December 2005

City Planning Approach for Rebuilding Enterprise Information Systems: The Move towards a More Effective EIS City Planning Approach

Yukio Namba
S-Vague Consulting, Inc.

City Planning Approach for Rebuilding Enterprise Information Systems – The Move towards a More Effective EIS City Planning Approach –

Namba, Yukio
S-Vague Consulting, Inc.
nambay@ba2.so-net.ne.jp

Abstract

An enterprise information systems (EIS) city planning approach was proposed by Namba and Iijima (2004) at PACIS2004. This framework is characterized by the utilization of metaphor to visualize an unseen object (i.e., architecture) and to leverage the concepts and methodologies of city planning from architectural and civil engineering to an EIS. As society grows more mature, effectiveness of city planning itself seems to be increasingly unsuccessful. Correspondingly, some criticize EIS city planning approaches, because they draw upon physical city planning. Especially in the recent business climate, EIS planning seems not doing well. In this paper, we try to understand the reasons why both physical and EIS city planning seem to some to be unsuccessful. It is not attributable to the nature of city planning, but rather to the requirements for city or EIS planning, which have changed as the maturity of the society or the firms' information systems. We then introduce post-modern city planning. This concept was born of the paradigm change between industrial and post-industrial society. From here, we discuss how postmodern concepts can be realized in the field of EIS. Finally, to illustrate applicability of these new concepts we examine the case of KDDI's rust-free system.

Keywords: city planning approach, architecture, enterprise information system, maturity model

1. Introduction

The Gartner Group (Schulte, 1997) proposed a city planning approach based on the metaphors of a city structure and a information system architecture of firm's level. Since then, other groups (e.g., IBM, 1999) have proposed similar city planning concepts using the same analogy. Namba and Iijima (2004) proposed an enterprise information system (EIS) city planning approach that leveraged the concepts and methodologies of city planning from architectural and civil engineering and used metaphor to visualize an unseen object (i.e., architecture). In their context, EIS is an organic aggregate of information systems like production control system, sales system, distribution system etc and is considered as higher granularity of each information system.

According to Namba and Iijima (2004), the EIS city planning approach consists of an EIS architecture and an EIS scenario. In order to describe the EIS architecture, they exploit the IEEE architecture description (IEEE Computer Society, 2000) and construct three architectural viewpoints using analogies from physical city planning. They also introduce the concepts of a current (as-is), ideal future (to-be), and pro tempore future (live-to-be) architecture to illustrate a migration scenario. This migration scenario includes the program management of the project, and the program management is named as the EIS scenario.
The three viewpoints are "structure," "whole and part," and "ins and outs." The structure viewpoint consists of three layers: "business," "information systems service (IS service),"

and "integrated information infrastructure." The part and whole viewpoint relates to the ability to accommodate an interest or the responsibility of sharing between a part and a whole. The ins and outs viewpoint is concerned with how to control boundaries between the inside and outside of an enterprise.

Many people, however, point out that physical city planning itself often does not go well. Moreover, they question the applicability and effectiveness of the EIS city planning approach as a basis of these discussions. Pursuant to this, this paper discusses why city planning for both physical city and EIS themselves seem ineffective. We also discuss the scope of applicability for the EIS city planning metaphor. Then we illustrate a new approach to city planning that could break through the current deadlock and discuss the potential problems with the EIS approach. Finally, we discuss the structure required by information systems to enable adaptive EIS by examining the case of KDDI.

2. Issues in Physical City Planning

2.1 Why Physical City Planning Seems Unsuccessful

Yoshikawa (2000) noted that modern city planning has been transformed by the arrival of post-industrial society and has, in fact, been almost recreated as an entirely new discipline. These transformations and their causes are as follows:

- City planning that attempts to construct new urban areas within the regulations of prior fixed planning has gradually become unworkable.
- The main emphasis of city planning has shifted from new urban development in suburban areas to restructuring and/or redeveloping an existing urban areas.
- The driving force behind city planning has shifted to resident participation or private sector initiatives as a result of the limited capability of the public sector.

Working in the background of these transformations are the following issues:

- City planning is unable to follow the speed of change of the real world.
- City planning takes large amounts of time to reach a consensus between owners of the project, local residents, and a city authority.
- Often, city planning must adhere to the plans of upper-level or neighboring areas.

Much of the blame for the failure of city planning can be attributed to rigid plans that have no built-in change mechanism. Even if change is possible, frequently it either costs too much or takes too much time, due to planning's inflexible methods. In addition, the diversification of citizens' requirements has accelerated this tendency. This leads to an objective function for city planning that is more complex, making it more difficult to meet each citizen's requirements. A good deal of this can be attributed to changes in stakeholders' concern for or interest in city planning, including required characteristics and functions and assessment methods. These parameters cannot be effectively addressed with the traditional methodologies of city planning.

These issues can also been seen in the area of information systems. In this environment:

- Information systems cannot follow the speed of change in the business environment.
- Dependency and influence from outside of the firm has increased.
- The degree of collaboration among existing systems has increased, creating spaghetti structures. This decreases efficiency of maintenance and becomes a barrier to interfacing existing systems, even when newly developed.

Normally, it is not necessary to build new systems from scratch, because major systems in a firm have been fulfilled over time.

The main issues lie in the process used to accomplish the target architecture. However, this does not involve the applicability and effectiveness of the EIS city planning approach itself, but rather issues of implementation and of goal realization. The EIS scenario provides important suggestions, because this scenario includes the processes needed to migrate from an as-is to a to-be, or actually a live-to-be, architecture. Moreover, the nature of a to-be architecture has changed as time has passed. The issues can be attributed to the architectural issues of each information system that composes the EIS. This is because the architecture of information systems deeply affects the flexibility of EIS.

Consequently, an EIS city planning approach must realize the following conditions in order to solve these issues:

- Set an appropriate to-be architecture that accurately reflects the business model of the firm.
- Design architecture that enables iterative development in order to shorten the time necessary for each project.
- Have a structure and adapt to changes in the business environment flexibly and agilely.

2.2 New Approach for City Planning

Modern city planning relies on the foresight and leadership of a public administration. City planning that is open to interactive, high-level discussions with participating coalitions is known as "post-modern city planning" and can be contrasted with more traditional "modern city planning" (Yoshikawa, 2000). Table 1 shows the characteristics and functions of these two types of city planning.

Table 1 Modern City Planning and Post-Modern City Planning

	Modern City Planning (Prior Fixed Planning)	Post-Modern City Planning (Consensus Type Planning)
Characteristics and Prerequisites	- Supply-side perspective - Prerequisite of foresight and leadership of public administration - Tree type and top down planning structures - Budget control and compliance	- Demand-side (city) perspective - Interactive participation and coalition - Leverages mechanism of market economy
Function of City Planning	- Structural cognition as abstracting whole city - Uniform control by laws or regulations - Uniform area designation system for major infrastructure - Urban policies pushed by societal growth and change	- Structural cognition as "rhizome" supported by a network - Plan-do-check cycle (iterative city construction) - Resident participation in planning for infrastructure - Emphasizes assessment in planning of public project and environment
Function of Market Economy	- Regulation and guidance against market failures such as overpopulation and deterioration of city environment - Invoked as part of financial policy to cope with economic fluctuation	- Escalation in competition for market economy - Competition and interpenetration between administration and market economy

Source: Yoshikawa, 2000

Modern city planning functions by understanding the city as an abstract whole that is controlled by laws or regulations. On the contrary, post-modern city planning functions by considering the city as a rhizome supported by a network. “A rhizome is a horizontal, root-like stem that extends underground and sends out shoots to the surface. Rhizome is also a figurative term to describe non-hierarchical networks of all kinds (Deleuze & Guattari, 1984).” It is not clear at this moment if rhizomatic structures can directly apply to information systems, but this contrast between modern and post-modern city planning suggests future directions for information systems, specifically for the level of EIS.

To realize concepts similar to those of post-modern city planning, EIS should be composed of highly independent modules, where each module is configured with a network if required. For this reason, an EIS must have a structure of distributed autonomous parts that harmoniously form a whole. Thus, an EIS and the information system that comprises the EIS should have a structure that enables this approach, although this discussion focuses on a finer granularity of EIS.

3. Discussion on Enabling a New Concept

3.1 Essence and Accident

Brooks (1995) pointed out that “the complexity of software is an essential property, not an accidental one. Hence descriptions of a software entity that abstract away its complexity often abstract away its essence.” Here, the term “accidental” does not mean “occurring by chance,” nor “misfortunate” but more nearly “incidental” or “appurtenant.” In the context of EIS, the meaning of Brook’s “essential” might be invalid nature of EIS. Since EIS is abstracted from individual information systems as an organic aggregate at the level of enterprise, this means to map business architecture into the business layer of the structure viewpoint. As a result, the IS service layer, which is composed of an application and an IS services portfolio, should be constructed so as to reflect the business layer. Moreover, the integrated information infrastructure layer is built. At this juncture, trade-offs in how to realize the given conditions, whether in the IS service layer or the integrated information infrastructure layer as a common function, should be considered.

Though essence and accident provide insight into processes like the development of the OS for System 360, they are applicable as well to coarser granularity systems like EIS. If only essences from the real world are selected, the core system can be built with them. Then an independent front-end system as an accident is built on the core system, which may prove flexible enough to handle environmental change and create a stable system. In this sense, it may be the “silver bullet” that Brooks mentions as the solution to the complexity of software products, even though he doubts its existence. Whether it is the silver bullet or not, seeking things that confer essence from the real world and trying to build EIS is a worthy endeavor.

3.2 Maturity Model for Information Systems

If someone adopted a post-modern city planning approach for developing an area from scratch, it would prove unsuccessful, because post-modern city planning requires full use of the infrastructure deployed in the preceding stage of modern city planning. For instance, a proper common interface will be required when one independent part tries to connect with another part. Furthermore, common protocols and coherence of data semantics are also required. Moreover, post-modern city planning requires structural development to equip infrastructure, and this requires moving beyond modern city planning. In other words, modern city planning is necessary to attain post-modern city planning. The relationship between modern city planning and post-modern city planning can be considered as stages of architectural development in a maturing process.

Ross (2003) argued that an architecture matures in four stages. Ross' use of architecture is similar to the EIS architecture that we have advocated, as she discusses the relationship among information systems in the enterprise. Specifically, she noted, "Firms' common experiences in evolving their IT architectures suggest four distinct stages of increasing enterprise IT architecture competency." According to Ross, the four stages are as follows:

- Stage 1: Application silo architecture. Here, the architecture consists of individual applications rather than an architecture for the entire enterprise.
- Stage 2: Standardized technology architecture. The IT architecture becomes enterprise-wide and provides efficiency through technology standardization and, in most cases, centralization.
- Stage 3: Rationalized data architecture. The enterprise-wide IT architecture expands to include standardization of data and processes.
- Stage 4: Modular architecture. The architecture builds on enterprise-wide global standards with loosely coupled application, data, and technology components to preserve global standards while enabling local variation.

Figure 1 illustrates the relationships within architecture maturity.

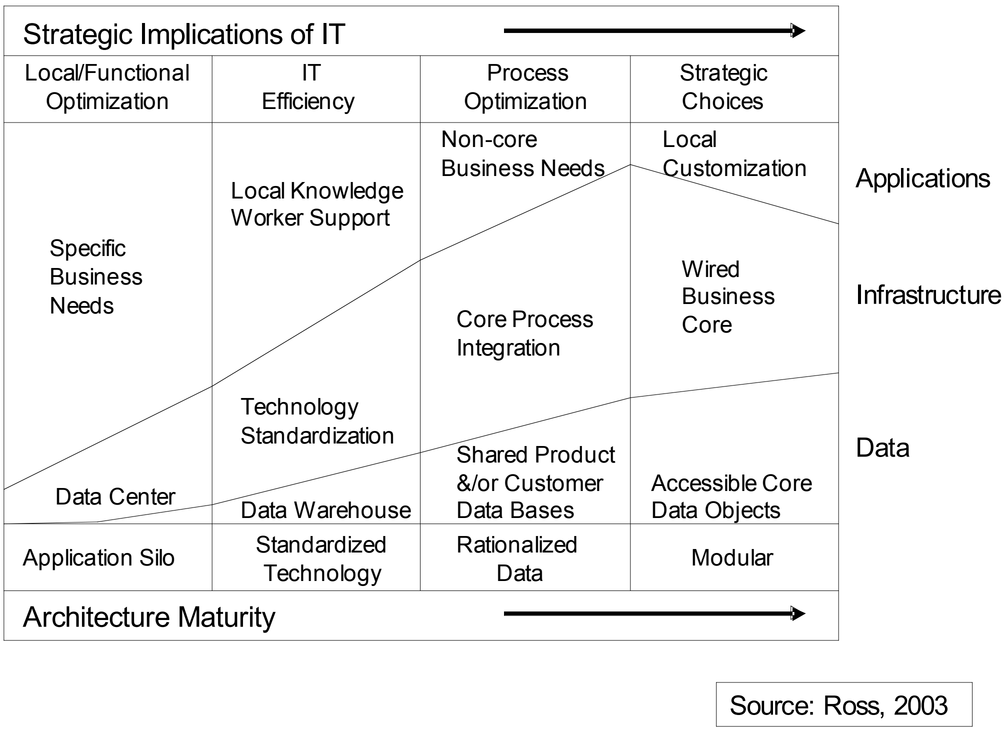


Figure 1 Changing Resource Allocation Across Architectures Stages

In Figure 1, each stage builds on the preceding stage. When a Stage 1 firm wants to become a Stage 4 firm, it must first standardize technology and deploy common information infrastructure (Stage 2), as well as rationalize data architecture enterprise-wide (Stage 3). Only after completing these processes can it take on the challenge of building a modular architecture as in Stage 4. As Ross pointed out, "Firms that attempt to skip stages consistently find that either the benefits are severely delayed or they must backpedal to acquire the missing organizational competencies."

Comparing the two types of city planning with Stages 3 and 4 in Ross's model, a relationship is evident. The target of Ross's Stage 4 is a systems structure where distributed autonomous parts harmoniously form a whole. This is analogous to post-modern city planning's rhizomatic structure. In city planning, it is difficult to reach the stage of post-modern city planning without going first through the stage of modern city planning. Post-modern city planning assumes that infrastructure has improved. For infrastructure improvement, the structured approach is effective, because it requires a wide range of scope and planning.

3.3 Structure Enabling New Approach

The critical idea here is that attaining a certain stage requires attaining the stage preceding it. Furthermore, an EIS and its components must have a structure for an EIS city planning approach to be carried out. In addition, a structure where distributed autonomous parts harmoniously form a whole (i.e., an EIS) is necessary for a system to adapt to the pace of change in the business or real-world environment.

On this basis, application or service functions can be configured to select the required function through the service layer. Here, a service is configured by a unit of actual operation process, and the system can invoke the service through a defined open and standard interface. Moreover, systems maintenance can be done per service unit, as the service itself is the existence of abstraction. In order to leverage unified service architecture for an EIS, service should be managed cohesively or spaghetti structures will result. This is mainly because the consistency of the data, especially the semantics of the data, is lost unless a data model is properly designed at the level of enterprise. Implementing a repository for service could potentially avoid a conflict of semantics. This method, however, becomes less efficient as the number of services increases. A criterion for service interchange will be required, but, with the increasing number of services, this task can be expected to increase exponentially. As a result, building systems based on a conceptual data model will be most effective.

4. Case Study: KDDI's Rust-Free Information System

4.1 Rebuilding KDDI's Information System

According to Shigeno (2004), KDDI has undertaken several mergers and acquisitions to keep the firm competitive. These business events, however, have forced the repeated integration of multiple information systems. As a result, the systems have grown large, complex, and rigid. This has lead to increased:

- Systems development time and cost for new development;
- Cost for systems maintenance and operation; and
- Systems failure.

Moreover, it has led to:

- Obstacles to sharing knowledge and know-how;
- Increased man-power and undermined morale; and
- The information systems division being considered by the management as an inhibitor to the firm's reformation.

Having recognized that the essential issue was an aging effect in the applications caused by uncontrollable complexity, KDDI designed, developed, and implemented an information system that could adapt to the changing business environment. Consequently, KDDI introduced the idea of object orientation, designed its information systems based on a conceptual data model, and rebuilt its mission critical back-end systems as a part of a structural reformation of the EIS. This concept and methodology incorporated the idea that an EIS is a simulator of the real world as a "universe of discourse" (Shigeno, 2004).

At the beginning of the project, KDDI divided its information systems into "variant" and "invariant." In reality, the company classified its information systems into three types: presentation systems, back-end systems, and informational systems. Following this line of thought, they designed a conceptual data model for back-end systems, which controlled data directly as an invariant element based on its business model, and built a subsystem along with the data model. Using these structures, the company can now modify and enhance its information systems via each subsystem, adapting to change within the business environment. By consolidating user-interfaces as presentation systems, KDDI accommodated the detailed change requirement for screen layout or design and allowed users to print forms promptly. In addition, the informational systems included data-warehouse and data-mart systems that reorganize data in order to exploit it effectively.

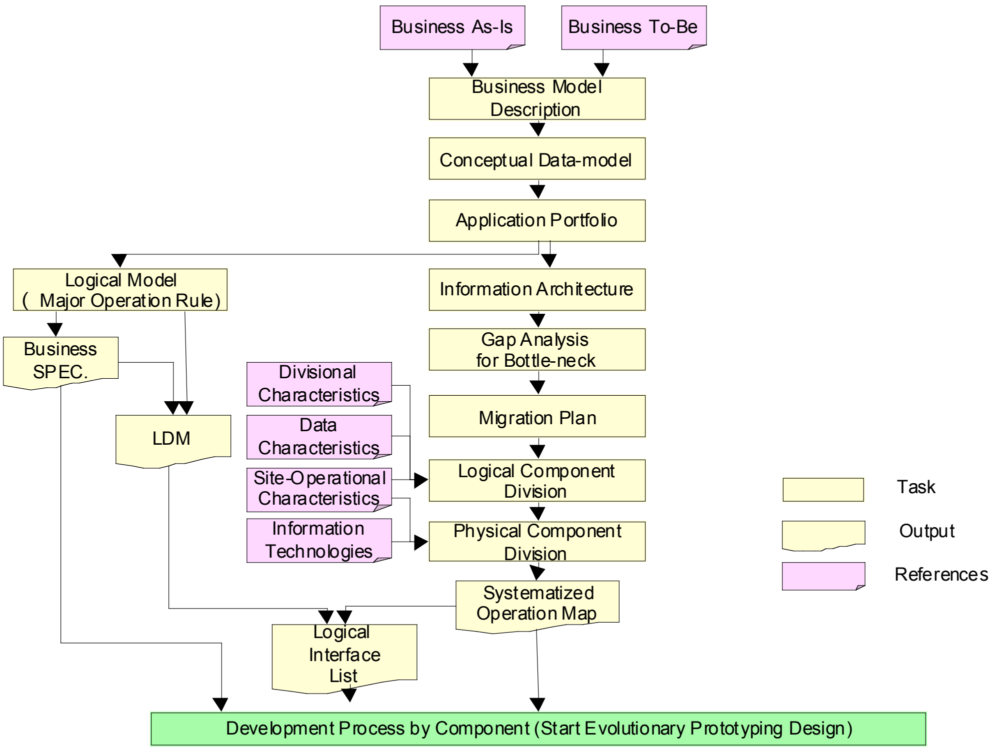


Figure 2 Flow from Designing Conceptual Data Model to Implementation

Figure 2 shows how KDDI built their information systems using the methodology and the guidelines of object orientation (Umeda, 2003).

KDDI defined its subsystems from an adaptation-centric rather than a function-centric perspective, which gave them the ability to exploit the fundamental principles of object orientation (i.e., information hiding and encapsulation). Thus, they were able to utilize a number of clever solutions, including:

- Hiding the entity that the back-end system controls from user-front systems;
- Hiding the physical configuration of the back-end system by using a hub;

- Hiding physical implementation by designing systems interfaces based on the conceptual data model; and
- Prohibiting direct data referring and updating between subsystems in the back-end system.

4.2 Insight from the KDDI Case

KDDI demonstrated that it was possible to build information systems with a concept almost identical to the EIS city planning approach. The benefit of this approach was its ability to change or promote a rust-free information system. In order to deploy these structures, subsystems should be defined along with the conceptual data model (ensuring independency of subsystems), and then the rules for implementation (such as the implementation of hubs) and the managing organization should be introduced. With respect to building adaptive information systems in a changing business environment, this case demonstrates that a conceptual data model can be adequately designed and that subsystems can be divided and deployed in a manageable size. Furthermore, this was an organized information system that effectively maintained its independence.

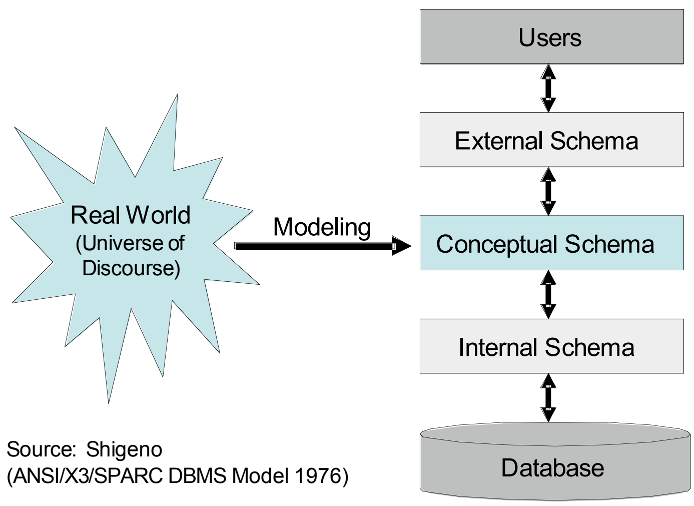
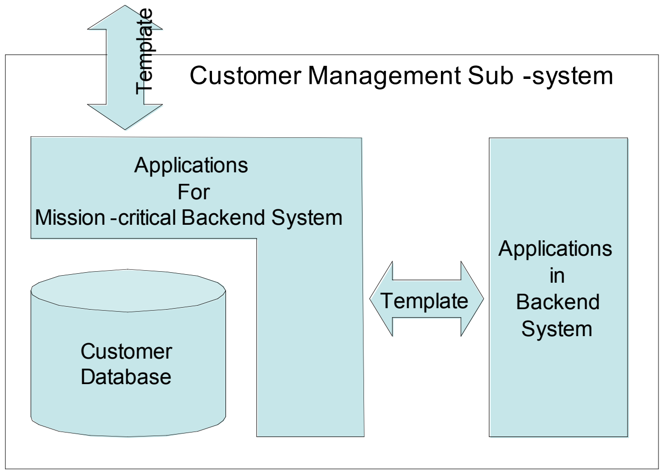


Figure 3 The Three-Schema Architecture

KDDI created the conceptual data model by modeling the real world and by recognizing that information systems simulate the real world. Next the application portfolio, the information systems architecture, and the migration plan were created based on this conceptual data model, and the component partitioning was performed. Figure 3 illustrates the three-schema architecture based on ANSI (Shigeno, 2004). According to Hay (1997), the conceptual schema forms the external view into a single, coherent definition of the enterprise's data. An external schema can consist of a variety of elements. An internal schema is an organization of data, based on the technology being used to record it.

KDDI developed a conceptual schema (i.e., data model) that modeled the real world with object orientation. The company then built the data model and, finally, the physical model. Through these processes, it partitioned the system into subsystems. Each subsystem, as shown in Figure 4, was separate from: (a) the other subsystems, (b) the applications in back-end systems, and (c) the front-end systems of the template. This architecture assured that KDDI's subsystems were independent of each other. The template attempts to prevent a subsystem from being an complex and complicated structure and maintains system flexibility.



Source: Shigeno, 2004

Figure 4 Structure of a Mission Critical Subsystem

Shigeno, the CIO of KDDI, stated in an interview that KDDI did not feel the necessity to change this model, even though it has been more than 10 years since the first application system based on this idea was implemented. This shows that the "essence" of an information system, if designed properly, can adapt to change over time.

In this sense, Brooks' meaning of essence, when applied to KDDI's systems, could be represented by the conceptual data model. This analogy seems to fit, since the company created its business model with the philosophy that the information system should simulate the real world. In the context of Ross' maturity model, the company built a Stage 4 model, which moved beyond the data and process standardization of Stage 3.

5. Conclusion

There are many reasons physical city planning appears unsuccessful. The major issues are that the speed of change and the diversification of residents impede the effectiveness of city planning. Though, until recently, it has been effective in building urban areas and their infrastructures, city planning is now criticized because it is stuck in the stage of modern city planning. Planning, in this stage, is based on the foresight and leadership of public administrations. However, the recent business climate that requires the ability to quickly adapt has revealed the weakness of modern city planning.

Applying this discussion to EIS city planning, a similar criticism can be developed. However, the critique does not originate from the essential elements of the EIS city planning approach, but rather from the issue of how to realize the live-to-be architecture of the EIS scenario. It originates from the issue of architecture for the level of information system that composes EIS. In other words, a finer granularity than the EIS level will be needed to realize this.

Post-modern city planning has attempted to resolve these issues. Post-modern city planning presumes that modern city planning has come before it. As a result, the level of information systems at a lower abstraction level of EIS becomes the issue. From this perspective, the difference between the city planning models can be attributed to differences between stages in the maturity model. If so, for EIS to migrate to a new concept of city planning, passing through each of Ross' stage one by one is necessary. In this way, Ross' Stage 4 would be achieved by realizing the standardization of technologies (Stage 2) and data rationalization (Stage 3).

It is predicted that an architecture that exploits independent application modules or services across networks will soon become popular. That is to say that Stage 4 is a completed feature of a modular architecture. The EIS approach will then have to select and utilize various IS services, which include application modules residing both inside and outside of a firm. In this situation, firms will have to consider: (a) what the core competency of the firm's business is; (b) how to realize this competency in EIS (in other words, via the three viewpoints); and (c) how to select and implement applicable technologies. In particular, it is important that firms define and design the boundaries of both business operations and information systems beyond that of the firm as a legal entity. This will ensure the integration of each information systems service or application, as well as the implementation of proper systems operation management.

From the EIS point of view, a service that is built based on the requirements of "parts" will generate problems. This is because services based on local requirements cannot be consolidated under an optimized policy. In the case of KDDI, the conceptual data model was built first and then this was used to guide the construction of the derivative systems. This approach might be able to solve the complexity problem of systems. EIS would then have a robust foundation to migrate to the stage where the concept, corresponding to post-modern city planning, will be workable.

References

Brooks, F.P., *The mythical man-month: Essays on software engineering, Anniversary edition*, Addison-Wesley, 1995.

Deleuze, G. and Guattari, Massumi, B. (Translation). *F. A thousand Plateaus*, University of Minnesota Press, 1987.

Hay, D. "From Relational to a Multi-Dimensional Data Base," 1997. www.essentialstrategies.com/documents/relmulti95.pdf

IBM, "IT architecture: Building your IT city plan," 1999. http://www-1.ibm.com/service/its/us/source/cwp-itcityplan.pdf

IEEE Compute Society, "IEEE recommended practive for architectural description of software-intensive systems," IEEE Std 1471-2000, 2000.

Namba, Y. and Iijima, J. "City planning approach for enterprise information systems," Proceedings of the Eighth Pacific Asia Conference on Information Systems, Shanghai, China, 2004, pp.169-180.

Ross, J. W., "Creating a Strategic IT Architecture Competency: Learning in Stage," *CISR Working Paper* No.334, April 2003.

Schulte, R., "Architecture and planning for modern application styles," Strategic Analysis Report, Gartner Group, April 1997.

Shigeno, T., "System Integration in Era of Change," *Proceedings of Systems Integration SIG*, Japan Society for Management Information, 2004. (in Japanese)

Umeda, A., "KDDI case," Modeling SIG, IS, IPSJ, 2003. (in Japanese)

Yoshikawa, T., *Evaluation of City Planning,* in Minohara, K. (Edit), *Challenge of City Planning,* Gakugei-Shuppannsha, Tokyo, 2000. (in Japanese)