

Chapter 4

Integrating Urban Data with Urban Services



Ryosuke Shibasaki, Satoru Hori, Shunji Kawamura, and Shigeyuki Tani

Abstract This chapter provides an overview of the architecture for integrating urban information. It describes how urban information should be integrated and how this integration can result in collective optimization of services. The integration of spatial and temporal information represents the initial approach for the architecture of social and technical integration. A much better metric to improve is user satisfaction, wherein users are the individuals and businesses in cities.

Further, three key channels for integrating information are discussed here. The first channel is the set of interfaces that enable systems to operate symbiotically. Specifically, this indicates the designing interfaces that allow businesses and services to communicate and interact with each other such that all of them operate not only independently but also as part of a larger organic system. The second channel is the set of social systems that recalibrate the rights and responsibilities concerning the use, management, and protection of data. Technology that can enable organizations to use personal information without compromising on data privacy and data principles is introduced. The last channel is a measure of the quality of life (QoL).

The original version of this chapter was revised: This book was inadvertently published with the incorrect license type CC BY 4.0 and the Open Access License has been amended throughout the book to the correct license type CC-BY-NC-ND. The correction to this chapter is available at https://doi.org/10.1007/978-981-15-2989-4_9

R. Shibasaki (✉)

Center for Spatial Information Science, The University of Tokyo, Tokyo, Japan
e-mail: shiba@csis.u-tokyo.ac.jp

S. Hori

Social Systems Engineering Research Department, Center for Technology Innovation—
Systems Engineering, Research & Development Group, Hitachi, Ltd., Tokyo, Japan
e-mail: satoru.hori.fy@hitachi.com

S. Kawamura

Security Research Department, Center for Technology Innovation—Systems Engineering,
Research & Development Group, Hitachi, Ltd., Tokyo, Japan
e-mail: shunji.kawamura.wz@hitachi.com

S. Tani

Social Systems Engineering Research Department, System Innovation Center, Research &
Development Group, Hitachi, Ltd., Tokyo, Japan
e-mail: shigeyuki.tani.dn@hitachi.com

This has already been discussed in the second section of Chap. 2. In this chapter, we discuss a theoretical framework for measuring the QoL using human sensing.

Keywords Anonymous analysis technology · City OS · Data platform · Personal data protection · Symbiotic autonomous decentralized system

4.1 Architecture for Integrating Urban Information

Two Approaches to Integrating Urban Information

Cities are large population centers with a defined space, and they host a cluster of shared and coordinated activities from which goods and services are efficiently produced and consumed simultaneously. Underlying this dense cluster of activity are infrastructure services, including those related to travel, distribution, communications, energy supply, waste management, and water supply and treatment. To ensure that these services operate effectively, cities must devote considerable resources to gathering data and quantitatively managing it. For years, water, electric power, and gas supplies; road and rail transport; and many other services have been run by control systems that are based on real-time data. Data gathering and analysis, as well as use of the findings to control services or guide decision-making, represent the core activities of urban information management.

Data/information related to each infrastructure service—water, power, gas, road and rail transport, and the like—are managed separately. However, if we could spatially map all of these infrastructure services together, we could understand how they interconnect or, in some cases, conflict. For example, water supply, sewage systems, power lines, gas pipelines, road networks, and subway networks often overlap with each other (above and below the ground). Workers who lay wastewater pipelines must understand the locations of the power lines and gas pipelines. The team must also try to minimize disruption to road traffic. When conducting public works, if the team can collate data on the locations of each infrastructural facility and related public works and adjust worksites and schedules accordingly, it will be possible to prevent accidents and minimize inconvenience to road users.

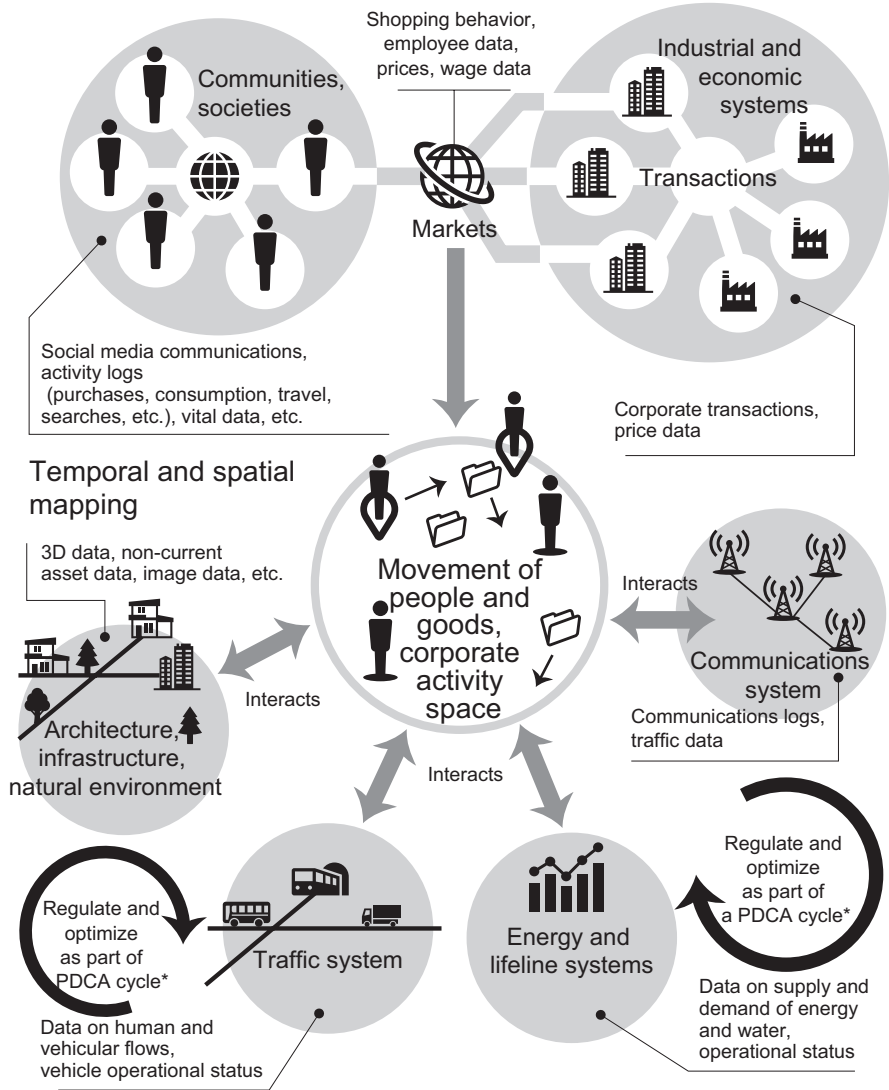
A system to facilitate such coordination has in fact been in operation for some 20 years now. In this system, parties share information on the whereabouts of facilities occupying road sections and information on planned construction/maintenance works so as to consolidate and visually map out the information. This system is underpinned by common regulatory stipulations, which provide that the relevant parties must use such a system to coordinate their operations. The system constitutes the basis for the parties to input, manage, and share data. The regulatory stipulations also provide that the costs of the system must be shared among the relevant actors. As this example illustrates, to ensure that parties share data and information, there must be an information-sharing system in place, and there must also be rules governing how the system works as well as a model for sharing expenses.

IT is used to optimize urban activities and infrastructure. Often, however, these optimizations have been carried out separately without considering the interconnections between them. We have mentioned how important it is to consider the different infrastructural facilities occupying road sections, but this also holds true for different transport services. For example, to ensure that passengers can transfer smoothly from a train to a bus, or to ensure that the mobility-as-a-service trend (MaaS: the integration of different transport services to allow users to seamlessly transfer between them) gains traction, it is essential to integrate information pertaining to each of the relevant services. But how should the information be integrated? The idea of integrating this information might seem like an obscure idea at first, but it becomes clearer when we consider how much urban services overlap spatially. At transport nodes, such as train stations, rail, bus, and taxi, services intersect. If the data related to each of these transport services are mapped together spatially and temporally, this will enable the visualization of the interconnections and conflicts between them. Consequently, we will get a clearer picture of how we should integrate them and how this integration can optimize the services collectively. Such spatial and temporal information integration represents the first of two essential approaches for social and technical integration architecture (see Fig. 4.1).

The second approach concerns the question: What should be optimized? If we are just focusing on an individual system, the optimization targets should be relatively easy to define. They would include things like travel time and operating costs. However, the situation gets more complicated when we consider the whole set of systems. Perhaps the obvious thing to optimize in this case would be the combined operation cost, but this metric does not much help us to envisage future urban systems. After all, an effective way to optimize costs is to lower standards in many cases. A much better metric to improve is user satisfaction—users being the individuals and businesses in cities. This raises the question: What is user satisfaction?

Users invariably seek services that offer comfort and joy, that take away the strains of life, that meet their demands down to the smallest detail, and that are deliverable on demand. Such services are not as fanciful as some might think; indeed, they are already being provided in some respects. Uber, for instance, has demonstrated how mobility services might work in a society where automated driving has proliferated. Uber vehicles are not automated as such, but the principle is similar: vehicles are dispatched upon the user's request such that the user does not need to drive. Likewise, if you stay at a luxurious hotel, you can get a very real taste of a comfortable lifestyle afforded by complete automation. At this hotel, you will not need to do any housework, and you can get something to eat or drink at the click of a finger. These high-level services could be delivered at a dramatically reduced cost through information integration or with AI and Internet of Things (IoT)-based technologies. Thus, these conveniences are technically feasible and people desire them. Yet, should we be seeking to extend such an ideal environment to everyone (as our optimization mission) simply because it is feasible and desired?

Rosemarie Parse proposed a theory of nursing called "Human Becoming" (Parse 1998). She developed this concept (which she had originally named "man-living health") after questioning the extent to which absolute nursing care and



*PDCA = Plan, Do, Check, Action

Fig. 4.1 Data landscape in urban management: temporal and spatial sharing enables interactivity

life-preserving medical care are necessary, and how much it is in the patient’s interest. Human Becoming assumes that humans derive meaning from freely choosing their actions and experiences, upon which they grow and change (or *become*). The theory also posits that humans make these free choices based on the information they gather in their intersubjective interactions with the environment.

Ideas such as these should be considered in a process of broad public discussion and test bed programs. As our society accumulates a body of discourse and experience, as well as a body of digital data, we can gain increasing insight into what we should be optimizing, and then develop the environment accordingly.

Channels for Integrating Information

There are three key channels to integrating information. The first channel is technical; it concerns the interfaces that enable systems to operate symbiotically. Specifically, this means designing interfaces that allow businesses and services to communicate and interact with each other such that they all operate independently but also as part of an organic whole. Section 4.2 introduces an approach to achieve such symbiosis: “Symbiotic autonomous decentralized system,” a concept that focuses on integrating existing services.

The second channel is institutional: it concerns social systems that recalibrate the rights and responsibilities concerning the use, management, and protection of data gathered from different systems, and that consider the outcomes, costs, and impacts of the data use. Currently, the notion that applies to property in general—that the one who acquires the property enjoys all the rights connected with it—applies to information and data too. However, issues concerning data privacy challenge this notion. If you own or manage someone’s personal information, you will potentially affect this person in some way. You cannot use the data against the wishes of the data principal. Ultimately, therefore, the data principal must have a right to be involved in the process of using or managing his or her data. A prominent example of this principle is the right to data portability (the right to transfer one’s personal data from one data controller to another), which is enshrined in the EU General Data Protection Regulation (GDPR). The principle also applies to the example we discussed earlier of assets occupying road sections. That is, to ensure the appropriate use of publicly owned roads, data must be shared to the extent necessary, and the different parties must compromise their own interests in pursuit of the wider collective interest. There must be an ongoing discussion on how to rectify the excessive emphasis on sectional interests and how to achieve the wider interests of the whole. Such a discussion will help enshrine data rights and stakeholder responsibilities as a cornerstone of governance. Once we have such a discussion and common understanding, we must stipulate the rights and responsibilities that should apply when different services are integrated. We must also design a model for how the costs will be shared. These institutional steps are essential, for without them, the systems, as technically feasible as they may be, will fail to gain traction in society.

The bulk of the urban data will be the personal information of users (including city residents, workers, and visitors). Societies around the world have now established the principle that personal information can be entrusted to reliable organizations and individuals, which will use the data to identify ways to improve and optimize urban services. This principle has been put into practice with schemes

such as personal information banks and personal data stores, but these schemes have met with difficulties. The reason they struggle is related to the irrecoverability of losses from personal information accidents, such as when the data are leaked. If we have technology that can enable organizations to use personal information without compromising data privacy, data principals will be much more inclined to give their consent to the use of their data, which will open up many new possibilities for using data. Section 4.3 introduces such a technology, one that encrypts personal data so that they can be analyzed while retaining the anonymity of the principal.

The third channel concerns governance structures under which society can continually fine-tune the separate systems, the architecture integrating these systems, and the methods for managing data. To this end, it is necessary to refer to quantifiable measures of citizens' QoL (the ultimate metric of society-wide optimization) and the distribution thereof. QoL is, by definition, a measure of quality of life. We already discussed this in the section on Habitat Innovation framework (Sect. 2.2). In Sect. 4.4, we will discuss a theoretical framework for measuring QoL: human sensing.

Ongoing Issues

Once the objective function is determined, approaches to system integration and optimization will start producing results in many different settings. However, a number of issues must first be addressed. For example, how can cities establish objective functions when they have so many different actors whose interests may come into conflict? How do they form consensus among these different interests? How should private businesses and public institutes (including local authorities and residential communities) share data and information as part of the process of forming consensus and determining common goals? These issues have only just started to be debated. That said, a number of ideas and schemes have already come forth. For example, data portability (the ability to gather, manage, and access one's own data) has gained worldwide traction. Likewise, there is a groundswell of support for the idea that public institutions can use data collected by private organizations in ways that can benefit communities. In the years ahead, it will be crucial to implement concrete measures by which citizens, communities, businesses, and local governments can amass a body of experience. It will also be important to increase opportunities for these actors to autonomously discuss specific strategies for addressing the issues.

4.2 Symbiosis of Urban Systems: Symbiotic Autonomous Decentralized System

A Vision of Service Cooperation

How can we make different services cooperate? In practice, it is unfeasible to develop a single megalithic system that binds all the services together. After all, different services operate under their own separate systems; therefore, to consolidate them all into a single system would take far too much money and time. Another problem is that every time you change a service, you would need to recalibrate the system as a whole, which will again cost time and money. Rather than developing a megalithic central system, it would be much more feasible to make existing systems cooperate.

How then do we accomplish this feat? To make the systems cooperate, they must be modified or a new function must be added. However, it may not be realistic to implement all these changes in one go. Instead, the systems should cooperate in stages. Once the systems are cooperated, each system will need to be constantly updated. During updates, the overall systems must remain unencumbered, even if the system in question is temporarily suspended. Given these requirements, it becomes clear that we should not couple the systems together so tightly as to make them all dependent on one another. Instead, we should aim for loosely coupled systems, wherein the composite systems operate independently but interact with each other so as to benefit the systems as a whole.

Autonomous Decentralized System

A concept that can help in the design of such a system is “autonomous decentralization.” This term is based on an observation about living organisms. An organism is made up of numerous cells. These cells are subsystems that operate independently, but they also interact with each other to enable the system as a whole—the organism—to function. Likewise, an autonomous decentralized system features a set of subsystems, each of which operates independently but in a way that contributes to the system as a whole (Hitachi 2019). This is the very principle we must follow in designing integration architecture.

Let us consider this autonomous decentralized system in a little more detail. For subsystems to operate interactively and harmoniously, they must communicate with each other. When a subsystem passes a message, it will usually pass the message to a particular subsystem. Likewise, when you send someone a package, you attach a label onto the package indicating the person’s address. The situation becomes more complicated, however, when a new subsystem is added. Under the conventional approach, if a message needs to be passed to the new subsystem, the sender subsystem must be modified. Likewise, you would need to update your

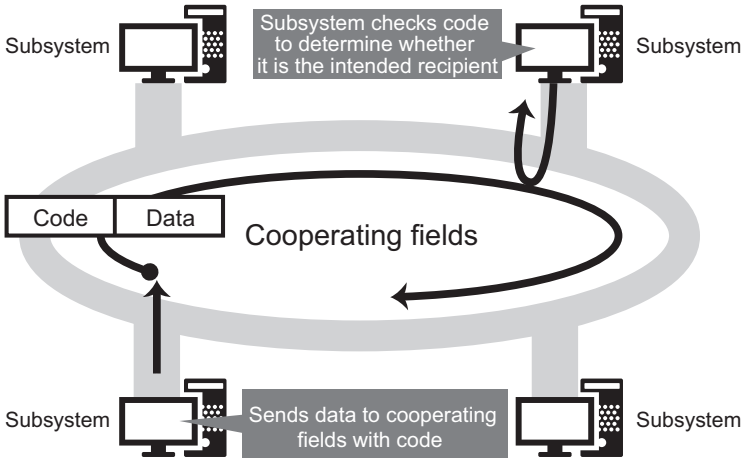


Fig. 4.2 Autonomous decentralized system

address book without delay if the domicile of one of the entries changes. However, an autonomous decentralized system avoids the need to modify existing subsystems each time a new subsystem is added, thanks to a mechanism described in the next paragraph. Such a system requires no address book.

Figure 4.2 illustrates how the subsystems pass messages to each other. Suppose that a system is made up of ten subsystems. When Subsystem A needs to pass a message to Subsystem B, it deposits the message in a designated collection area (without indicating Subsystem B as the intended recipient). The subsystems (other than Subsystem A) then check the collection area to see whether the message is intended for them. The message will only be picked up by the subsystem that determines that it is the intended recipient. How does Subsystem B verify that it is the intended recipient of the data? The data that each subsystem processes are structured in a way that accords with that subsystem’s particular function. Thus, each subsystem checks the structure of the data, and if the structure corresponds to the subsystem’s function, the subsystem will conclude that it is the intended recipient of the data.

We turn now to considering forward compatibility. What happens when Subsystem B gets an upgrade, becoming “Subsystem B+”? Subsystem B+ processes the same kind of data as Subsystem B. As such, Subsystem B+ will determine that it is the intended recipient of the data that Subsystem A sent. Therefore, there is no need to modify Subsystem A (Subsystem A does not need to be told to change the recipient from Subsystem B to Subsystem B+). Thus, an advantage of the autonomous decentralized model is that the subsystem can be easily modified in stages, making large-scale system development much simpler.

The places where the subsystems deposit their messages are called “cooperating fields.” The subsystems are all linked to the cooperating fields, so they can send all deposit data in and collect data from the cooperating fields. We mentioned that

subsystems determine whether the data are for them by checking the structure of the data. The process is actually even simpler in practice. There is a coding system to describe different types of data content, and the messages deposited in the cooperating fields are each labeled with a code. Subsystems need only to check the code to determine whether the data are intended for them.

Symbiosis of Systems

The principles of autonomous decentralization we have just outlined are also applicable to the cooperation of the systems for different sectors or services. If a cooperated system is akin to an organism, then a cooperated group of systems is like a symbiotic community of independent organisms. Hence, Hitachi has coined the term “symbiotic autonomous decentralized systems” (Irie et al. 2016).

To illustrate this principle, consider the autonomous decentralized cooperation of transport management systems, including those related to trains, buses, and taxis. Each of these systems operates independently, and in the course of their operations, the systems post real-time data on their transport operations onto cooperating fields. Then, another system can view the data posted onto the cooperating fields, and use this data to shape an efficient transport plan for the entire group of systems. This plan will then be posted onto the cooperating fields. This process enables transport services to be much more efficient than a situation where each transport system formulates plans separately.

This symbiosis can occur across different sectors to enable even more efficient service delivery. To take transport and energy services as an example, as part of an effort to promote electric vehicles, transport plans can be arranged so that electric vehicles recharge during hours when energy prices are lower. Such cross-sector cooperation will help optimize society as a whole, bringing us closer to the supersmart society.

4.3 Personal Data Protection: Anonymous Analysis Technology

Personal Data Leaks

It is from Big Data, such as data on people’s shopping history and sensor data, that we gather and analyze data, and extract new information. One method for exploring Big Data is association rule learning, which can help identify relations between variables. For example, an analysis of shopping histories might tell us that when people buy diapers, they tend to buy beer as well. Such relationships are called “association rules.” The discovery of a good association rule can prove very useful

in guiding product planning, promotional campaigns, and store layouts. Big Data analytics are conducted not only in marketing but also in a wide range of fields. For example, sensor data are analyzed to determine the causal factors of accidents.

In the years ahead, Big Data will increasingly be used to shape services that rely on personal data. Data analysts will be increasingly entrusted with data from massive samples, including data on the TV programs people watch every day, the websites they visit, their shopping history, and the shops and restaurants they have visited. They will use the data to find association rules that indicate trends, such as people's tastes and preferences, the products that groups with similar tastes and preferences tend to purchase, and where they go to purchase these products.

How, though, can we entrust our personal data to these organizations with peace of mind if there are no solid security measures in place? The best method currently available is one that involves blacking out key information, such as the principal's name and address, so as to prevent the principal from being identified. In the years ahead, we will see more use of encryption as a means of enhancing personal data security. If data are sent for analysis in an encrypted form, it helps prevent the risk of the data being exploited for malicious purposes. Encryption is already used in the Internet; when we submit personal data online, for example, the data are encrypted. Anonymous analysis technology (Naganuma et al. 2014) enables analysis to be conducted without the encrypted data being decrypted and returned to its original state. In this way, it significantly offsets the risk of unauthorized access or malicious leaks. Naturally, the way to decrypt the data is concealed from the party analyzing the data.

Anonymous Analysis

Generally speaking, if you entrust a data analyst with your personal data but provide the data in an encrypted form, the analyst will be unable to process the data, as only you know how to decrypt it. If on the other hand you use anonymous analysis technology, the data analyst could find association rules in the data even in its encrypted state. From these association rules, the analyst could identify certain products to recommend to you, but these product recommendations would expose tastes and preferences that you may be uncomfortable sharing. No one wants to broadcast all their tastes and habits to the world. The notable thing about anonymous analysis technology is that the product recommendations themselves are encrypted so that the analyst cannot understand them. You alone can decrypt the recommendations using your initial password. Such technology is now in the process of development.

Figure 4.3 illustrates the technology. First, you encrypt your personal data with a password and upload the data to a cloud server (a remote data center). When you send an encrypted query, the data center collates the query with your encrypted personal data and issues an encrypted response. Because the data and query remain encrypted on the cloud server, no one other than you can understand them. Finally, you receive the encrypted response and decrypt it using the same password and check the content.

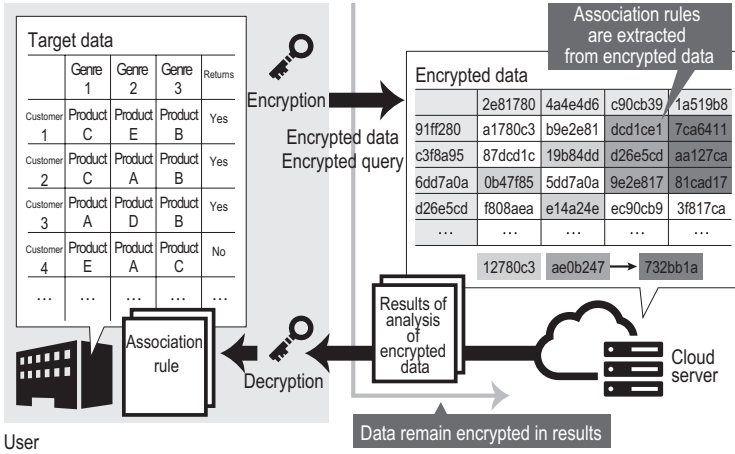


Fig. 4.3 Anonymous analysis service

Anonymous Analysis Using Searchable Encryption

The key technology in anonymous analysis is searchable encryption. Searchable encryption allows encrypted word searches to be performed on encrypted documents such that neither the words searched for nor the documents analyzed will become known. In conventional searches, one must temporarily decrypt the data to find the target terms. With searchable encryption however, the number of times search terms appear in a document can be identified while keeping the data encrypted. Searchable encryption can therefore be used to statistically analyze data and find association rules without breaching anonymity.

The ability to access data without compromising privacy will significantly expand the use of data, because it will become much easier to obtain the consent of the principals toward the use of their data. Thus, anonymous analysis—technology that enables data to be analyzed securely (in that the data remain encrypted)—has an important contribution to make in protecting privacy.

4.4 Measuring Happiness: From the Internet of Things to the Internet of Humans

In the manufacturing sector, the Industrial Internet, Industrie 4.0, and similar concepts have been proposed as ways to connect machinery, robots, and other things to the Internet, to go digital, and to realize significant leaps in productivity. Japan’s vision of Society 5.0, on the other hand, proposes a human-centered society, one that delivers comfort and happiness through a high degree of cyber-physical convergence.

The key factor that differentiates Society 5.0 from other concepts is that in Society 5.0, connectivity extends to humans as well as things; in other words, Society 5.0 has an Internet of Humans, not just an Internet of Things.

IoT-Driven Digitalization

With the rise of the Internet and smartphones, we now live in what some dub a “ubiquitous network society,” in which we can connect whenever, wherever, with whomever. Moreover, the rise of IoT (i.e., the fact that Internet connectivity has extended to “things” through sensors and wireless devices) has further digitalized society (Ministry of Internal Affairs and Communication 2015). As discussed in Chap. 1, a vision of Industrie 4.0 was outlined as part of the High-Tech Strategy 2020 Action Plan for Germany (Industrie 4.0 Working Group 2013). Industrie 4.0 proposed a vision of digitized supply chains that use data collected from IoT-based devices to innovate manufacturing processes.

In 2012, General Electric Company (GE) outlined its vision of the Industrial IoT or the Industrial Internet. The idea of the Industrial Internet is to connect manufacturing hardware with advanced analytical software so as to dramatically reduce cost and generate new value (Japan Business Federation 2016). In each of these ideas, a core role is played by cyber-physical systems, which characterize the fourth industrial revolution. Such systems are already being used to fully digitize manufacturing via IoT, and significant gains in productivity are starting to be realized.

Society 5.0’s Novel Concept: Human Centricism

Whereas economic systems have traditionally derived their competitiveness from their ability to consolidate “things” and money in ways that improve efficiency, in Society 5.0, the source of economic value will instead lie in people and data according to the Growth Strategy 2017 (Growth Strategy Council 2017); moreover, data related to people’s wisdom and behavior will generate value and create a society in which individuals from all walks of life can actively contribute. The way in which we use data gathered from the Internet of Humans, in addition to that gathered from the Internet of Things (which was the main player in Industrie 4.0 and the Industrial Internet), will be of critical importance in our efforts to usher in Society 5.0. The next section explores the benefits of the IoH, as well as the problems it entails.

What Is the Internet of Humans? It Starts with Human Sensors

Why do we speak of humans, as well as things, being connected in a network? Let us consider some examples. Hitachi recently conducted research into wearable sensors that measure happiness.

According to Yano et al. (2015), happiness correlates significantly with performance. Happy people are 37% more productive and 300% more creative than unhappy people. They also have more friends and longer healthy life spans. There are economic effects too: companies with happy workforces report higher earnings per share (Yano et al. 2015).

In a Hitachi study, the activity patterns of call center employees were measured using wearable sensors (as shown in Fig. 4.4). The data, which represented a total of over 1 million days, indicated that the sensors tended to emit signals suggesting happy moods during times of active behavior patterns (Yano et al. 2012). A call center team with high happiness levels won 34% more business than a team with lower happiness levels.

These findings imply that even in these times of automation, our mental well-being remains key to economic success. They further suggest that we will gain new economic growth opportunities if we use the IoH to digitize human activity and create a people-centric society that supports happiness.

The Benefits of IoH

We have just described one aspect of IoH—the use of wearable sensors to monitor human activity. From the perspective of the people wearing these sensors, this is a passive process; their sensor data are gathered and used by others. How should IoH

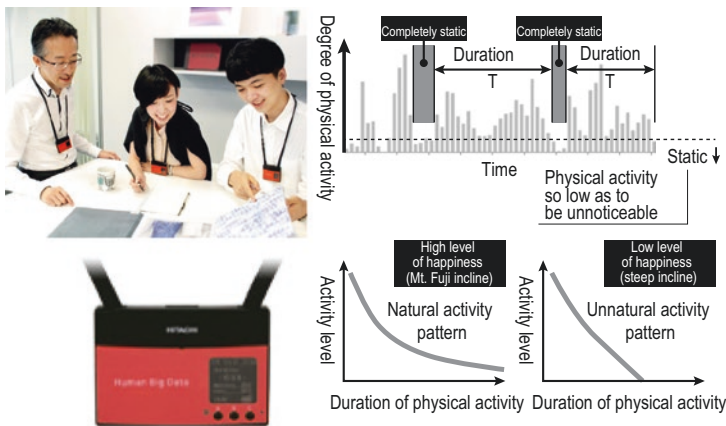


Fig. 4.4 Physical activity patterns associated with happiness (measured by wearable sensors)

operate in Society 5.0's economic system? Habitat Innovation avers that active citizen participation is key to such an economic system, and data are no exception. The ideal form of IoH according to Habitat Innovation is one where citizens provide data actively, not passively.

To get an idea of active data provision, we can consider energy supply and consumption. To control energy supply, energy companies monitor the amount of energy we consume each day and use the data to forecast future energy demand. The energy companies must maintain a constant balance between demand and supply to ensure a continuous supply of energy at rated voltage and to avoid outages. To this end, they must forecast demand accurately and flexibly adjust supply to accommodate sudden demand changes. What would happen if citizens actively provide energy consumption forecasts for the next day, the next week, or the next month? The uncertainty over future demand would be minimized, allowing energy companies to forecast demand and adjust supply at much lower cost, thus freeing up economic potential.

An example of a pilot project that accorded with this approach to IoH is Kutsuplus ("call plus"), an on-demand minibus service launched by Helsinki City Transport (HSL) (Toyota 2015). Kutsuplus was a service that matched passengers' travel needs with a minibus driver. Users would enter their starting point, destination, and desired arrival time into a smartphone app. The app would then match the query with a suitable boarding point, disembarkation point, and timetable. Unlike in conventional bus services, minibus drivers would adjust their routes and timetables to reflect the data that users provided. Minibus drivers could then deduce the optimum routes to meet user needs and dynamically customize the service accordingly. The result was an economical transport tailored to citizens' demand (see Fig. 4.5).

The Problems That IoH Entails: Hurdles That Must Be Overcome on the Way to Society 5.0

When citizens actively provide data, they enable urban service providers to dynamically adjust their services, which in turn unleashes economic potential. However, the IoH also entails problems that we must overcome to realize Society 5.0. These problems concern the reliability of data and the privacy of the data principals.

The problem regarding data reliability is that datasets can contain dubious data that unscrupulous individuals submit with malicious intent. E-commerce and review sites address this problem by allowing users to rate the reliability of the content. The "like" button is an example of this.

As for privacy, the importance of this issue has been underscored by the EU General Data Protection Regulation (GDPR), which came into force in May 2018. The jurisdiction of the GDPR extends to all multinational companies around the world that process the personal data of EU residents, and there are tough penalties for multinationals who fall foul of the GDPR (EU GDPR.ORG 2019). Insofar as

Urban traffic services		
	Society 5.0	Conventional society
Objective	Greatest possible happiness for every individual	Minimal overall waiting times
Characteristics	Considers individual needs	Does not consider individual needs (only collective need)
	Maximizes the satisfaction of each individual alongside optimization of resource-use	Optimizes resource use to reduce waiting times

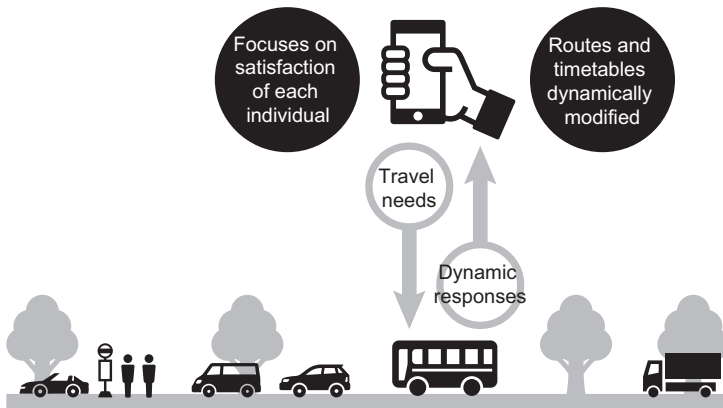


Fig. 4.5 Urban traffic services in Society 5.0’s people-centric society

Society 5.0 will be based on human connectivity, we must address the challenge of data privacy. We previously mentioned anonymous analysis technology; in the discussion below, we introduce an intriguing data privacy service.

In 2016, the major railway company Tokyu Corporation launched Station Vision (the registered trademark is “駅視 (Ekishi)-vision”), a service that relays station crowd-level data to users as image data. The data are based on video camera footage. If the service sent this footage to users unedited, it would violate the privacy of the individuals that appear in it. To avoid this problem, Station Vision replaces the images of the people with icons. Using Hitachi’s people-flow analytics, Matsukuma et al. (2017) developed a system that detects people’s walking direction and then replaces the images of these people with icons depicting their movement, as shown in Fig. 4.6. If the same icon was used for each person, it would be hard to intuitively understand the crowd dynamics, as the direction of each individual would be unclear. The use of direction-specific icons makes it much easier to gage crowd levels, and does so without compromising privacy. Station Vision thus provides a way for users to check the crowds at stations from their homes. When trains are delayed, such as during heavy snowfall, users can check the crowd



(Level of crowding)

Fig. 4.6 “Station Vision,” Tokyu line app information service

levels at the stations and then decide whether to take an alternative route or to wait at home. The service also helps railway companies ease congestion at stations (Matsukuma et al. 2017).

As we have learned, IoH—human connectivity that enables the digitization of behavior and demand—has an important role to play in society. When citizens provide data actively, rather than passively, urban services (including energy and transport services) will be able to dynamically customize their services to users. This change will bring economic benefits, but to gain these benefits we must also address the privacy issue. In doing so, we will accelerate progress toward Society 5.0.

References

- EU GDPR.ORG (2019) GDPR key changes. <https://eugdpr.org/the-regulation/>. Accessed 4 June 2019
- Growth Strategy Council (Headquarters for Japan’s Economic Revitalization) (2017) Growth strategy 2017: reforms aimed at achieving society 5.0, June 2017. https://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/miraitousi2017_summary.pdf. Accessed 4 June 2019
- Hitachi Webpage on the Autonomous Decentralized System (2019). https://www.hitachi.com/products/it/control_sys/platform/ads_net/index.html. Accessed 4 June 2019

- Industrie 4.0 Working Group (2013) Recommendations for implementing the strategic initiative INDUSTRIE 4.0: final report of the Industrie 4.0 Working Group, April 2013. <https://www.din.de/blob/76902/e8cac883f42bf28536e7e8165993f1fd/recommendations-for-implementing-industry-4-0-data.pdf>. Accessed 4 June 2019
- Irie N, Ohashi A, Onodera T, Kato H (2016) Information and control systems—open innovation achieved through symbiotic autonomous decentralization—. *Hitachi Rev* 65(5):13–19
- Japan Business Federation (2016) Society 5.0 to IoT nado e no torikumi (Initiatives related to Society 5.0 and the IoT). https://www.jpo.go.jp/resources/shingikai/sangyo-kouzou/shousai/tokkyo_shoi/document/16-shiryu/03.pdf. Accessed 4 June 2019
- Matsukuma N, Osawa T, Nukaga N, Otsuka R, Kato M (2017) Using people flow technologies with public transport. *Hitachi Rev* 66(2):145–149
- Ministry of Internal Affairs and Communications (2015), 2015 White paper on information and communications in Japan. <http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2015/chapter-5.pdf#page=13>. Accessed 4 June 2019
- Naganuma K, Yoshino M, Sato H, Sato Y (2014) Privacy-preserving analysis technique for secure, cloud-based big data analytics. *Hitachi Rev* 63(9):577–583
- Parse RR (1998) *The human becoming school of thought: a perspective for nurses and other health professionals*. SAGE Publications, Thousand Oaks, CA
- Toyota (2015) On-demand public transportation changing human mobility in cities. https://open-road-project.com/en/innovationreview/post_611/. Accessed 4 June 2019
- Yano K, Lyubomirsky S, Chancellor J (2012) Sensing happiness: can technology make you happy? *IEEE Spectr* 49(12):32–37
- Yano K, Akitomi T, Ara K, Watanabe J, Tsuji S, Sato N, Hayakawa M, Moriwaki N (2015) Measuring happiness using wearable technology—technology for boosting productivity in knowledge work and service businesses. *Hitachi Rev* 64(8):517–524

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits any noncommercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if you modified the licensed material. You do not have permission under this license to share adapted material derived from this chapter or parts of it.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

