microservices" is going in a similar wary. The competition should be translated to economic autonomy.

Amazon two-pizza team is well-known. Netflix is the most transparent company which shows its journey to make corporate organization and culture be autonomous and nimble. Please visit their home page at https://labs.spotify.com/2014/03/27/spotify-engineering-culture-part-1

Recently, General Electric (GE) has adopted microservices concept into its digital company so as to maximize its software productivity in digital transformation. The concept of "autonomous small teams with loosely-coupled system thru APIs" is expanding beyond net service companies.

Takeaways

Although the open and democratic API market has not been successful yet though, the emerging financial effects of APIs on businesses have gained steam, thanks in part to mobile and social media technologies. Advanced IT Companies are generating revenue by exposing APIs as business building blocks for third party applications. Major companies that have gained revenue from APIs include SalesForce.com, Amazon, Facebook, Twitter, Google, and Netflix. The Spirit remains as "Business Competition by Small Teams" whether it exists inside or outside of enterprises.

We must pay more our attentions to "Sociotechnical aspect" which includes these observations:

Organization and culture determines the architecture and productivity of software systems.

Quality control of API is crucial for open and democratic markets. For that reason the currently successful API market has become an administrated market where quality management is conducted by a single company.

In order for the market of Bazaar type to appear, the rating system including the quality of products (i.e., APIs) and the persistence of services is inevitable. This means that you must build a Sociotechnical System. With technology alone, innovation does not occur.

Design of Service System

Kazuyoshi Hidaka
Professor, School of Environment and Society
Tokyo Institute of Technology

Abstract

Two significant design principles of service system are proposed to realize Future Services & Societal Systems in Society 5.0. First one is to implement structure and mechanism for realizing co-creation of value into the design. This co-creation is caused from the new paradigm: "customer as a significant resource in the service dominant economy". Second one is to design the system by considering dyad structure of it - confliction between very different requirements and phenomena -, which is the characteristics of a socio-technical system composed of very different elements. These two principles will let the design activity of service system go up to the next level.

Body

In this paper, two significant design principles of service system [Ref.1, 2, 3] are proposed to realize Future Services & Societal Systems in Society 5.0. First one is to implement structure and mechanism for realizing co-creation of value and second one is to design for dyad.

In the discussion of Service Dominant Logic [Ref.4], it is said that operant resource (skill and knowledge) became dominant resource comparing to operand resource (natural resource and physical goods) in our recent economy. If the skill and knowledge become significant resource for our economy, customer's role changes to more proactive one, because operant resource can be also provided by customers while operand resource could be provided by only providers (i.e. company) in the transaction of value creation system (service system). Customer change from a mere consumer of value to a co-creator of value. This new paradigm of "customer as operant resource" cause the new phenomenon of "co-creation of value" in the service system. Therefore, service system needs structure and mechanism to realize co-creation of value, and in design phase, special attention should be paid to this characteristic.

In the goods dominant economy, the main target of economic transaction is physical goods, so logistics of physical goods are significant social infrastructure for distribution of value. In the service dominant economy, skill and knowledge play as the key resource for economic growth, so distribution mechanism of skill and knowledge become significant social infrastructure. This is the reason why Information and Communication Technology - effective carrier of skill and knowledge - become significant social infrastructure in service dominant economy.

Second design policy, design for dyad, was drawn from the observation on the Japanese government research program for service science, named Service Science, Solutions and Foundation, Integrated Research Program (S3FIRE) [Ref. 5]. This program is the first national grant for SSME research in

Japan, continued since 2010 thorough 2016, by Research Institute of Science and Technology for Society (RISTEX) of Japan Science and Technology Agency (JST). The program aims to develop technologies and methodologies to solve specific and emerging problems of service and to establish a research foundation of “Service Science”. There were two types of research: solution-oriented “service science” research (type A) and foundation-oriented “Service Science” Research (type B). Eighteen projects are granted for three-year in the various service fields including health-care, education, tourism, hospitality, and public services.

One of research outcome of the program is to clear the category of the value of service system and develop the evaluation methods of those, through social science type of analysis on business transaction data and behavior change of stakeholders. This research was conducted in the banking service system, because continual growth of each stakeholder in long term relationship is required rather than one time success of the business transaction in banking business [Ref.6]. Another research outcome is to develop the visualizing and improving methods of skills and learning achievement of service practitioners, through realizing mechanism to detect human awareness. This research was conducted for care service, because in care homes or nursing houses, skill management of caregivers (nurse) is very critical to provide qualified service for care recipients (like old peoples) [Ref.7]. Other examples of research outcome is to develop service design technology based on engineering design, through involving collective/customer/organizational knowledge and learning into design process. This project aimed to innovate tour business where free independent travelers are growing recently [Ref.8].

Based on the observation on the six year service science research program including above research practices, it became clear that service system had dyad structure characterized by conflicting requirements or phenomena, such like, rationality vs. irrationality, objectivity vs. subjectivity, and physical phenomenon vs. mental phenomenon. Because service system is a socio-technical system composed of very different elements, designers of the system always face conflicting requirements and phenomena reflected by dyad structure of the service system. In the past and on-going design relating to social and service system, only one side of the dyad is tend to be focused in one design activity, because a designer always work in one or a few (academic) disciplines which cover only one side of the dyad structure. To realize Future Services & Societal Systems in Society 5.0, doing systematic design (and also management) considering dyad is very significant.

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Social Impact and It's Concern

Yukiko Horikawa
ATR Intelligent Robotics and Communication Laboratories

Abstract

With our aim to realize Super Smart Future of Society 5.0 that has the meaning of Japan, the country most suitable for innovation in the world, is the topic in our social impact session. Unprecedented high speed outcome of innovative technology infiltrate into our social life and we, citizens are compulsory facing the mass flow of actual good and bad influences in our daily life without our notice.

Important subjects of Ethical, Legal, Social Challenges caused by implementation of leading edge technology to our society is facilitated and this discussion bring us deeply further to the issues to tackle and fast actions to catch up.

Economical, Legal, Robotics Technological, and Funding fundamental points are all merged into this session for finding practical implementation issue that will lead us to the sort of clues to face our current situation.

Body

We all gathered this impact session of this summit and rendered some topics that are related to speaker's professional fields. As the result, we have to deeply think about social adjustment to tackle and face the practical solution for various Ethical, Legal, Social Challenges. Being related to JST research theme, we realized the technology itself should not be developed by only technical point of view without the perspective of real user's opinions or acceptability. That indicates knowing of multi-stakeholder's existence create millions of unprecedented complex situations. Also we must not forget that the realization of Super Smart Society of Society 5.0 surely forced experience the unpredicted aftermath by innovative networked technologies. We strongly need to fully and deeply discuss further about these issues with all sorts of different area of professional team with real use-cases.

Prof. Masahiro Kuroda,

"Economist's point of view: How to create effective demand by ICT"

He explained the historical growth Japan faced after World War till current age and its economic changes. He mentioned about the economy's theory and algorithm to foster to ease an economical discrepancy and inequality. Exploiting IoT technology, we need to face social adjustment to get full benefit out of new economical trend value and create relevant platform for society.

Dr. Alexandra Media-Borja

"Smart Human-Centered Service Systems of the Future"

She introduced about the trend of NSF's funding themes and strongly focused human-centered "service system" that is expected in beyond traditional boundaries. She stated the complex issues that include socio-technical hurdles of our intricate environments to achieve the vision of controlled theory.

Dr. Norihiro Hagita

"Robotics and its Societal Impact : Intelligent Systems Creating Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration"

He explained Robotics in Cyber Physical Spaces with the sample of Pokemon Go, which we live in complex dual world of vertical and tangible real space and its challenge in Smart Networked Robotics Project alongside with ATR's research history and project dynamics and his group of JST CREST Projects. He strongly insists and promotes the situated service necessary in Japanese Super Ageing Society to help improving our quality of life using Co-Experience Knowledge and Wisdom concept on Human-Robot Interaction (or Collaboration) .

Attorney Mr. Kobayashi

"Fear for Autonomy"

Internet Technology makes society smart. And smart society brings a lot of benefits to human.

Yet technology itself have both positive and negative effects. He rendered the topic of an issue arose in Osaka Station regard to Privacy heat-ups by citizens. He stated that although the topic is not that fatal, citizen's antipathy is irrational and emotional, and very much difficult to explain logically. People feel fear by watched 24 hours with unknown eyes. Robots that are set in the house could be a media to collect all the family's privacy information. That information can be kept in cloud and cloud information could easily spread out to someone unknown by hacking action. He mentioned about "Trolley Problem" and insisted to have international common regulation on autonomous vehicles.

Smart Human-Centered Service Systems of the Future

Alexandra Medina-Borja, Ph.D., US National Science Foundation

Abstract

We anticipate a future in which people and the built and natural environments are melded at multiple temporal and spatial scales. The integration of sensing (embedded around, on, and in us), communication, and computation advances converging with our increased knowledge about human perception, cognition, behavior and physiological functions will likely create this future. Yet, to achieve this aspiring state, a fundamental conceptual rethinking is needed at different levels. First, rethinking of physical infrastructure not any longer considered only as a physical entity but deemed as a service; second reframing of other more traditional service systems as we know them today as cognitive cooperative systems. In this new realm the cyber-physical world will cooperate and work side by side with the human world. However, this future can only be viable with the emergence of new bold research to catalyze interdisciplinary social and hard sciences and engineering. These convergence is needed to shape human-technology partnerships that provide a sustainable, vibrant, livable people-centric world. Research, social and ethical implications of this future are discussed.

Introduction

Service systems must be designed to address the most pressing problems affecting humanity. “Futurists” have claimed in multiple venues that the “underemployment” in manufacturing will also hit the service sector. John Markoff, in his recent book [1], identifies a genuine concern that in engineering such systems there is an increasing tendency to take humans out of the loop. It is undeniable that humans will be working with machines and in some cases, replaced by them. In that case, the substitution of human labor by automation in the service sector will potentially affect the majority of the population in the developed nations.

To improve this outlook, the only solution is to achieve true cooperation of humans with engineered systems. For example, the necessary improvements in the healthcare and education sectors will use humans to do what humans do best (e.g. creativity, synthesis, social skills), and machines to do what machines do best (e.g. fast processing of massive amounts of data, precision, application of force), effortlessly cooperating with one another. This is the new version of what Hollnagel and Woods [2] called “joint cognitive systems” in the early 80s, when developing expert systems required new techniques to elicit expert knowledge and then design the interaction with the decision maker interfacing with the system. Today technology is much farther along those early intelligent systems, but engineering this cooperation is still not an easy task as it implies that cyber-physical systems can adapt and respond to human interaction in a seamless way. In 2001 Hoc [3] produced an extensive review of literature of the human-machine cooperation literature, defining and distinguishing cooperation and highlighting the cognitive approach to design this interaction. Based on that and other definitions, other authors have generated insights into virtual reality, automation and control, and ergonomics, to name a few ([4], [5], [6]). Still, few of those papers conceptualize the human in a mathematical framework that a control system could use to understand complex human interactions, adapt to and react appropriately.

In addition, our definition of "service system" can be stretched to include artifacts such as "Smart Refrigerators" and "Smart Homes" that in fact will not be deemed objects but service providers when interacting with humans [7]. But having the smart devices or artifacts is not enough. As Larson pointed out in a recent commentary in the INFORMS journal Service Science [8], even in an era in which technology drives our way of living in more ways than one, service systems still face challenges stemming from discrepancies between how technology functions and how human beings act, feel, perceive, think. This author provides examples where the introduction of technology did not have a positive impact, among many for a lack of coordinated actions between the service users, the technology and infrastructure were prime reasons.

In order to improve operations and activities in services, it is essential that scientists and engineers achieve the ideal system design and configuration; the cyber-physical world needs to understand, interact and incorporate the human world at different scales. Machines doing what they do best—fast computational calculations, information search, objective interpretations and linkages of data—and humans complementing them with intuition, improvisation, complex decision-making, empathy, etc., is the key for a future where smart services improve the quality of life of the population in ways scientists have not yet fully comprehend. New bold research to catalyze the interdisciplinary science and engineering to shape a human-technology partnership to provide a sustainable, vibrant, livable people-centric world is needed.

Therefore, to advance this agenda and achieve the smart world that we speculate in this paper will be beneficial to all members of society. True convergence of computational sciences, engineering and cognitive and behavioral sciences is needed. From the research standpoint, first, we need new discoveries and modeling approaches that formalize the scientific understanding of human behavior, cognition, perception and action in the context of interactions with engineered systems. Just as an example, psychology scientists have known for a sometime about Barsalou's Perceptual Symbol System theory [9] by which perceptual symbols are records of the neural states that underlie perception and therefore the brain uses active configurations of neurons to represent the properties of perceived entities and events. Hence, people mentally simulate (that is, the mental reenactment of perceptual or motor experiences they are living) and research in this direction is already starting to find evidence that the reactivation of motion, for example, using dynamic pictures, can influence other human cognitive tasks, such as faster categorization of objects [10]. It is clear that findings motivated by these and other theories could be used by cognitive engineers, computational scientists and mechanical engineers working together to develop devices that enable faster categorization of objects by humans. This could be useful in many work-related situations where productivity can be increased by visual recognition. The problem is that very few engineers know about this and other important behavioral and cognitive theories. Second, work will be needed to evaluate the processes and performance of these smart socio-technical service systems. Optimization algorithms and measurement frameworks today reduce humans to a combination of data patterns, probabilities and states, or utility functions. Therefore, measurement and modeling do not consider human variability and spontaneous random behaviors (what Larson calls adaptive role and agency in such systems) that affect how humans interact. It is impossible to measure quality and productivity of these systems unless new mathematical frameworks are implemented. Finally, considerable, longer-term work will be needed to codify these discoveries and to integrate them into engineering education and practice. These discoveries will also inform design considerations for larger engineered systems with emerging behaviors that need to be better understood. The resulting systems will leverage the best qualities of human and the engineered system, thereby enabling highly productive human-human interaction. Larson provides examples on designing the cities of the future. Yet we have a poor understanding of how to design cities where all people can have a high quality of life level. Larson explains that cities that provide relevant benefits (or services) to people and work with people require overcoming several demographic driven challenges and the need for access to all.

Potential implications of this smart services future

It is not new than in 10 years robotic and artificial systems will be much more intelligent than currently available. Autonomous technology will enable individual autonomy in previously impossible domains (own doctor and own flying cars). Moreover, in a very near future smart artifacts will be able to interact with humans, creating value and becoming de-facto service providers. Hence, the concept of “service system” and service will be expanded beyond traditional boundaries.

There are multiple social implications for this. First there are currently needs for regulation and policymaking that touch on ethics and safety for society. Privacy and safety are some considerations already under the radar of governments. However, we are not yet by any means at the level by which the embedded intelligence of the cyber-physical world around us and within us has achieved its maximum potential and so solutions to guarantee privacy and safety are going to be fundamental to the expansion of these technologies and systems. Also, we do not know whether robots or intelligent cyber-physical agents will in fact help improve people’s lives through social interaction; to what extend this social interaction has the potential to replace actual humans, and negatively affect society in the long run, or to the contrary, will people actually let them interact with them?. NSF has funded several ongoing projects in this space. In addition, smart technologies have the potential to shift the economic international landscape in many ways. Once we are able to design our own shoes, send them for fabrication at an available maker-space nearby home, we will forever shift the international landscape as many products that are now produced in low-wage regions of the world will be designed and produced in people’s homes and neighborhoods. The sharing economy will cross the boundaries of private individual ownership (I share my house or my car) to the corporate space (I share the idle machines time in my factory) or I share 3-D printers in my neighborhood maker space. We cannot predict the unintended impact of this shift. Finally, what are the educational/academic implications of human-machine systems? Do we need a new academic discipline that borrows focused knowledge across engineering (such as control and dynamic systems, optimization, design) and computational science (cognitive computing and deep learning), while understanding in a deep way concepts and theories of the behavioral sciences? Or, are true collaborations across academic silos sufficient? Beyond those research capacity building oriented questions, the key question about education remains: can we provide access to more children and young adults to a world-class education regardless of the region of the world where they are located? Can we create adaptive and intelligent systems that cooperate with the teacher and assure that all children regardless of background or innate abilities learn? And if we do, what are the implications of a new world landscape where every kid can read, write and eventually achieve tertiary education? For sure, if society provides the necessary ethical oversight to these systems, this is a scenario that can generate positive outcomes for humanity.

Acknowledgments

These ideas have been evolving, and have been cross-pollinated by many colleagues, inside and outside NSF. As there is no space to include all, I want to recognize specially Jordan Berg, David Mendonca, Louise Howe, Pramod Khargonekar and Betty Tuller, among others.

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Intelligent Systems Creating Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration

Norihiro Hagita, ATR
(Advanced Telecommunications Research Institute International)

Abstract

This talk briefly introduces intelligent systems creating co-experience knowledge and wisdom with human-machine “harmonious” collaboration[1]. The researches are supported by the Japan Science and Technology Agency (JST) as the CREST research project. The development includes the ethical, legal and social (ELS) challenges. That is, the systems are supposed to observe, recognize and structurize internal/external information of individual human and group activities while coping with ELS issues: the dignity, privacy, trust, liability, etc. These assume the cyber physical spaces and include services with human-robot interaction and collaboration, wearable sensors, cloud computing and the development of an open platform using the state-of-the-art technologies in appropriate areas such as brain and cognitive sciences, social sciences, natural language, and robotics.

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Fear for Autonomy

Attorney's view about Society 5.0
Masahiro Kobayashi, Attorney at Law (Osaka Bar Association)

Abstract

When artificial intelligence or IoT technology is put into practical use, legal regulations are required. I named it "Fear for Autonomy," which is one of the most important issues which must be considered when making legal regulation. For example, people may have fears of the systems on which many surveillance cameras operate. If IoT devices spread to houses, they will be concerned about privacy invasion. In order to quell these fears and concerns, it is necessary to show peace of mind, showing that advanced technology complies with regulations. Also it is necessary to decide appropriate rules so that artificial intelligence introduced in automatic driving technology, working environment, financial transaction etc. runaway or artificial intelligence does not deprive human judgment that should be done.

Body

Internet Technology makes society smart. And smart society brings a lot of benefits to human.

However, technology will not always be welcomed. Because technology has both positive and negative effects. And technology has risks of abuse, even if it has been developed in good will. Here is one of the reasons why we have to regulate technology by legal system.

There are two important points to make legal system. One is to protect Human rights. The other is not to inhibit the development of technology. Striking good balance is difficult work.

I will speak about one of the big issues occurring when we make legal system about technology and Smart-Society.

I call it "Fear for autonomy".

In autumn 2013, a public institution set up 92 digital video cameras in Osaka Station. They planned to shoot all faces of visitors and make the data of their migration path automatically. The number of people who visit Osaka Station is over 800 thousand per day. So, this trial would have become an important milestone, to show the arrival point of the face-recognition technology, and that of the big-data processing technology.

However, this trial was rejected by newspapers, human-rights groups, and Osaka City Council. The institution could not take photos of all visitors. Only they could do was to take photos of dozens of volunteers.

In spring 2014, I was asked the legal assessment from the institution. From an attorney's point of view, this trial has some problems about the right of privacy. But these problems were not fatal. Besides, hundreds of video cameras are already set up in Osaka Station for years before this trial. The thief, the molester, missing children, the physically challenged, the injured or the sick had been tracked by the human security guards. Yet no one has complained about it.

I could not understand why machines were not allowed when human do the same thing. I thought that this antipathy is irrational and emotional, so it is difficult to explain logically.

But now, I think I can explain by using the keyword “The Fear for autonomy”. As I cited before, security guards can track some visitors from a monitor room. But this new surveillance system makes it possible to monitor the behavior of millions people for 24 hours. The ability of the new surveillance system is far superior to that of human. It can be called “The God’s eye” or “Monster’s eye”. It has intelligence, but can neither know what it thinks nor even control it. This is the reason why people fear the autonomous system.

According to my experience, about introduction or experience of new technology, only complying law is not enough to be welcomed by people. You have to let people think that you hide nothing. That means pre-established system which responds sincerely to the questions of people. It involves disclosure and accountability. In detail, you need to advertise by posters and signboards, explain by websites, and set complaint counters.

In Smart Society, robots are set in houses, and make communications with its families. Private conversations will automatically be uploaded to the cloud through robots, analyzed by artificial intelligence, downloaded to the robot. Millions of conversations will be stored at the storage of cloud.

Can a detective get the conversation data from the cloud when he thought the son of a family might be suspect? Does it mean that bugging devices are set in every house? Or can you speak your partner bad in front of a robot?

The harmonization of privacy and technology is one of the areas where new legal system is most needed. However, japan is proceeding over 30 years behind Europe, Canada, and the United States. For example, these countries established the system of Privacy Commissioner between 1977 and 1984. But that system of Japan will start next year. In addition, Privacy Commissioner of Japan would not be given a supervisory authority for the government agencies. However, government agencies have the greatest amount of personal data, there will be the largest damage when these are leaked or used illegally.

When we think about the legal system of autonomous cars, we know that we should fear autonomy.

Let us imagine a situation that a young man is riding on an autonomous car driving along the road which is on the top of the cliff facing the sea. Then, a human-drive big truck has come out from the opposite lane. If it went straight, it would remain in the head-on collision. If it turned to left, the car would jump into the sea. If it turned to right, the car would run over a young woman with a baby.

Which choice should the car choose? Will your answer change if one eighty-five-year-old man, instead of one young man, was riding on the autonomous car?

This is remodeled question which is called “Trolley Problem” on philosophical study. Because it is philosophical question, there is more than one correct answer. However, there is one thing certain. Artificial Intelligence must not define the priority of values of human lives. A young man, an old man, a mother, children, a criminal, or a Nobel Prized Professor, non-human being must not choose who shall die or survive, except God.

Therefore, we the human have to decide the rule of priority, and teach the rule to autonomous cars.

And all cars of all makers of the world have to confirm the same rule of priority. Because disunity rules make it impossible to predict the behavior of the car. If TOYOTA cars go right, NISSAN cars go left, and HONDA cars go straight in the same situation, nobody can protect oneself.

Then, what should be the rule of priority? I think the first principle of the rule is, “Protect the human in the car”. Second principle is, “Protect the human out of the car”. Third principle is, “Protect itself” Don’t you think that will be the first “Three Laws of Robotics” not in the novel but in the real world?

According to these rules, the autonomous car should jump into the sea when empty. And it must protect eighty-five-year-old man even if it hits the young woman with a baby.

Then most of you think that “Wait a minute, who compensate the young woman and the baby for their injuries?” Indeed, their injuries does not seem to be compensated in the current law. Because no one has faults, and no defect in the car. So, I think we have to establish an insurance system to compensate for the damage caused by autonomous cars even if there is no faults or defects. The government obligates the owner of the car to make contract the insurance. The owners pay the insurance premiums.

Insurance company pay the compensation on behalf of the owner. If there is a defect in the car, the insurance company can claim all or part of the compensation to the manufacturer.

I will speak about last two issues which make me fear to autonomous.

One is autonomous labor management system. The other one is autonomous stock or exchange trading system.

They say that autonomous labor management system will evolve rational distribution of working hours. Artificial intelligence can make perfect shift tables, which will eliminate standby times. But remember, this shift table may reduce the salary. Because labors get salary not only by working, but also by waiting.

Efficient outsourcing system will make housewives and retirees earn some income by teleworking. But remember, their income may reduce other’s income. Because if the size of the market is same, the increase of workers results the decrease of working time of other labor.

The autonomous stock or exchange trading system is more terrible.

As you know, the international discussion in order to limit the HFT (High Frequently Trading) has already begun. But I am worried about the more exclusive system. The artificial intelligent system reads newspapers, weather information, public documents of governments and corporations, and every tweet all over the world, analyze them, and decide to buy or sell stocks, exchanges, or other financial instruments.

A lot of human traders will be fired. Computers, I think around one hundred, will dominate the financial markets. But that is not enough.

It means no one will be able to understand the algorithm that artificial intelligence obtained by deep learning. And that means anyone will notice the runaway of artificial intelligence, and anyone will be able to predict the stock market crash.

Today, intelligent technology has obtained the great power to change the world. We are about to enter such an era as 1945, when the physicist has been put to practical use of the nuclear technology. It means you are at the door of heavy responsibility. And I will support you and always be on your side.

Appendix 2 Program

(1) Date & Time: 7th November, 10:00 am to 6:30 pm

(2) Venue: Tokyo International Forum, Yurakucho, Tokyo, Room G409

(3) Program

10:00 – 10:10 (10) Opening, Kazuo Iwano and Jim Spohrer

10:10 – 10:40 (30) Keynote Speech, Innovation for Jobs - Disrupting Unemployment, David Nordfors, Co-founder of I4J (Innovation for Jobs)

10:40 – 12:20 (100) Vision Session, Yassi Moghaddam,
Executive Director, ISSIP, Moderator
* Innovation and People *

(25) *Cognition as a Service: An Industry Perspective, Jim Spohrer, Director, Understanding Cognitive Systems, IBM Research*

(20) *ICT Impact to Society and Education, Hiroto Yasuura, Professor, Kyushu University*

(20) *How Artificial Emotion Intelligence Will Change Our Lives, Daniel McDuff, Microsoft Research*

(20) *Reality 2.0 and Wisdom Computing, Kazuo Iwano, Principal Fellow, CRDS, JST*

(15) *Q&A and discussion*

12:20 – 13:20 (60) *Various discussion with lunch boxes (Closed)*

13:20 – 13:50 (30) *Keynote Speech, What do we need for Smart Service Society? Data Sharing, Organization, and Technology, Yuichiro Anzai, President, JSPS*

13:50 – 15:25 (95) Technology Session, Yosuke Takashima (JST), Moderator
* Future Service Society, Cognitive Service System, Reality 2.0, Service *

(20) *Future Research Directions: NSF Smart and Connected Communities, Sunil Narumalani, Program Director, NSF*

(20) *Evolution of IoT and it's Social Impact, Hideyuki Tokuda, Professor, Faculty of Environment and Information Studies, Keio University*

(20) *Micro Services and Innovative Organizations Toward API Economy, Minoru Etoh, Senior Vice President, NTT DoCoMo*

(20) *Science of Service System,*
Kazuyoshi Hidaka, Professor, Tokyo Institute of Technology

(15) *Q&A and discussion*

15:25 – 15:35 (10) Break

15:35 – 17:10 (95) Impact Session, Yukiko Horikawa,
ATR Intelligent Robotics and Communication Laboratories,
Moderator
* ElSI, SBE, SSH *
(5) *Session Overview, Yukiko Horikawa, ATR Intelligent Robotics and Communication Laboratories, Moderator*

(15) *Economist's point of view - IoT and its impact, Masahiro Kuroda, Principal Fellow, CRDS, JST*

(20) *Smart Human-Centered Service Systems of the Future,*
Alexandra Medina-Borja, Program Director, NSF

(15) *Intelligent Systems Creating Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration, Norihiro Hagita, Director, ATR Intelligent Robotics and Communication Laboratories*

(15) *Attorney's point of view – Fear for Autonomous,*
Masahiro Kobayashi, Attorney

(25) Q&A and discussion

17:10 – 18:20 (70) Panel Session, Yassi Moghaddam, Moderator

* Vision, Technology, Impact, Readiness *

(60) Panel: Yuichiro Anzai, Jim Spohrer, David Nordfors, Daniel McDuff, Hiroto Yasuura, Norihiro Hagita, Kazuo Iwano

18:20 – 18:30 (10) Wrap up

■Editting member■

Project director	Kazuo	Iwano	JST CRDS Principal Fellow (Until December, 2016)
Project director	Yasunori	Kimura	JST CRDS Principal Fellow (From January, 2017)
	Yosuke	Takashima	JST CRDS Fellow
	Satoru	Bannai	JST CRDS Fellow
	Naohumi	Yamada	JST CRDS Fellow

※Please contact the following unit for inquiries.

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「Future Services & Societal Systems in Society 5.0」

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Systems / Information Science and Technology Unit
Center for Research and Development Strategy,
Japan Science and Technology Agency

Ks Gobancho Bldg., 7, Gobancho Chiyoda-ku, Tokyo 102-0076 JAPAN
Phone: +81-3-5214-7481
Fax: +81-3-5214-7385

https://www.jst.go.jp/crds/

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