Fujitsu's Approach to Smart Cities

● Hisatsugu Tamai

The problems now facing Japan, such as an energy shortage and a falling birthrate combined with an aging population, are problems that other countries around the world will eventually have to face. Japan is thus in a position to be a front runner in solving these problems and thereby become a leader in solving problems and creating a new society. To help Japan play this role, Fujitsu is promoting Smart Cities in which information and communications technology (ICT) is used to contribute to society and people's lives. Fujitsu's idea for creating a Smart City is to realize smarter energy usage and social infrastructures by using ICT, to have discussions with communities in order to resolve local issues, to find ways to revitalize communities, and to develop a means of sustainably circulating social values through ICT. This paper outlines Fujitsu's approach to Smart Cities and presents its approach to developing solutions to problems in different industrial fields. It also describes demonstration experiments in which Fujitsu is participating. Energy solutions that provide an infrastructure for Smart Cities are also described.

1. Introduction

Today, the world is facing various challenges. To give an example, the world's population has more than doubled in the last 50 years and recently reached 7 billion. In 1970, there were only two cities in the world with a population of more than 10 million; by 2010 there were 23 of these so-called "mega cities." The number is expected to reach 35 by 2020. In recent years, the increase in vehicle ownership due to population growth has been leveling off in developed countries while it has been growing significantly in emerging economies. The growing concentration of people and vehicles in cities not only leads to worsening traffic congestion but also to adverse economic and environmental conditions that degrade the quality of life (QoL). Consequently, there is an urgent need for effective environment improvements to urban infrastructures.

In Japan, we have been facing various problems including an energy shortage due to economic growth and an aging population due to a declining birth rate and increasing life expectancy. Since the Great East Japan Earthquake of March 2011, the energy shortage has become an even more serious problem due to the loss of electricity generated by nuclear power. Despite increasing efforts to develop new energy sources such as solar and wind power, it will be some time before we are able to make up for the loss of nuclear power. In addition, the price of crude oil has continued to creep upwards and will inevitably lead to increased pressure on the supply and demand for energy throughout the world. Japan's aging population is a major social challenge. The ratio of people aged 65 and over is 23.0% in Japan, which is much higher than the global average of 7.6%. To support Japan's "super-aging" society, manufacturers must address various issues such as the need to achieve unprecedented levels of productivity and to ensure that current know-how is handed down. In neighboring China, it is predicted that the one-child policy will result in an elderly population ratio similar to Japan's current situation in about 30 years.

However, these issues also present new opportunities in the sense that needs create new industries. To ensure that we can continue to make efficient use

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of limited resources while providing people with a rich and comfortable lifestyle, it is important that we start implementing various measures now. At Fujitsu, our aim is to change Japan from a country beset by problems into one that solves problems (**Figure 1**) by using our information and communications technology (ICT) capabilities to make a social contribution so that Japan can lead the world in the creation of a new type of society.

ICT can be used to address many of the issues mentioned above. Those cities in which state-of-the-art ICT and environment technologies are used to enhance the efficiency and sophistication of social infrastructure are called "Smart Cities." In this paper, we present an overview of Fujitsu's approach to Smart Cities and some examples of our work in this field.

2. Evolution of ICT

ICT has continued to evolve dramatically, and astronomical increases in price-performance ratios have brought networks with greater speed, capacity, and mobility and terminals that are more advanced and ubiquitous. This has led to the creation of large volumes of data, commonly referred to as "Big Data."

To give an example, the processing power of Fujitsu's latest smartphone is several times greater than that of what was the world's fastest supercomputer 13 years ago. A smartphone can be operated by a touch panel, connected to a high-speed network, and even

used for speech recognition. It has many functions that supercomputers did not possess, yet it fits in the palm of the hand. It is no exaggeration to say that the evolution of information processing technology has led to changes of the same magnitude as those brought about by the industrial revolution.

Mobile networks have also grown in capacity along with the spread of mobile phones and the increasing sophistication of mobile services. Compared with the first-generation analog system of the 1980s, the latest fourth-generation Long Term Evolution (LTE) system offers significantly greater transmission capacity. Mobile terminals are also becoming more advanced and diverse and are being used in all sorts of situations. Recently, sensors with GPS and communication functions have been incorporated not only in smartphones and tablets but also in cars, home appliances, and other devices such as machine tools. Social networking services like Twitter and Facebook have also seen rapid expansion of their user bases, and in some sense they have come to play the role of sensors for people's actions and thoughts.

From its initial purpose of improving the efficiency of back offices, ICT has now penetrated every corner of our business infrastructure and can even be regarded as part of the infrastructure in its own right. It has thus reached the stage where it is powerful enough to support an entire society. We are therefore in no doubt that ICT will play a major role in realizing social problem-solving systems and Smart Cities.

3. Fujitsu's idea of a Smart City

Before discussing Fujitsu's approach to Smart Cities, we will introduce the definition of a smart community as put forward by the Japanese Ministry of Economy, Trade and Industry (METI). Note that most government policy initiatives are focused on energy.

Figure 1
Changing from a country beset by problems into one that solves problems.

■ **METI definition of smart community**
1) New information networks
 - New information networks that connect things to people and to other things (the Internet of Things)
 - Systems based on the fusion of energy equipment with information networks

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2) New energy systems
- Systems that integrate centralized power sources, distributed power sources, and batteries
- Systems that support large-scale production of solar power
- Systems that enable customers to participate in energy management
3) New traffic systems
- Systems based on the fusion of energy and communications, with electricity storage at their core
- Networked systems in which vehicles act as sensors
- Systems that are environmentally friendly and convenient to use
4) New style of urban planning that saves energy and makes life more convenient
- Streets where people can feel at one with nature
- Living spaces that save energy and are more comfortable

Source: Issues and Proposals at the Smart Community Forum—An attempt to create a new lifestyle and a new community—, by METI
http://www.meti.go.jp/english/press/data/20100615_02.html

Various opinions about the definition of a Smart City were collected as "new Smart City declarations" at the Smart City Week in 2011, which is attended each year by many businesses and regional authorities.

■ **New Smart City declarations**
1) Citizens and enterprises
The key players in Smart Cities are their citizens and the enterprises engaged in industrial activities there. Together they will realize an optimum society for citizens.
2) Quality of life of citizens
The objective of Smart Cities is to further enhance the quality of life (QOL) of their citizens.
3) Clear vision
It is essential for Smart Cities to have a clear vision and to be promoted in accordance with that vision.

4) Always evolving
Smart Cities will continue to evolve ahead of the needs of citizens and changes in the local communities.
5) Japan's contribution to the world
Japan will transmit to the world its experience in building better societies through overcoming natural disasters and the demographic issues of a low birth rate and aging population.

Source: Smart City Week 2011 Steering Committee,
http://expo.nikkeibp.co.jp/scw/2011/english/scw.shtml

In particular, given that a Smart City is led by its residents and the companies doing business there with the aim of improving the QoL of its residents, it could be described as a state of shared consciousness among local authorities, businesses, and various other organizations that are involved in the embodiment of the Smart City, regardless of the degree of locality or the scale of the promotion.

Given this concept of a Smart City (improve the QoL of the residents and solve problems relating to matters such as the environment, economy, and energy), we define a Smart City as a place promoting a Human-Centric Intelligent Society where social and business revolutions are supported by ICT, which is Fujitsu's medium-term vision.

Fujitsu's Smart City uses ICT to implement a smart social infrastructure for energy and other utilities, to find solutions to local problems, and to help create stimulation plans by considering the region's best interests. By using ICT to continuously create cycles of social value, this Smart City can support real businesses based on new business models. The promotion of real businesses begins with a review of the regional models that have been used so far. For real businesses to flourish in a Smart City, the most important thing is to develop a mechanism for circulating value (money or something equivalent) among the players in the region, such as local authorities, local businesses, medical institutions, and residents. As ever, it is difficult to create sustainable value in a model of economic burden between specific players such as local businesses and residents, or regional authorities and local businesses, and it is

essential to circulate service charges, taxes, subsidies, regional currencies, various types of points, and the like as a form of social value. A Smart City should provide a region with sustainable stimulation based on business models created in the region itself.

In addition, the realization of a Smart City requires that various complex issues including the flow of various resources, energy, information and people are monitored, visualized, analyzed and optimized. By harnessing the power of ICT, Fujitsu will contribute to the realization of a more sustainable society and a safer global environment by ensuring that the value in cities, towns, and villages is enriched while at the same time reducing their impact on the environment.

4. Smart City initiatives

Hitherto, the ICT developed in separate businesses, organizations, and business fields has been transformed into an axis of the regional community, and Fujitsu's approach to its Smart City initiatives has been to join them together in a form suited to the characteristics of the region. In this section, we discuss Fujitsu's efforts towards the creation of a Smart City.

4.1 Providing solutions that cross over between industries and business areas

Fujitsu has provided many ICT solutions to private enterprises such as the manufacturing, distribution, and financial industries and to public bodies such as local authorities, educational establishments, and medical organizations. Different customer categories are needed in each of these solutions. However, when aiming to solve social problems, there is a limit to how far we are able to tackle problems from an industrial and business perspective.

To solve social problems in the future, we must use ICT to connect data in forms that cross between each of these categories instead of applying ICT to specific categories or to individual business fields (**Figure 2**). Slowly but surely, this will give rise to cases where ICT forms sideways links between people and things that were not connected before and to cases where ICT has a broader interface with social issues. Some examples are introduced below.
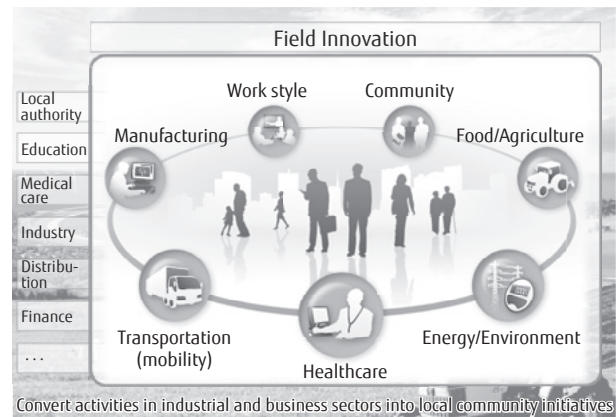

Figure 2
Use of ICT to connect data in forms that cross between categories.

4.1.1 Healthcare: Sharing information for stronger medical services

Fujitsu has been providing hospital systems in which medical records are stored electronically. The system is divided into approximately 30 subsystems on an infrastructure where information from the systems of each department (including image data) is coordinated and used to provide essential information to medical teams inside the hospital. Recently, there has been a growing number of projects aiming to implement high-quality services over entire regions by linking together the systems of hospitals, clinics, and pharmacies.

The system with the greatest number of participating medical organizations is the Ajisai Net, which is a coalition of medical collaboration network systems that connects 200 facilities in Nagasaki Prefecture. In addition, the HumanBridge regional medical collaboration package system has been applied in more than a dozen regions. With the consent of patients, diagnostic information is accurately shared and reflected in the diagnosis and can be smoothly transferred when the patient is, for example, referred from a clinic to a central hospital or transferred between hospitals. The result is a framework for providing high-quality medical services throughout a region. We are in the process of implementing this framework throughout Japan.

As Japan's population continues to age, medicine and healthcare will become more and more a part of everyday life. Various health-related services are already available in the online world, and it is now possible to purchase equipment such as weighing

machines and blood pressure monitors that cooperate with network services. Connecting this sort of data with actual medical care would transform various aspects of healthcare including the treatment of chronic diseases. It would also present new business opportunities in food production and distribution, such as enabling people to order meals that are matched to their level of fitness or medical condition. To enable the elderly and infirm to live comfortably, there is a growing need for housing equipped with health monitoring functions such as sensors, and new services that use networks to support everyday activities like shopping are likely to become a growth area.

4.1.2 Food and agriculture: Using information cooperation to maximize profits

Hitherto, ICT has barely been used in the fields of food and agriculture. We have started working on the construction of a "Rich Food Future" project that uses ICT to transfer skills from the older generation farmers to the younger generation farmers and to establish a value chain from producers to distributors and consumers for improved competitiveness.

By using ICT on farms, we can transform the know-how of veterans into visible "explicit knowledge" and bring about advances in the "visualization of management, production, distribution, and clientele" in the field of agriculture, thereby using ICT to establish a value chain from producers to distributors and consumers. In this way, we aim to achieve a highly productive and competitive agriculture business through the rationalization of work and the expansion of business.

4.1.3 Transportation: Monitoring roads and other parts of traffic infrastructure

We are working on the visualization of traffic information such as congestion data and the visualization of deterioration in transportation infrastructure, which is starting to become a problem.

We are already providing cloud-type traffic management services using digital tachographs, which are now available for commercial vehicles. A digital tachograph is used not only for driving and safety management but also as a way of promoting economical driving. Using the data collected from digital tachographs enables various other kinds of information to be obtained. For example, driving data collected

from various vehicles can be used to identify sudden braking hotspots. The experimental verification that sudden braking hotspots are correlated with accident blackspots made it possible to start a service that notifies users of sudden braking hotspots. Moreover, images collected from various vehicles could be used to predict road deterioration and repair times.

4.2 Fujitsu's Field Innovation

Our Field Innovation activities involve visualizing people, processes, and ICT in the field with the aim of quickly solving complex problems. The people that support these activities are called Field Innovators, and we have trained a total of 600 of them so far. These Field Innovators form project teams comprising several members and spend several months on site with clients (mostly corporations) examining issues by on-site observation and working with clients to resolve these issues.

Problem-solving may be performed using various methods across the region even if the problems are identical. It is therefore important to have an accurate understanding of local problems and their background and to work on a solution together with residents, local businesses, and local governments. We are currently starting work on putting our accumulated business know-how and skills to use in regional stimulation and new styles of urban planning.

4.3 Community-based projects

Fujitsu is currently participating in activities aimed at the implementation of Smart Cities and smart communities in over 20 regions (**Figure 3**). Some of them are introduced below.

4.3.1 Aizuwakamatsu City

In the Aizuwakamatsu region (which is in the Fukushima disaster area), with the aim of establishing an ICT platform to support the widespread uptake of renewable energy while contributing to and stimulating the local economy, we are cooperating with Aizuwakamatsu City and Tohoku Electric Power Co., Inc. on the METI Aizuwakamatsu Area Smart Community Promotion Project while building relations with the local government, chamber of commerce, local businesses, and educational establishments such as the University of Aizu.

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Figure 3
Locations of community-based projects.

The core of this project is the Energy Control Center (ECC) project. In the ECC project, we use integrated management and visualization of electric power information that can be generated locally from renewable energy to provide an independent and continuously operable energy platform.

We are also studying urban stimulation measures such as using electric vehicles (EVs) as the city's official vehicles and tying them in with the region's disaster prevention measures so they can be used as mobile batteries in the event of a natural disaster, thereby making the city more robust to disasters. We also aim to expand our residential services in cooperation with local information not only for the visualization of energy but also for contracted ECC consumers and demand-response (DR) peak suppression.

Fujitsu will continue to participate in the implementation of Smart Cities and smart communities based on new services and the ECC infrastructure.

4.3.2 Urayasu City

To promote urban planning that is kind to the environment, a consortium of members from industry, academia, and government has been set up with Urayasu City as its principal target. The aim of this consortium is to provide residents with everyday services that are ideally suited to their needs by

sharing the advanced techniques and know-how of each participant.

Fujitsu is participating in this consortium and is studying the services needed to implement a sustainable city together with its stakeholders while improving local brands by implementing sustainable city planning integrated over the whole region.

4.3.3 Toyota City

In Toyota City, a variety of verification trials are underway based on the idea of developing a so-called "Smart Mobility & Energy Life in Toyota City (Smart Melit)," where people and vehicles can coexist better than anywhere else in the world. This is an experimental project promoted by METI to try out systems for a low-carbon society.

Fujitsu is supporting the ICT aspects of this project in the formation of advanced model cities for foreign countries through the energy management of the entire living space in the region. In particular, our aim is to verify the effectiveness of DR measures by collecting and analyzing diverse data from various households.

4.3.4 Satsumasendai City

Satsumasendai City is located in the north west of Kagoshima Prefecture and is the largest city in the prefecture in terms of area. It has a number of nuclear and other power generation facilities scattered around and is said to be the energy supply base of Kyushu. After the Great East Japan Earthquake, the city promptly launched a next-generation energy vision committee.

Fujitsu is participating in the formulation of a new vision, and in March 2013 we clarified the public issues and contributed to an action plan for involvement utilizing next-generation energy.

We will participate in the development of a Smart City by supporting the ICT aspects of this endeavor.

5. Energy solutions

Finally, we will discuss the energy solutions on which the infrastructure of Smart Cities will be based. On the demand side, in order to work on energy savings for consumers such as businesses and homes where energy supply issues are brought to the surface by the occurrence of natural disasters, substantial expansion has been achieved by the introduction of building energy management systems (BEMSs) and

home energy management systems (HEMSs) for controlling and visualizing power use. In addition, when shortages in electrical power lead to an increase in the number of electricity suppliers due to the expansion of renewable energy, there will be a need for supply and demand optimization simulation mechanisms to strike a balance between the electricity supply and demand and for energy operation systems to control the supply of electricity in local distribution areas. These systems will be made more complex by the systematic reforms of processes such as power retailing and the separation of electricity generation and electricity transmission, which are currently being discussed.

To organize these energy solutions, Fujitsu is accelerating its efforts to provide energy management systems that can be used efficiently and stably (**Figure 4**).

5.1 Supply-side solutions

Supply-side solutions consist of solutions that support smart meter networks on the supply side, supply-and-demand optimization in the power distribution area, and solutions for the monitoring of systems and power outages.

The introduction of smart meters to measure and collect energy data in real time on the demand side is currently progressing throughout Japan. Fujitsu is providing power companies in Japan and overseas with management solutions and wireless communication networks that can support large-scale networks for the collection of data from smart meters installed in each home and business. The advantage of this technology lies in its ability to automatically form large-scale networks through ad hoc routing protocols (with 1000 smart meters autonomously forming connections to a single base station). This enables a stable network with autonomous self-healing capabilities to be configured at lower cost. The middleware management system collects and monitors smart meter data and has been operating continuously for ten years. Kansai Electric Power Co., Inc. is deploying commercial services based on the use of this communication technology.

In Japan, where there are few energy resources, cluster/community energy management systems (CEMSs) support the introduction of renewable energy such as solar and wind power from local areas and local businesses. An optimal balance between supply and demand is achieved by using power generation
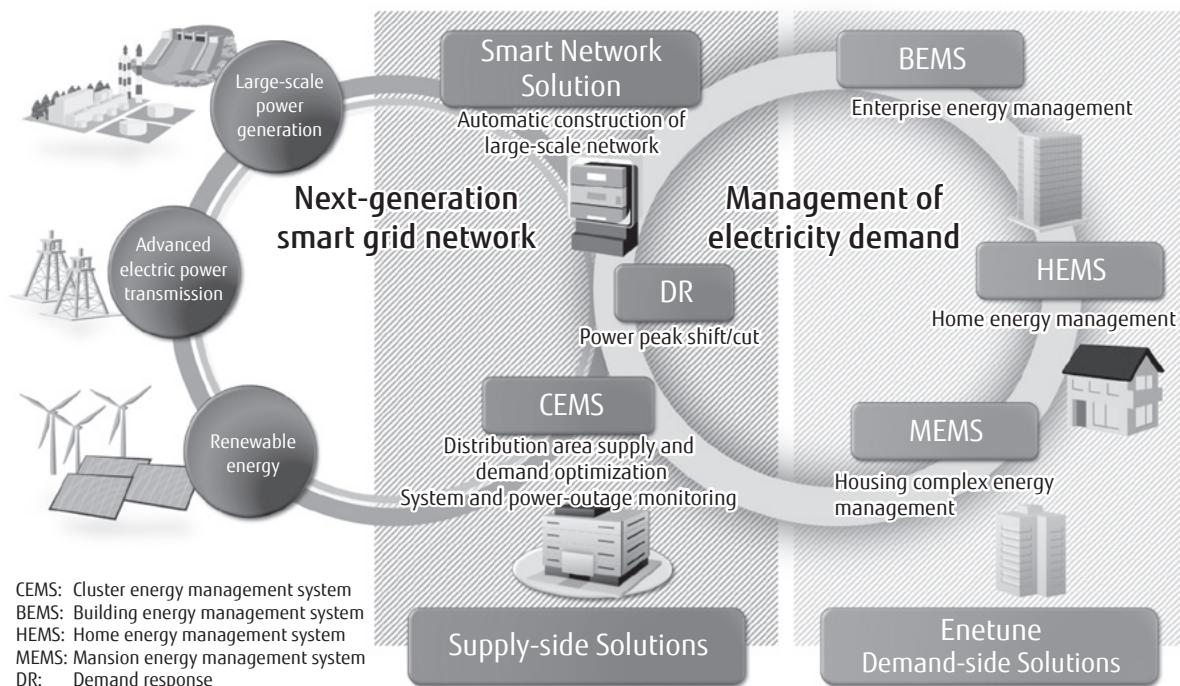

Figure 4
Efficient use of energy.

information from the supply side and predicted demand from consumers in the region. ICT will be used to reduce supply and demand by supporting the promotion of energy savings through visualization, recommendations, and demand response.

5.2 Demand-side solutions—Enetune cloud-based energy management system

The Enetune system comprises a range of solutions that support energy savings and the efficient use of energy.

In June 2012, to promote the use of ICT for energy-saving and energy-reduction measures in the BEMS aggregator of the METI, we started providing FUJITSU Intelligent Society Solution Enetune-BEMS as an energy solution for our business customers in Japan. The use of a cloud-based system makes it possible to visualize combined and cross-sectional energy information at multiple locations, to suppress peak power demand, and to reduce costs using control and demand management functions for overall optimization.

On the basis of our proven track record with the HEMS, we developed the Enetune-Home residential cloud-based smart house service, and in August 2013 we began offering a service model centered on an electric power visualization function. The advantage of this service is that it uses the Internet to provide a visual indication of energy usage without the need for a dedicated terminal.

In the future, to build on this Enetune-Home platform, we will create many smart house services that provide new value by using Fujitsu's rich cloud solutions together with service models that are useful for the local area and local residents through collaboration with local businesses and authorities. In this way, we will use ICT to produce smart houses that offer their residents a better quality of life.

6. Conclusion

Fujitsu is using ICT to support and guide society from behind the scenes. Towards the realization of Smart Cities, we will use ICT to help resolve social issues and to promote the creation of new value in local areas.

To realize Fujitsu's vision of achieving a rich society where people can live without fear, i.e., a Human Centric Intelligent Society, we will continue to contribute to the development of local communities.

Hisatsugu Tamai
Fujitsu Ltd.
Mr. Tamai is engaged in the promotion of business in Smart Cities.