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“Reconstruction” Leads to the Creation of “Urban Systems”

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The Great East Japan Earthquake has caused the country to refocus attention on its cities and regions. Given that the victims of the earthquake are still suffering, the country must deal with the immediate practical problems of restarting everyday life and preserving livelihoods. While so doing, the country must also proceed with a comprehensive and systematic program from a medium- to long-term perspective to facilitate the structural transformation of regional industries.

This program involves creating new "urban systems" where physical locations and software solutions are organically interrelated by rebuilding physical spaces as locations suitable for the region's lifestyle and economic activities and providing new schemes and services in such locations.

In order to build these new urban systems, it will be necessary to redesign and reconnect various service chains that are in place in cities and regions. The technology that is gaining attention as a means of enabling these new schemes and services is information and communications technology (ICT).

Here, it is important to note that the realities of the region's society and urban development should not be overlooked. To incorporate these realities into new schemes and services, the fusion of ICT and cities is required. Specifically, the characteristics derived from geographical spatial structures, such as economies of density and the sharing and optimal use of resources based on zone structure, must be fully incorporated in the systems to be created by using ICT.

In order for post-earthquake reconstruction efforts not to end up simply as a short-lived trend, a change of business models is necessary on the part of the ICT industry to enable handling fields that are characterized by small scale and diversity, which is inherent in urban development. Actually, in the earthquake-affected areas, a new business model known as the "SaaS aggregator" has been appearing as part of the process of recovering a company's business operations.

I Earthquake Shifts Focus Back to the Regions and Structural Issues

The Great East Japan Earthquake has caused the country to refocus attention on its cities and regions. Given the reaction to the bubble economy, as well as the globalization and informatization of the economy, it is fair to say that the issues of urban development and the problems faced by the regions had faded in terms of their relative importance. However, we witnessed an unfathomable extent of impact when the lifestyles and economic activities of regional societies were completely destroyed by the Great East Japan Earthquake. As a result, all attention refocused on the regions. Furthermore, although Tohoku's production contributes only a few percent to the country's GDP (gross domestic product), the loss of the region's production became a bottleneck to various industries throughout the entire Japanese economy, leading to the re-recognition of the significant presence of Tohoku.

In addition, the Great East Japan Earthquake, in an instant, brought to light structural issues that otherwise might have emerged gradually over time. In other words, the earthquake threw a light on the structural issues related to the regional economy and social systems not only in the quake-hit Tohoku region, but also in the country as a whole. With our attention drawn back to the region, we first and foremost notice a structural deterioration in regional industry and economy, as well as the fact of being unable to sucessfully constitute a major part of the global network.

Table 1 includes an excerpt from the Declaration of Support for the Reconstruction of Miyagi, as put forward by the Miyagi Earthquake Reconstruction Conference (chaired by Hiroshi Komiyama). The need to address the above-mentioned structural issues can also be seen among reconstruction plans prepared by affected municipalities.

II Barriers to Overcome

Unfortunately, before any of these structural issues can be addressed, the reality is that we have to push ahead with reconstruction in those areas that present a "here and now" obstacle to progress, in that they are still suffering from the damage caused by the earthquake.

The lesson that we can look to is that learned from experience in the Great Hanshin Earthquake, which occurred in 1995 (Table 2). Both Hyogo Prefecture and the City of Kobe conducted detailed follow-up studies of the recovery processes from the damage inflicted by this earthquake. Among the findings of these studies, the author would like to discuss four obstacles that must be overcome in the reconstruction of the Tohoku region.

The first of such serious obstacles is that standing in the way of the reconstruction of places for people to

Table 1. Structural issues as identified in the efforts to recover from the Great East Japan Earthquake

Changes that otherwise might have occurred gradually over time were brought to light in an instant ⇒ These changes also constitute present structural issues affecting the entire country	Declaration of support for the reconstruction of Miyagi (excerpt)
1. Attention drawn back to cities and regions • "Ties between people" • Outburst of the deep psyche held among people in an inapparent manner	• Creating communities through integrating welfare and nursing care services and urban development, by means of effectively utilizing shared living space as common property (commons) and based on a historically fostered culture of disaster preparedness and earthquake disaster experience • Creating society made up of communities that were based on "ties between people," which was built on the cultural and spiritual climate of Miyagi. In these communities, people can enjoy spiritual happiness and safe and secure living
2. Bottlenecks in cooperative networks that became apparent in various industries • Autonomous infrastructure management by developing compact cities • Developing infrastructure that ensures safety, reliability and improved productivity (preventing migration of people and hollowing-out of industry)	• Creating a society where an advanced ecology industry such as renewable energy drives the regional economy
3. Structural deterioration in regional industry and economy • Changing the social structure to make it suitable for a decreasing population • Fully improving efficiency through selective reconstruction and concentrating management resources on selected areas	• Creating a lively and vigorous society where people are provided with sufficient employment opportunities and in which young people can thrive • Creating an autonomous region where the development of ecological cities gives rise to new demand, and where leading-edge industries that can meet such demand are clustered
4. Unable to sucessfully constitute a major part of the global network • "Autonomous reconstruction" within supply chains • Forming regional industry clusters (concentration and enhancement)	• Strengthening ties with other countries as part of reconstruction efforts and creating a society that develops in parallel with evolving Asian dynamism and trends toward globalization

Table 2. Lessons learned from reconstruction after the Great Hanshin Earthquake, which reveal the issues we face "here and now"

Lessons for reconstruction		Situations experienced after the Great Hanshin Earthquake	
Places for living	Early start up of urban development with the participation of victims	• Evacuation of victims to various places • Conflicts of victims' interests	• Urban development under the condition in which residents were evacuated to various places caused opposition and confusion • Difficulties in coordinating residents' interests even for urban development that was led by residents
	Formulating and implementing a comprehensive plan	• Difficulties in securing appropriate places • Difficulties in supplying houses in a collective manner	• Difficulties in matching the needs of residents in a finely tailored manner • Difficulties in making appropriate prospects for the supply of houses; the resulting excess supply left a source of problems in the future
Regional strengths	Boosting the economic strength of victims	• Financial difficulties faced by victims	• Even after a new city plan was formulated, residents' economic situations caused delays in community reconstruction
	Promptly taking measures to stop the migration of people and encourage them to stay	• Delay in restoring the population to what it was before the earthquake	• Lower population after the earthquake shrunk the local commercial zone
	Relief of local industries to which priority is given	• Difficulties in quick relief • Difficulties in selection and concentration	• The issue of "relief/lifesaving" of small- and medium-sized companies remained unsolved • It was difficult to implement the structural transformation of existing industries and to give priorities to support strategic industries
	Establishing a source for a unifying force covering the entire area	• Loss of a source of unifying force	• The earthquake weakened the unifying force covering the whole area
	Local reconstruction power	• Lack of economic power in local areas	• Demand for reconstruction did not contribute to a business cycle favorable to local areas
Funding	Injection of private-sector funds	• It was estimated that 70 percent of funds for reconstruction came from the private sector	• Public-private reconstruction projects were established with the initiative taken by the private sector • Government support functioned as "gap finance" to encourage funding from the private sector
	Flexible reconstruction finance	• Many restrictions stalled quick decision making	• Reconstruction funds were used to enable the flexibility that government measures lacked

live. To address the needs of the people who lost their homes in the disaster, group relocation and the construction of public housing are planned. However, given that each victim faces his or her own particular circum-stances, it is not always easy to rebuild homes in a way that suits everyone. In addition, because the reconstruction of infrastructure such as roads, railways and levees, as well as the clearing of wreckage, must go on in tandem with the construction of homes, shortages of materials and construction crews mean that home rebuilding is subject to delays and rising costs, which slows the reconstruction efforts.

The second obstacle is that impeding the restoration of the economic strength inherent in the region. Subsequent to the Great East Japan Earthquake, the major obstacle that has been holding back the recovery of the economy has been the complete loss of offices and workplaces. Therefore, how to give employment and livelihoods back to the disaster victims, thereby underpinning the region's economic strength, is a major issue to be dealt with. Furthermore, those people who had been doing business in the region have seen their markets uprooted by the disaster, making it even more difficult to overcome the economic issues. Any delay in the reconstruction of housing will cause the population to be slow to recover, thus compounding the problem.

Coupled with the above issues, the third barrier that is faced is the loss of a kind of unifying force in the region. Tohoku is one of the largest fishery centers in Japan. However, the significance of this wide-area fishery center could be lost to other regions if reconstruction is delayed. If the reconstruction of affected companies were significantly delayed and the advantages of comprehensive fishery centers that have been built up over the years, in which all related facilities are clustered, were compromised, it would become impossible to prevent industries, including manufacturing, from moving out of the region.

The fourth barrier is that which disrupts the smooth flow of reconstruction funds. According to the report of Hyogo's Ten-Year Reconstruction Committee concerning reconstruction funds, which was published in March 2005, 70 percent of the funds spent for reconstruction after the Great Hanshin Earthquake came from the private sector. As such, to promote investment in reconstruction by the private sector, an environment must be established that encourages investment in projects related to reconstruction. However, as described above, those situations where local companies alone are unable

to provide necessary reconstruction funds and where material and labor costs are soaring act as major deterrents to the inflow of private-sector funds from outside the region.

III Need for "Urban Systems" in Efforts towards Reconstruction (Rebuilding Places and Schemes in an Integrated Manner)

While taking on the above-mentioned issue of "here and now," a forward-looking approach must be adopted to deal with the structural issues within the region. To do so, merely addressing individual problems will not suffice. In fact, efforts are being made to launch many reconstruction programs (Table 3). However, before moving forward with these programs, focused efforts must first be put into restarting people's day-to-day lives and livelihoods. In doing so, efforts should also be made to devise and implement a comprehensive and systematic program from a mid- to long-term perspective in order to address the resolution of structural issues facing regional industries so that Tohoku's industries can be part of a larger network. These efforts should be undertaken while ensuring profitability to attract investment from the private sector.

The term "reconstruction" inevitably conjures up images of physical plans and solutions such as land use and facility construction. However, in the wake of the Great East Japan Earthquake, the range of concerned issues is very wide and complex, making it difficult to limit attention to only physical issues. Rather, all of the reconstruction programs are required not only to restore the physical locations where people live and earn their livelihoods, but also to provide schemes and services (non-physical plans and solutions). In other words, "urban systems" should be newly created where physical facilities (hardware) and schemes (software) are organically interrelated.

However, the urban engineering that forms the background of the engineering aspect of urban development is essentially related to the area of physical planning and is not intended to provide systematic engineering solutions for non-physical systems. On the other hand, politics, economics and society, which form the background of the non-physical aspects of a city, constitute research themes under the umbrella term of social science. Even so, social science does not necessarily provide the engineering aspects needed to construct specific systems in cities and regions.

Therefore, information and communications technology (ICT) is attracting attention as a means of redesigning and reconnecting various service chains in cities and regions to enable new schemes and services.

Behind this recognition of ICT is the fact that the technological infrastructures and environments needed to enable the handling of the vast amounts of information used in cities have finally spread to a stage where the use of ICT is commonplace. Specifically, according to Japan's Ministry of Internal Affairs and Communications, at the end of March 2011, the proportion of households in Japan that have access to broadband

Table 3. Reconstruction programs after the Great East Japan Earthquake

"Here and now" barriers	Structural issues from a mid- to long-term perspective	Shifting focus back to cities and regions	Structural deterioration of regional economy	Bottlenecks in cooperative networks became apparent	Unable to sucessfully constitute a major part of the global network
Places for living	• Early start-up of urban development with the participation of victims • Formulating and implementing a comprehensive plan	• Group relocation • Public restoration housing	• Compact city	**Regeneration of "urban systems" that integrate places and schemes**	
Regional strengths	• Boosting the economic strength of victims • Promptly taking measures to stop the migration of people and encourage them to stay		• Medical and welfare service network • Cloud computing for small- and medium-sized companies	• Smart grid	
	• Relief of local industries to which priority is given			• Promoting the renewable energy industry	
	• Establishing a source for a unifying force covering the wide area		• Business diversification		
	• Local reconstruction power			• Efficient supply chain	
Funding	• Injection of private-sector funds • Flexible reconstruction finance			• Advanced utilization of airports • Encouraging export industries (automobiles, electronics, etc.) to establish centers in the region	

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services (the household coverage of service areas) reached 100 percent. Technologies involved in these services include wired technologies such as fiber to the home (FTTH), digital subscriber line (DSL) and cable Internet, as well as wireless technologies such as 3.5G mobile phone networks, worldwide interoperability for microwave access (WiMAX) and fixed wireless access (FWA).

Because the development of such ICT infrastructure led to the spread of mobile terminals and various sensors, it has become possible to digitize many activities within a city at low cost. Furthermore, with the transition to Internet Protocol Version 6 (IPv6), the large amounts of data that are called "big data" can now be individually identified and used. Cloud computing can provide a platform to manage and use such big data. By being subjected to advanced mathematical analysis, the data produced as a result of activities in the cities and regions can now be put to a wide range of uses.

So, in specific terms, what kinds of urban systems are required? This paper discusses the basic issues facing urban development in the future including the reconstruction after the Great East Japan Earthquake, and presents four ICT-based urban systems that offer solutions to these issues. These are:

(1) Urban systems that ensure safety and security in residential areas and that regenerate community functions (neighborhoods)
(2) Urban systems that improve the efficiency of public services and that revitalize city centers (civic centers)
(3) Urban systems that strengthen the competitiveness of regional industries and that enable them to add more value to their products (industrial areas)
(4) Urban systems that optimize operation and maintenance of urban infrastructure

(1) Urban systems that ensure safety and security in residential areas and that regenerate community functions (neighborhoods)

The issues facing "neighborhoods," which are the places for living, relate to ensuring safety and security in residential areas and regenerating community functions. The issues also involve how best to provide an environment for living that is tailored to the declining and aging population.

To address these issues, in addition to the redevelopment of urban areas through land rezoning and readjustment, the use and renovation of housing stock resulting from the aging population is unavoidable. In order to make these physical solutions effective, it would be essential to create non-physical plans and solutions (schemes and services) that directly touch on daily life, which include ensuring the safety of roads leading to schools, providing support for disadvantaged people, providing a welfare service system and a medical service system. Typical of such services are a monitoring system for elderly people and telemedicine. Because it is necessary to create specific schemes that go beyond organizational boundaries such as for networking support staff and experts and enabling hospitals and clinics to cooperate, many expectations are placed on ICT's networking functions for fulfilling these aspects (Table 4).

Table 4. Urban systems in neighborhoods and the use of ICT

Area	Issues	Urban systems					
		Physical plans/solutions (land use, facilities)	Non-physical plans/solutions (schemes, services)	ICT			
				Application	Service chain	Data object	Remarks
Residential area	• Ensuring safety and security in neighborhoods • Providing environment for living that is tailored to the trend toward an aging population and fewer children • Regenerating community functions in neighborhoods	• Redevelopment of urban areas • Use and renovation of housing stock • Development of common spaces and community facilities • Community-wide relocation	• Support for disadvantaged shoppers	Shopping and delivery services for elderly people living alone	B2C	IOP	• SNS • Matching
			• Crime prevention such as ensuring safety of roads leading to schools	Monitoring children's locations	M2P	IOT	• GPS
							• Web cameras, sensors
			• New welfare services by networking support staff and experts	Welfare services for and the monitoring of elderly people living alone	M2P	IOT	• SNS • Matching
Community center				Support services for child raising and nursing care	C2C	IOP	
			• Establishing a scheme enabling core hospitals and community clinics to cooperate	Telemedicine, service provided through tie-up between medical care and nursing care	B2B	IOP	• Data sharing • Video distribution

Notes: 1) Underlined plans/solutions are those to which special attention is given in post-earthquake urban development efforts. 2) B2B = business to business, B2C = business to consumer, C2C = consumer to consumer, GPS = global positioning system, IOP = Internet of person, IOT = Internet of things, M2P = machine to person, SNS = social networking service.

(2) Urban systems that improve the efficiency of public services and that revitalize city centers (civic centers)

Turning our eyes to civic centers, we find issues related to public services and those concerning commercial functions in the region. Among these issues, those involving public services include efficiently providing medical services for which demand has been increasing due to the aging of the population, offering new educational services in schools and libraries and upgrading methods of participation by residents in government services. The issues facing the commercial functions that mostly consist of the activities of companies in the private sector include the revitalization of city centers and shopping areas.

To address these issues, there will be a need to develop advanced medical facilities such as medical centers, information-providing facilities in educational institutions and government organizations and attractive commercial spaces and tourist spots. It will also be essential to create new schemes such as those needed to enable hospitals and clinics to cooperate, those for using information and learning at home and those enabling residents to send information. The creation of systems supporting new retail services for both residents and visitors and those establishing new

Table 5. Urban systems in civic centers and the use of ICT

		Urban systems					
		Physical plans/solutions (land use, facilities)	Non-physical plans/solutions (schemes, services)	ICT			
	Issues			Application	Service chain	Data object	Remarks
Civil services	• Improving efficiency of medical services to meet increasing demand (medical institutions)	• Developing advanced medical facilities such as medical centers	• Establishing a scheme enabling core hospitals and community clinics to cooperate and enabling collaboration between doctors and other medical personnel	Telemedicine, service provided through tie-ups between medical care and nursing care	B2B	IOP	• Database • Data sharing • Video distribution
				Management of individuals' health data and medical history	B2C		
	• Educational services meeting the need of the information age (schools, libraries)	• Developing facilities enabling the offering of new educational and library services	• Enabling the use of content in various formats • Enabling learning at home	Electronic textbooks, electronic library	B2C	IOP	• Digital archive
	• Diversifying ways of public relations and public hearings such as interactive communications and individualized responses	• Installing facilities for providing information	• Delivering a wide variety of information content • Enabling citizens to send information	Civil service promotion	B2C	IOP	• SNS • White space
				Consumer-generated media (CGM) services	C2C	IOP	
Commercial functions	• Revitalizing city centers and shopping areas	• Developing attractive commercial spaces and tourist spots	• Targeting as customers both current neighbors and people who were previously neighbors but were evacuated and now live far away • Developing new retail services by networking commercial facilities and homes • Marketing approaches that encourage visits from outside the region • Establishing sales channels for specialty products, etc.	Shopping and delivery services for elderly people living alone	B2C	IOP	• SNS • Matching
				On-demand stocking and sales			• Sensing • EC (electronic commerce)
				Attracting customers through special events, video distribution	B2C	IOP	• Event programs • White space
				Branding and packaging of local specialty products	B2B	IOP	• EC
				Establishing a supply chain consisting of local companies	B2B	IOP	• SNS • EC
			• Advanced building/facility management	Remote monitoring of buildings and parking lots	M2M	IOT	• Sensors

Notes: 1) Underlined plans/solutions are those to which special attention is given in post-earthquake urban development efforts. 2) M2M = machine to machine.

sales channels for specialty products is also necessary.

In creating these schemes that are directly related to government organizations and business activities, an expectation is placed on the use of ICT's networking functions that enable collaboration with residents or consumers, such as on-demand services (Table 5).

(3) Urban systems that strengthen the competitiveness of regional industries and enable them to add more value to their products (industrial areas)

The challenges facing industrial areas, where manufacturing, agriculture and fisheries industries that drive the regional economy are located, include increasing added value that industries located within the region can bring to the region and establishing low-cost production and sales chains that are capable of taking on international competition.

Solutions to deal with these issues include the development of regional industrial clusters that have unique features, establishment of hubs for production facilities (referring to farming land in the case of agriculture and fishing ports in the case of fisheries), and development of value-adding facilities such as those for processing and distribution. Together with the development of these physical facilities, non-physical solutions (schemes and services) form urban systems that can deal with the pending issues. These schemes and services include establishing cooperative relationships with local companies, developing advanced production management and business operation systems for local companies and building a region-wide supply chain (Table 6).

To successfully develop and implement these schemes, which are directly related to industries, information must be shared among all companies involved. Here again, ICT, including cloud computing, is expected to play a significant role.

(4) Urban systems that optimize operation and maintenance of urban infrastructure

Supporting these various urban functions is urban infrastructure, which includes transportation, power, water

Table 6. Urban systems in industrial areas and the use of ICT

		Urban systems					
				ICT			
	Issues	Physical plans/solutions (land use, facilities)	Non-physical plans/solutions (schemes, services)	Application	Service chain	Data object	Remarks
Manufacturing	• Creating added value to the products of regional industries	• Regional industrial clusters having unique features	• Establishing a service chain that offers increased added value through collaboration among a variety of local entities (manufacturers, designers, those specializing in processing, sales, etc.)	Portal site and supply chain consisting of related local companies	B2B	IOP	• SNS • EC
			• Enhancing business operations of small- and medium-sized local companies	Cloud computing for business operations of small- and medium-sized companies	B2B	IOP	• Cloud • SaaS
	• Introducing a low-cost production and distribution system within the region to enhance international competitiveness	• Parts/components and assembly clusters	• Establishing an efficient supply chain within the region	Regional supply chain	B2B	IOP	• RFID
Agriculture and fisheries	• Increasing the productivity and added value of primary industries	• Agricultural intensification • Developing processing and distribution facilities	• Improving the efficiency of production process management • Production and shipment based on sales results	Production of high value-added agricultural products	M2M	IOT	• Sensing • Traceability
		• Integrating fishing port facilities and processing and distribution facilities	• Developing a scheme that enables resource management in accordance with market needs	Marketing high value-added agricultural, forestry and fishery products	B2B	IOP	• EC

Notes: 1) Underlined plans/solutions are those to which special attention is given in post-earthquake urban development efforts. 2) RFID = radio frequency identification, SaaS = software as a service.

supply and sewerage systems. In a broad sense, urban infrastructure includes regional commons such as safety, security and the natural environment in addition to the above-mentioned public utilities. The issues facing such urban infrastructure include reducing the operation and maintenance cost of infrastructure such as roads, optimizing transportation systems, ensuring energy supplies to support living and industry, reducing CO_2 emissions and preparing for disasters.

As solutions to these issues, it becomes necessary to develop a new transport system, redevelop traffic nodes, conduct maintenance to prolong the usable life of

Table 7. Urban systems in urban infrastructure and the use of ICT: (1) Public utilities

		Urban systems					
		Physical plans/solutions (land use, facilities)	Non-physical plans/solutions (schemes, services)	ICT			
	Issues			Application	Service chain	Data object	Remarks
Transportation	• Providing an optimal urban multi-mode transportation system	• Developing new transportation systems such as LRT, ITS and EV • Redeveloping traffic nodes such as stations and airports	• New transport services such as car sharing and car navigation • Transportation management based on demand • Information services at traffic nodes such as stations and airports • EV charging service	Navigation of public transportation facilities	M2M	IOT	• GPS • Probe navigation
				Joint use such as car sharing and bicycle rental	M2M	IOT	• IC card
	• Reducing the operation and maintenance cost of roads, etc.	• Repairs, maintenance work	• Optimizing operation and maintenance by examining the current situation (snow removal, etc.)	Monitoring road facilities, buildings and parking lots; monitoring the operation of construction machinery	M2M	IOT	• Sensing
Power, gas, water and sewerage	• Autonomous energy management so as to prevent bottlenecks in life and industry	• Developing cogeneration plants • Installing renewable energy equipment such as solar panels	• Region-wide energy supply-demand management	CEMS, BEMS, FEMS	M2M	IOT	• Smart grid

Notes: 1) Underlined plans/solutions are those to which special attention is given in post-earthquake urban development efforts. 2) BEMS = building energy management system, CEMS = community energy management system, EV = electric vehicle, FEMS = factory energy management system, ITS = intelligent transport system, LRT = light rail transit.

Table 8. Urban systems in urban infrastructure and the use of ICT: (2) Commons

		Urban systems					
		Physical plans/solutions (land use, facilities)	Non-physical plans/solutions (schemes, services)	ICT			
	Issues			Application	Service chain	Data object	Remarks
Natural environment	• Environmental conservation such as for green belts, rivers and coasts • Countermeasures for climate change such as reducing CO_2 (carbon dioxide) emissions	• Imposing use regulations and developing environmentally friendly facilities	• Environmental conservation through the participation of households and businesses	Programs such as eco-points, carbon offset, funds and volunteers	C2C	IOP	• Database
Safety and security	• Using a combination of hardware and software to establish measures to prepare for disasters and for evacuation	• Raising the level of banks and land, determining evacuation routes and evacuation centers	• Providing appropriate information to people who must evacuate if a disaster occurs	Ensuring availability of a means of communication in a disaster such as conventional media and SNS	C2C	IOP	• White space
				Monitoring for crime prevention and disaster reduction	M2M	IOT	• Web cameras • GIS

Notes: 1) Underlined plans/solutions are those to which special attention is given in post-earthquake urban development efforts. 2) GIS = geographic information system.

infrastructure such as roads, develop renewable energy power generation facilities, and to make buildings earthquake resistant. In addition to these hardware measures, non-physical solutions (schemes and services) include new transport services such as car sharing, transport management based on demand, optimal management of operation and maintenance of facilities, energy supply-demand management within a region and providing information on disaster preparedness. A combination of these physical and non-physical solutions would form urban systems that can address the pending issues (Tables 7 and 8).

To successfully implement these solutions, which are directly related to urban facilities and infrastructure management, a wide variety of information that is generated by activities within a city must be provided as feedback to these solutions, which includes data collected from sensors installed in various facilities and data on the actual use of transport facilities. Here, again, how best to use ICT is a major point in question.

IV Urban Systems Comprised of Service Chains (Fusion of Information and Communications Technology and Cities)

In this way, the role played by ICT is important for the creation of schemes and services that constitute urban systems. Looking at a ground-breaking case (the Regional ICT Utilization Model Construction Project, established by Japan's Ministry of Internal Affairs and Communications), we find that the utilization of ICT for the creation of schemes and services that constitute urban systems can be broadly classified into three patterns depending on the type of data being used (IOP or IOT) as well as on the characteristics of service chains that are configured by using ICT (B2B, B2C, C2C, etc.). ICT use can also be divided into five sub-patterns (Table 9).

The first pattern is intended to create service chains that go beyond the existing organizational boundaries of government bodies and businesses. Furthermore, this pattern can further be subdivided into the "creation of new industries" through collaboration among government and business organizations by going beyond the existing boundaries and the "creation of new services" through collaboration between organizations and individuals.

The second pattern is designed to provide service chains that enable new urban management through mutual support and self-help efforts with the participation of residents. In other words, this pattern uses ICT to form a "social community" that facilitates collaboration among individuals.

The third pattern aims to provide service chains for new urban infrastructure management. This pattern can be subdivided into "urban facility sensing" whereby information at fixed points is gathered by sensors and managed in a time series, and "user information feedback" where information on the users of a facility is fed back.

Another point that the author would like to stress in Table 9 is that such service chains have a relationship neither too close to nor too remote from the spatial structure of a city. "User information feedback" and "urban facility sensing" services gather information about users' activities and the status of facilities throughout a region. With respect to other patterns and sub-patterns, however, specific service chains will be established within specific areas in a region based on their respective characteristics. For the "creation of new industries" service chain, corporate networks are required in civic centers and industrial areas. The "creation of new services" service chain requires networking government bodies, businesses and citizens in civic centers, communities and residential areas. The "social community" service chain requires networking citizens in residential areas.

In other words, the schemes and services of urban systems grow naturally according to the geographic spatial structure of a city.

V Design of the Spatial Structure that Forms the Foundation of Urban Systems (Compact City)

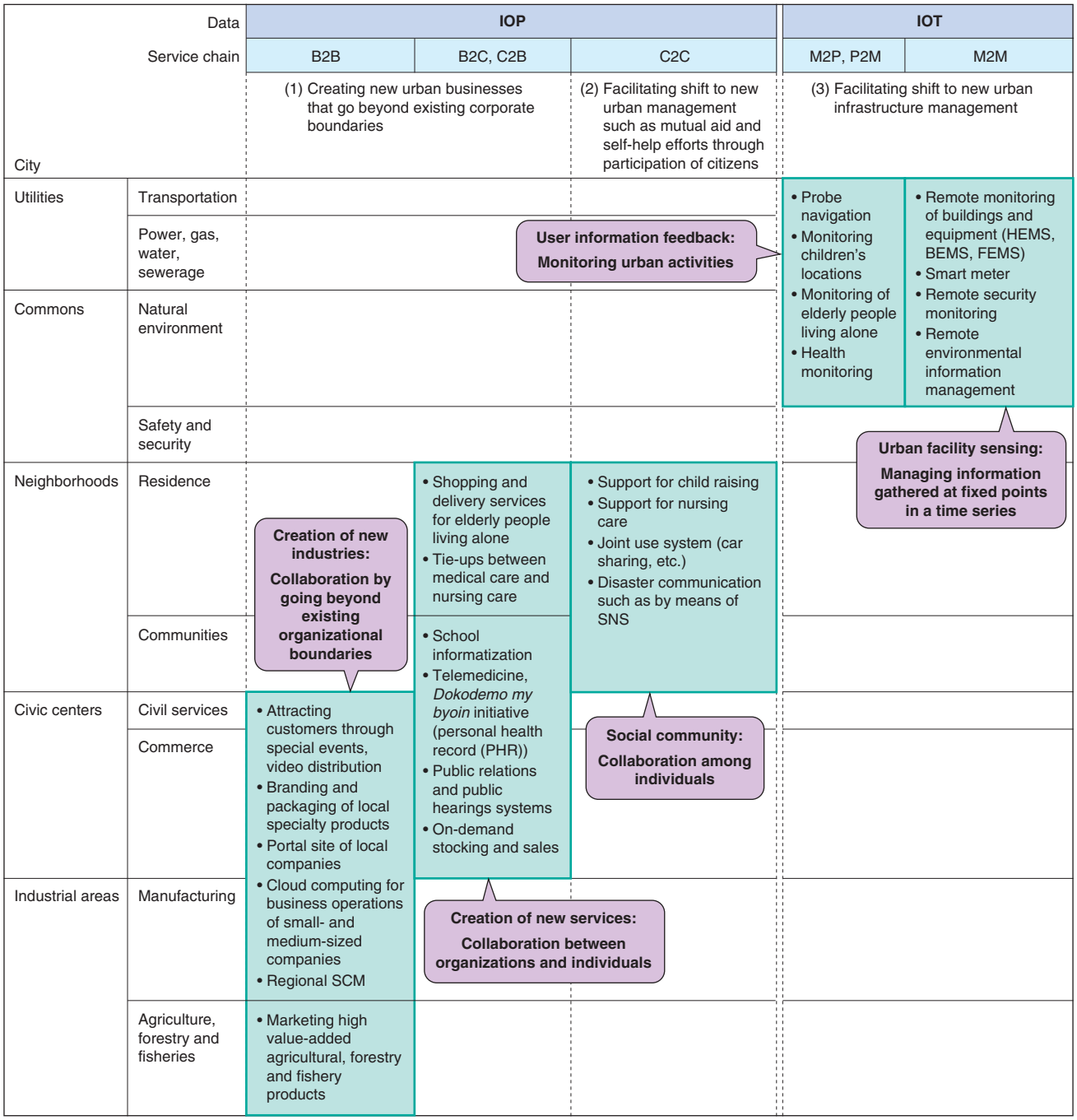
1 "Spatial structure" facilitates the economies of density and optimization of resource use

What is the point of incorporating the geographical spatial structure into the schemes and services of urban systems? By looking at the geographical spatial structure from two angles, namely, "spatial uniformity" and "how spaces are connected," the following two meanings emerge.

(1) "Uniform region" structure exhibits the economies of density

The viewpoint of giving attention to spatial uniformity involves that activities for specific purposes are clustered with a density of a certain level, thus creating an area that is different in nature from that of its surroundings. Such regional spaces are referred to as "uniform regions" or "formal regions." These uniform regions are home to dedicated functions such as residential, commercial or industrial areas, and exhibit certain economies of density.

Table 9. Classification of ICT services in urban development



Notes: C2B = consumer to business, HEMS = home energy management system, P2M = person to machine, SCM = supply chain management.

(2) "Nodal region" structure encourages sharing and optimal use of resources

The perspective of focusing on how spaces are connected relates to that spaces are functionally linked together into "zones" based on certain standards. These regional spaces are referred to as "functional regions" or "nodal regions." Examples of these functional (nodal) regions include residential, commuting and medical care zones.

Taking medical care zones as an example, there are primary care zones where immediate medical care is provided within each municipality (city, town or village) and secondary care zones where medical care involving hospitalization (excluding specialized medical care, long-term care beds and medical care for beds other than general beds) is provided for multiple municipalities. As such, the roles of medical facilities are shared depending on geographical spaces. Such role sharing determines how medical equipment and personnel resources are allocated. Organizations and systems that manage zone functions facilitate the sharing and optimal use of resources.

The incorporation of geographical spatial structures into schemes and services means that the effectiveness of schemes and services as well as business feasibility

can be guaranteed through the economies of density that are inherent in the relevant spaces as well as by means of sharing and optimally using resources based on the zone structure. That is, such incorporation is nothing but explicitly reflecting these spatial elements in the configuration of urban systems.

Let me explain this concept with a specific example. A typical example of this concept can be found in the scheme involved in a convenience store. When talking about convenience stores, people generally think of the strategic use of ICT such as the highly advanced use of input and output data at stores and achieving high space efficiency based on the analysis of such data. Indeed, convenience stores are rare examples of cases in which ICT investment is directly linked to management performance. Nevertheless, the service chains of convenience stores are not attained by ICT alone.

Optimal ordering based on the efficient use of information can be achieved because a delivery network that is adapted to frequent needs is in place. This network consists of manufacturers, warehouses and retail outlets that are deployed in a suitable manner. In other words, a nodal region that can be referred to as a "frequent delivery zone" is created. In order to enable a frequent delivery zone to function properly at low cost, it was essential to determine uniform regions that could be referred to as "neighborhood retail areas" and open stores in such regions in a concentrated manner (strategic dominance), thereby increasing the density of stores. That is, by integrating such spatial factors and information systems, it has become possible to realize the scheme that we know as the convenience store. Furthermore, only when a scheme becomes the one that can fully utilize the economies of density derived from geographical spatial structures, is the convenience store feasible as a business model that generates profits. This is a specific example of incorporating geographical spatial structures into information systems (Table 10).

Similarly, for services such as security, energy and communications, it is possible to adopt a business model in which users are acquired under a collective agreement that covers each geographical area. Such a collective agreement will enable a company to provide repeated services and remote monitoring at low cost. Again, it can be said that this is a business model that incorporates the economies of density so that system efficiency is improved by increasing the density of services in a region.

Unfortunately, among the urban development projects that are planning to use ICT, the author found many having no insight on geographical spatial structures such as the economies of density. Indeed, according to the 2005 National Census, 66 percent of Japan's population lives in densely inhabited districts (DID) where the population density is at least 4,000 people per square kilometer. As such, any economies of density may have already been leveraged without being explicitly mentioned.

However, in the case of telemedicine systems in sparsely populated areas that lack the economies of density, the question is how business feasibility can be guaranteed without the economies of density. Moreover, in the case of regional energy management systems that intend to ensure the economies of density through concentrated use within each district, the question is whether it is actually possible to use the scheme of a collective agreement. Many projects are irresponsible in that they fail to consider this essential point in terms of their feasibility.

Although seemingly paradoxical, the essential point of urban development making full use of ICT does not lie in the details of information technology. Rather, it is how best to leverage these geographical spatial structures of cities and regions to ensure business feasibility.

2 "Compact city" as a design concept of geographical spatial structure

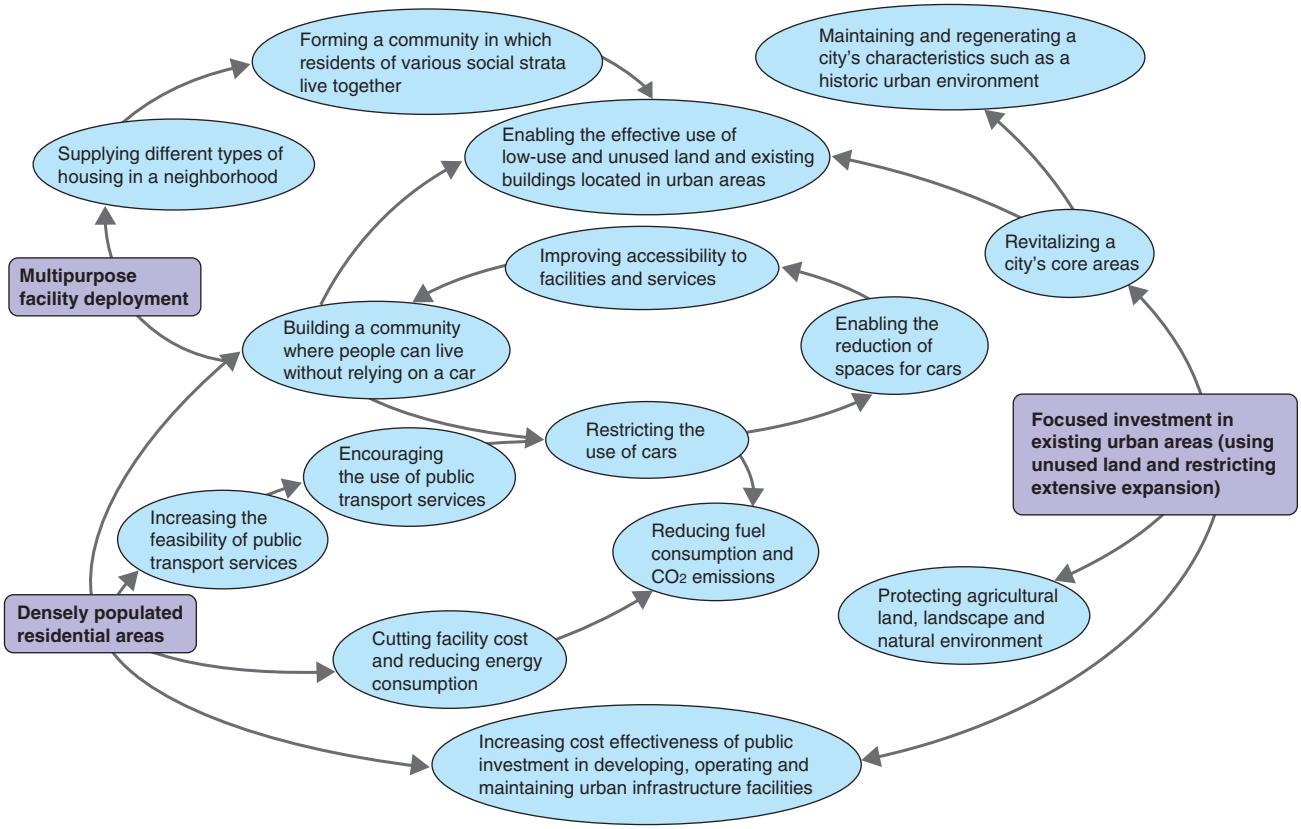
In order to make ICT-based urban development viable and effective, the design of the geographical spatial structure that enables economies of density and that allows sharing and optimal use of resources becomes important.

Attracting attention as such design concept is the idea of the "compact city" (Figure 1), which has been greatly discussed in the field of environmental protection. This concept is designed to create a city that draws on economies of density by increasing the density of population and buildings and facilitating mixed land use through making focused investment in existing urban areas and promoting use of unused space. In other words, by

Table 10. Information systems in which geographical spatial structures are incorporated (example of convenience stores)

IT (information technology)	Geographical spatial structures		
Information systems	Uniform regions (neighborhood retail zones)	Nodal regions (frequent delivery zones)	
	Density	Deployment	Nodes
• Advanced use of input and output data at stores • Ordering based on analyzed data	• Opening stores in certain regions in a concentrated manner (strategic dominance)	• Deployment of manufacturers, warehouses and retail outlets	• Joint deliveries • Frequent small-lot deliveries

Figure 1. Mechanisms of the compact city



Source: Compiled based on Kiyonobu Kaido, *Compact city—Jizoku kano na shakai no toshizo wo motomete* (Compact City—Pursuing a City Image in a Sustainable Society), Gakugei Shuppansha, 2001, and related publications.

increasing the density of population and buildings, it becomes possible to improve the economic efficiency of urban infrastructure development, operation and maintenance, increase the feasibility of public transport and civil services and reduce the energy cost for the entire region.

In addition, by encouraging mixed land use, it becomes possible to access a variety of facilities and services within a single neighborhood so that people can live in their city by walking around instead of driving a car. Moreover, by providing different types of housing, different generations, family structures and occupational structures will be able to come together to form a community. That is to say, the inhabitants can choose appropriate housing depending on their life stages. Enabling people to change their residence in accordance with their life stages will make the most effective use of the city's housing stock.

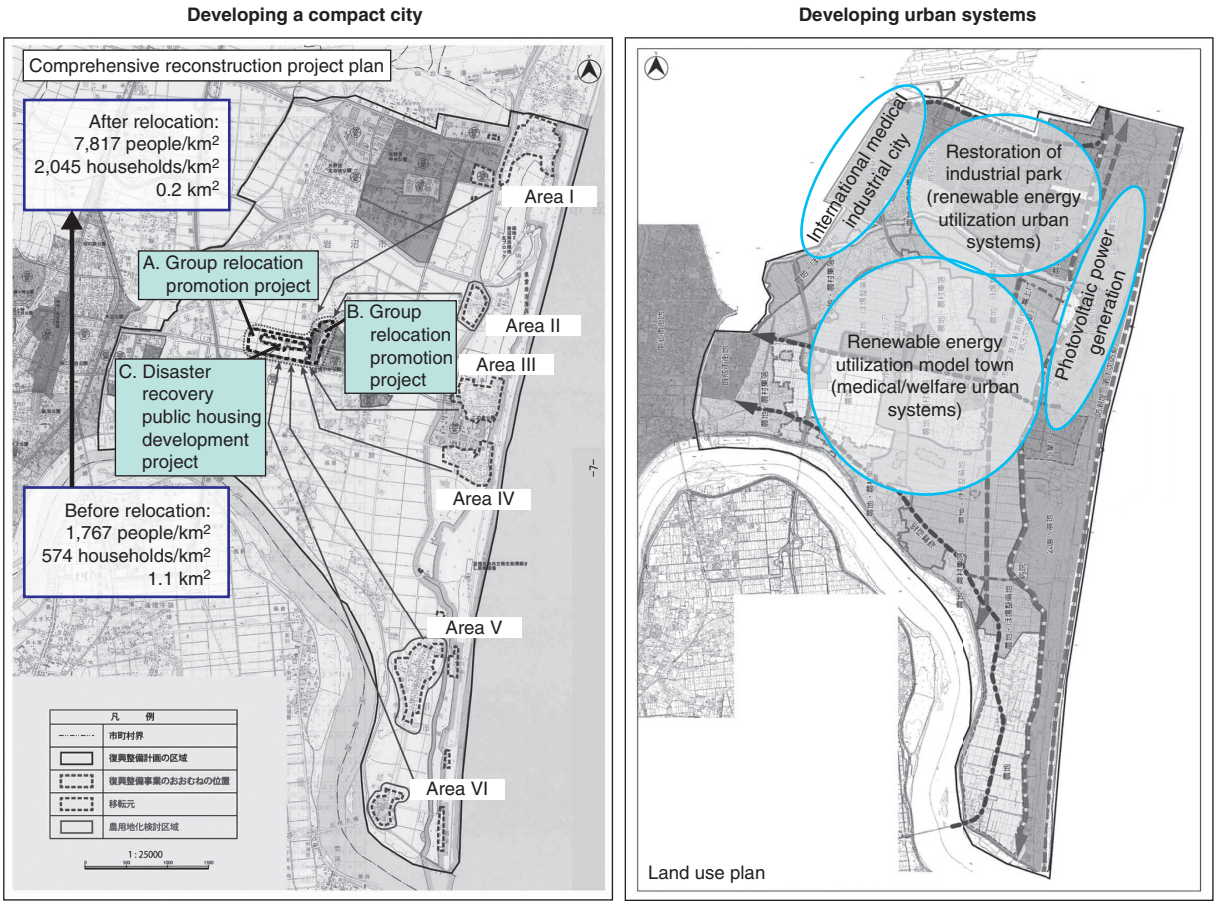
The reconstruction plan of Iwanuma City in Miyagi Prefecture adopted the creation of the compact city as one of its concepts. The plan calls for the relocation of all six coastal villages that were affected by the tsunami to existing inland residential areas. The average population density of the villages to be relocated is 1,767 people per square kilometer. After relocation, the population density is expected to increase to 7,817 per square kilometer, which is equivalent to that of densely populated areas (Figure 2).

According to the Study Report on Compact City Development published by Toyama City, on a per-capita basis, as the population density increases, the costs of maintaining and renewing urban facilities such as roads, parks and sewers fall, as do the per-household costs of providing repeated services such as garbage collection and regular nursing care visits. Applying these study results to the plan of Iwanuma reveals that the per-capita cost of maintaining and renewing urban facilities in a compact city would be reduced to one-third of that incurred by land use prior to the earthquake.

Iwanuma's post-earthquake reconstruction master plan, which assumes the creation of a compact city, aims to build an "international medical industrial city, which is in harmony with nature" and an "advanced model city utilizing renewable energy," which will be the leading projects. If we follow the context discussed thus far, we can say that these projects will contribute to reviving the livelihoods and industries of the region through developing urban systems such as "medical/welfare urban systems" and "renewable energy utilization urban systems" (Table 11).

For example, medical/welfare urban systems will facilitate the stabilization of the region's population and the revival of the local community by providing a living environment in which schemes that enable the sharing of the health information of residents who face the increasing trend toward aging are provided among

Figure 2. Actual status of a compact city envisioned in the post-earthquake reconstruction plan (Iwanuma City, Miyagi Prefecture)



Source: Compiled based on Iwanuma City's post-earthquake reconstruction master plan and its restoration plan.

Table 11. Urban systems to be developed as leading projects for the reconstruction of Iwanuma City

			Medical/welfare urban systems	Renewable energy utilization urban systems
Goals to be achieved through reconstruction efforts			Quickly restoring livelihoods according to needs and moving towards a regional structure that is suitable for an aging population	Preventing the hollowing out of industry, promoting autonomous regional economies and expanding job opportunities
Structure of urban systems	Land use and development of facilities		Developing a compact city (1): Developing residential areas where housing for elderly people and welfare facilities are included through group relocation and land readjustment	Developing a compact city (2): Reconstructing industrial parks by installing power generators using renewable energy
	Schemes and services		Establishing schemes that provide health care services to elderly people living in housing built for them and in welfare facilities. In the future, networking community clinics and comprehensive hospitals	Providing autonomous power supplies to companies located in the region and providing energy services to these companies including surrounding residential areas
		Use of ICT	Introducing cloud computing for medical records	Introducing energy management systems

Source: Compiled based on Iwanuma City's post-earthquake reconstruction master plan (September 2011) and related materials.

residences for use by elderly people, welfare facilities and community clinics/regional hospitals. To actually develop these systems, the use of ICT such as cloud computing for medical records is essential. In addition to such information services, compact spaces must be developed where residences for use by elderly people and medical and welfare facilities are constructed within a close range through group relocation and land readjustment in order to increase the feasibility of medical and welfare services such as face-to-face consultations and regular nursing care visits.

Similarly, renewable energy utilization urban systems aim to dispel the anxiety among companies about the supply of energy by introducing autonomous power supplies to industrial parks. By so doing, these systems will stimulate a renaissance by avoiding the hollowing out of industry, securing job opportunities and enhancing the vitality of local economies.

To this end, ICT-based energy management systems must be developed. However, for such systems to work in practice, energy must be used collectively within a region. As the prerequisite for such collective energy use, spatial issues must be addressed so as to enable integrated, compact land use.

In this way, by developing urban systems that consist of schemes and services based on ICT and geographical spatial structures known as the compact city, the reconstruction programs will become practicable and effective.

VI Business Models for Urban Systems (Creation of Business Ecosystems that Can Accommodate Regional Diversity)

As was mentioned in Chapter I, in the wake of the Great East Japan Earthquake, attention has been refocused on regions and urban development. Speaking in terms of industrial and business activities such as in the ICT industry, the "regions" have been ignored for a long time, but are taking their place in the limelight again as business areas.

However, to date, "regions" have not been considered as business areas because economies of scale have been difficult to achieve due to the characteristics of regions, that is, small-scale and diverse regions are spatially distributed, making "regions" less appealing. Such characteristics do not change even in the face of post-earthquake reconstruction. From this point of view, in order to maintain and continue the momentum of efforts for post-earthquake urban reconstruction that were suddenly initiated after the earthquake, there is a need for some kind of innovation in the business structure to deal with business areas that have the characteristics of "a wide variety" and "small scale."

In the case of the ICT industry, it is thought that cloud services that support the sharing of communications infrastructure, hardware and software could act as a trigger leading to innovation in business structure. However, a business model for such shared use must be designed so as to provide services to as many customers as possible at the lowest cost possible. To achieve these goals, it is necessary to dramatically reduce the per-customer cost of services including selling, general and administrative expenses. Targeting not only large-scale companies but also small- and medium-scale companies in an effort to secure a sufficient number of customers might result in an increase in the number of companies that are not necessarily familiar with ICT. This situation brings up the dilemma of increasing the costs incurred to support each individual customer.

For these reasons, structural changes in the ecosystems of ICT companies become necessary, such as setting up alliances between large companies having nationwide coverage and local companies that are better placed to hear the voices of customers. In fact, if we look at how disaster-stricken businesses are recovering, we find that local companies that are in close touch with affected businesses are acting as an interface between those businesses and ICT vendors, which could well be the seed of business transformation.

Finally, as an example of these activities, the author would like to introduce the case of the tourism industry that is involved in reconstruction after the earthquake.

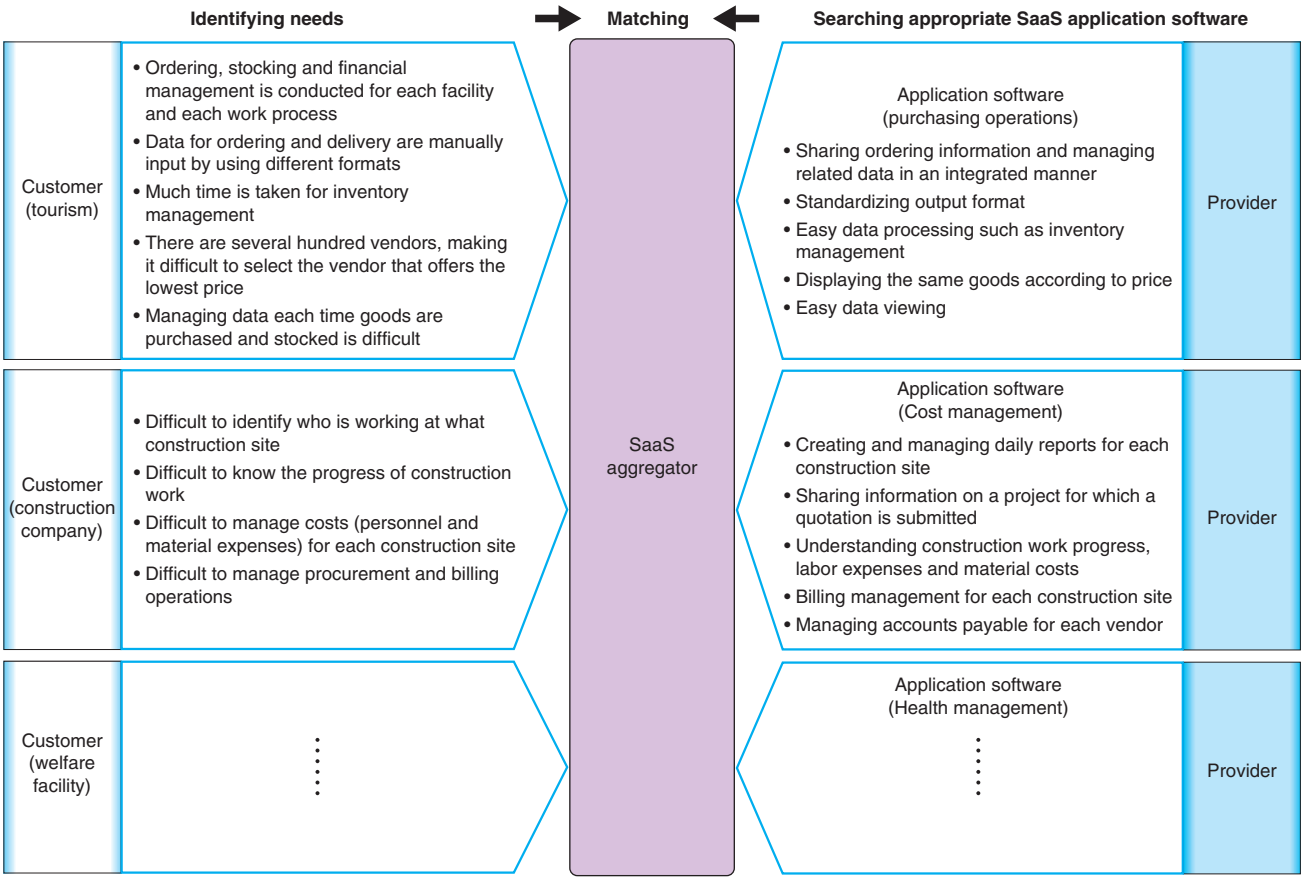
Abecho Shoten Co., Ltd. (Kesennuma, Miyagi Prefecture), which is a leader in the marine products processing industry, is also engaged in tourism as one of its core businesses. Its tourism operations consist of hotels (Minami Sanriku Hotel Kanyo, Kesennuma Hotel Kanyo and Kesennuma Plaza Hotel) and marine products sales through Kesennuma Osakana Ichiba (fish market). The earthquake dealt its purchasing operations a devastating blow. As a result, the company decided to introduce a joint purchasing system for rebuilding its purchasing operations, which are the foundation of the business. To get the company back on its feet as quickly as possible in the face of extremely difficult business conditions, the company could not afford to spend large amounts of time and money on introducing information systems. Instead, the company chose to consider the adoption of cloud-based systems, for which the deployment cost is low.

Unfortunately, major IT vendors did not have any cloud-based product offerings that were tailored towards small- and medium-scale hotels. This is because it was not easy for major vendors to provide services such as visiting each small- or medium-scale company in each region, examining their respective needs and introducing cloud services, which are costly.

To overcome this issue, the Tohoku Industry Promotion Association (Sendai City) stepped in to act as an intermediary to determine the needs of Abecho Shoten. The association selected application software offerings that were suitable for the company from among those offered by small- and medium-sized IT vendors. These services enabled Abecho Shoten to adopt a cloud-based system for its operations (Figure 3).

According to the association, it has also been making similar efforts to introduce cost management systems on behalf of small- and medium-sized construction companies whose work has been increasing because of post-earthquake reconstruction demand. The association expects that the range of such services it offers will further expand. Therefore, the association is aiming to enlarge its role as a "Software as a Service (SaaS)" aggregator, whereby it matches the cloud services of many different providers with the needs of its customers. To this end, the association is embarking on the

Figure 3. New business model for ICT-based urban development



development of businesses and human resources in the region.

In cases such as that of Iwanuma's medical/welfare urban systems, as described in Chapter V, requiring the introduction of application software to manage the health care of elderly people in welfare facilities, clinics and housing dedicated for use by elderly people, there will surely be a need for such SaaS aggregators operating on the ground.

The Great East Japan Earthquake led us to refocus our attention on the "regions." Such re-highlighted regions and cities raised two issues for ICT business. They are the "fusion opened up to other fields" such as regions and cities, and the "response to diversity" needed for small-scale, dispersed regional markets. Change of ICT business in response to these challenges is about to begin.

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