Chapter 23
The Design of Service Systems Architecture for Building Smart Public Infrastructures

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ABSTRACT

This chapter shows a systems technologies framework to lead the approach to design information service system architecture standing on the systems concept. It also presents application examples for building smart public infrastructures. Moreover, it shows that a systems concept, autonomous decentralization, gives a consistent design approach for the reference architecture, the concrete architecture, and the implementation. The presented service system provides an autonomous process for a service receiver to get valued information changing the state of the receiver. The example of the service system provides, recursively, the information to see in smart public infrastructures (MIERUKA in Japanese) for rapid decision making among stakeholders in the business process.

INTRODUCTION

Economic activity in society depends on public infrastructures, which provide irreplaceable support to the lives of people. Typical examples of public infrastructures include electricity, transportation, and water and sewage services. All of these domestic industries are categorized as tertiary industries (or service industries in a broader sense) and residents and organizations (enterprises) are the recipients of these services.

For instance, the need to implement smart grids has increased in the field of electrical power generation, transmission and distribution as global momentum has increased toward introducing environmentally-friendly energy sources that will bring an end to issues with global warming. New ideas have also been put forth in other areas of public infrastructures, such as multi-modal transportation, which increases convenience for riders by linking multiple modes of transport such as trains and buses. An interesting idea in the

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water and sewage fields is to desalinate seawater on the supply side and recycle grey water on the demand side.

Public infrastructures in Japan have grown to provide the most advanced services available globally in terms of power-outage times, the quality of drinking water, and the density and reliability of rail transport. Earthquakes in Japan are taken as opportunities to reexamine the overall public infrastructures of regions or cities, rather than to consider their various components, such as electricity, water, sewage, or transportation, separately. Moreover, it is necessary to complete the overall public infrastructures in emerging nations, where various components of the infrastructure such as the overall power generation and distribution system, transportation networks, and water systems are not fully consolidated, by considering issues such as municipal planning and the speed of construction. The idea of "smart cities" pursues public infrastructures that provide total services to residents from the perspective of the regions or cities described above, rather than from the perspectives of the main individual constituent industries. This is an initiative toward achievements in social issues on a global scale, starting with the perspectives of local residents.

The information systems shared in the activities of both enterprises and society have become crucial in people's daily lives. The societal issues related to issues of energy and the environment have become more serious, and the role of information systems is becoming even more important. These circumstances create demand for enhancements to public infrastructures through information technology. The field of electrical power distribution has smart grids, and already the idea of smart communities or smart cities has been suggested, which have expanded from electrical power to include multiple aspects of public infrastructures, such as transportation and water and sewage systems. "Smart" generally means providing public infrastructure services to residents more safely, securely, and conveniently through Information and Communication Technologies (ICT).

International academic societies are successively issuing journals featuring these themes and are discussing the various technologies needed to achieve them (Arnold, 2011; Naphade, 2011). These are ideas for building social systems with objectives that include artificial structures coexisting with the environment, for example, by taking into consideration the earth's limited resources, accommodating the diverse values of stakeholders, and respecting human nature by not overemphasizing efficiency. These are core ideas for enhancing public infrastructures, and many countries are also engaged in practical tests toward implementing these ideas.

The importance of academic work on such initiatives has long been raised. Research is being advanced on technologies spanning various academic fields such as natural sciences, humanities, social sciences, and engineering, and social and environmental issues are being examined using approaches that are objective-oriented and measured by achievements and problem solving. The importance of systems science and technology in approaching and solving these significant problems faced by society from an overall perspective has been advocated by the government in Japan (Arai, 2004). Systems science and technology, which is a so called trans-disciplinary science, is an essential elemental technology for accomplishing tasks and solving problems when planning, building, operating, and maintaining systems such as public infrastructures, which are large scale, complex, and require semi-permanent maintenance and development (Funabashi, 2010).

The following section overviews recent trends in enhancing public infrastructures and prospects for the future. We particularly outline current initiatives, and focus our discussion on the system technology frameworks needed to implement these ideas.