Approach to EA at Fujitsu and Relationships between EA, SDAS, and SOA

● Hiromi Matsuyama

Enterprise Architecture (EA) is an increasingly popular system that totally optimizes business and information systems by IT governance and adjustment of business and information strategies. The EA used at Fujitsu has features such as 1) an approach for realizing IT governance, 2) early development support of EA, and 3) smooth cooperation for operation and further development of EA. Our EA receives good reviews by providing a practical EA methodology in the form of a development and consulting service. From the viewpoint of System Development Architecture & Support facilities (SDAS), Fujitsu's EA is not only positioned as an entry point that connects a business strategy with system requirements analysis, but also deeply incorporates the concept of SDAS into its methodology. This paper outlines EA, Fujitsu's approach to EA, and the relationships between EA, SDAS, and Service-Oriented Architecture (SOA).

1. Introduction

Enterprise Architecture (EA) is gaining attention as a mechanism that can totally optimize business and system operations by strategically aligning management strategies with information strategies and realizing IT governance. EA is not only an upstream phase that links management strategies to System Development Architecture & Support facilities (SDAS), which is an integrated system development methodology developed by Fujitsu, but also has a close relationship with SDAS from the viewpoint of smooth linkage with the development phase.

This paper outlines EA and then describes Fujitsu's approach to EA and the relationships with SDAS in the EA building process. It then describes the interrelations between EA and Service-Oriented Architecture (SOA).

2. Overview of EA

EA is a structure for improving business operations and systems from the viewpoint of "enterprise-wide optimization" to quickly respond to changes in the social environment and changes in information technologies. It organizes and systematizes business processes, information system structures, and technologies to be used by putting an entire organization into perspective.

In Japan, EA was first adopted by the government in the autumn of 2002 for the improvement of e-government procurement processes. Then, in 2004, the government assigned assistant Chief Information Officers (CIOs) to individual government agencies as EA promoters to develop EAs for all projects relating to information systems by the end of fiscal year 2005.

In addition, EA started to be applied in the private sector, centering largely on private enterprises facing a rapidly changing business environment, for example, automobile, electronic, and finance enterprises, and enterprises facing a reorganization of their industry. Nowadays, the accelerated pace of change in business makes it difficult to build systems to suit management

strategies. This trend has diverted the attention of industries to EA as a mechanism for appropriate investment and enterprise-wide IT governance. It is believed that the application of EA will become an important issue that every organization and enterprise must consider.

3. Fujitsu's approach to EA

3.1 Definition of EA structure by Fujitsu

There are a variety of EA frameworks. Fujitsu defined a practical EA structure by further improving the EA frameworks of the Japanese government, which were modeled after the Federal Enterprise Architecture Frameworks (FEAF) of the U.S. (**Figure 1**). This structure was also made public and was generally accepted.

The following explains the six pillars of EA.

1) EA governance

EA governance realizes basic control for implementing enterprise-wide optimization. All EA activities will be implemented under this EA governance. Organization-wide EA governance is normally promoted by the information departments and the planning and development departments of organizations, but dedicated teams are often formed for its promotion.

2) Principles

The principles are the mission of EA put into document form. Although they are the most important part of an EA, enterprises as well as government agencies are often unaware of their importance. It should be noted that it is difficult to develop principles as one expects them to be, but that if consensus cannot be formed during the process of developing principles, the EA will be reduced to a dead architecture over the long term.

3) Architecture models

Architecture models are prerequisites for an EA. For the construction of specific IT systems, design and development will be implemented according to these architecture models. Fujitsu has divided them into the following four tiers based on the architecture models of the Japanese government.

- Business Architecture (BA)
- Data Architecture (DA)
- Application Architecture (AA) or Service Architecture (SA)
- Technology Architecture (TA)

These four tiers are described (modeled) with respect to the As-Is model (or baseline architecture), which models current operations and systems; the Target model (or best practice), which presents improved operations and next systems; and the To-Be model, which represents the future (or ideal) state with the time base taken into account.

4) Reference model

This model is referenced when generating architecture models. Its content can be a set of best practices, the results of investigation of the current state, or the projection of a future state. The Japanese government has published the following five reference models.

- Performance Architecture (PRM)
- Business Reference Model (BRM)
- Data Reference Model (DRM)
- Service Reference Model (SRM)
- Technology Reference Model (TRM)

With the exception of PRM, which is a set of models for assessment indicators, these models correspond to individual architecture models.
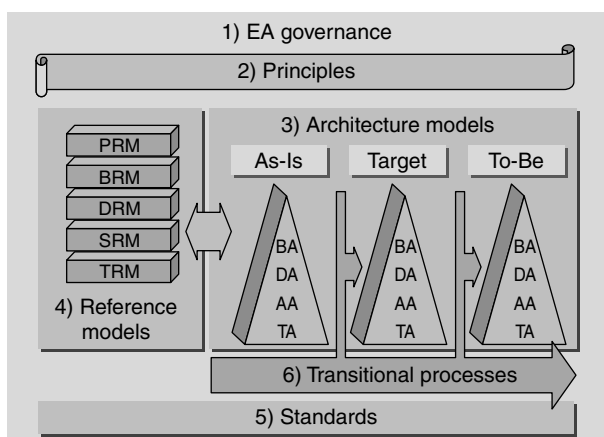

Figure 1
Structure of Enterprise Architecture.

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5) Standards

The standards are technical and institutional rules and standards that should be referenced in EA activities. Some examples of these standards are the development standards, data definition standards, security policy, and operation management standards.

6) Transitional processes

Transitional processes are the processes required to make a system operational and are based on the current operations and IT system. The wider the introduction area of a target organization becomes, the more difficult the planning of possible transitional processes becomes. In general, the processes targeted for putting the next system into operation are collectively called an implementation plan.

For an EA structure, its specific content and points of importance vary depending on the current state, strategy, mission, and goals of the target organization. Because the content of an EA structure cannot be uniformly determined, attention is particularly focused on establishing the EA building process.

3.2 Fujitsu's concept for EA building process

The EA building process varies, and it is not clearly defined even in the EA of the Japanese government. After study, Fujitsu divided the EA building process into five phases (**Figure 2**).

The EA building process starts after a vision and mission based on the management environment have been developed and confirmed. In the EA building cycle, individual phases are implemented in sequence to form the cycle of plan-do-check-act (PDCA).

1) Phase 1: Developing principles

In this phase, principles that constitute rules for promoting an EA are developed and, if necessary, the area to be optimized by the EA is
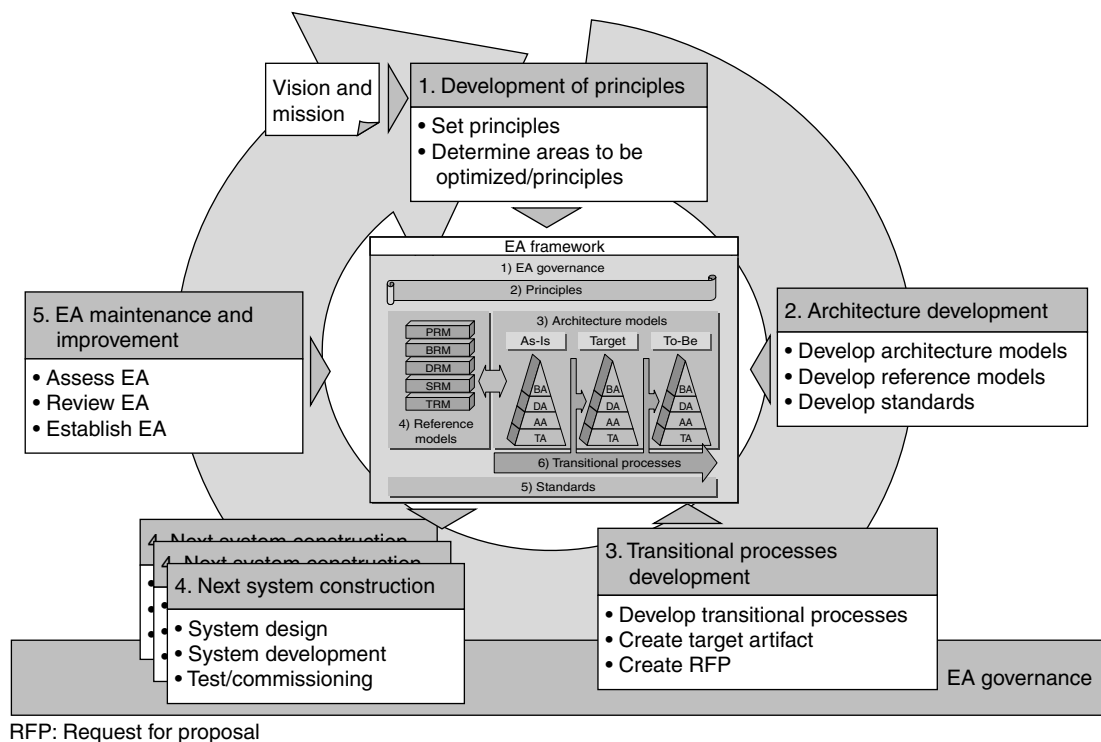

Figure 2
EA building process.

determined. Because it is difficult to introduce an EA from scratch to an entire organization or system, the often-adopted approach is to introduce EA to a smaller area and then extend it according to the results of the introduction.

2) Phase 2: Developing a main architecture

In this phase, architecture models, reference models, and standards are developed. When developing architecture models, the following are described: business operations and processes for BA (top tier); logical and physical data models for DA (second tier); individual applications and their inter-relationships for AA (third tier); and the network infrastructure, middleware, and hardware of an IT platform for TA (bottom tier).

It takes a huge amount of time and work to completely develop reference models and standards. Instead of developing them from scratch, the examples of other enterprises can be referenced or existing reference models and standards can be improved after their assessment and modification as the EA implementation proceeds.

3) Phase 3: Developing transitional processes

In this phase, transitional processes are developed for moving from the developed As-Is model to the Target model and the To-Be model. In many cases, only the To-Be model is developed in Phase 2 and a possible Target model is developed in Phase 3 considering the transitional processes in this phase, and then the Request For Proposal (RFP) is created based on the resultant product. Therefore, the RFP creation phase overlaps the definition of requirements in development.

4) Phase 4: Building the next systems

In this phase, individual systems are developed. Fujitsu's integrated system development methodology SDAS is utilized in this phase.

An EA is not visible in this phase.

5) Phase 5: Maintaining and improving the EA

In this phase, the EA is maintained and improved through feedback from the results of development. Although the Target model substitutes the As-Is model after development, feedback

to the EA from model changes that have been made during development can lead to EA maintenance and improvement.

Each phase is composed of several steps, while EA governance controls the processes as a whole. EA governance refers to a standard for assessing the levels of improvement and also refers to management and control throughout the entire cycle.

3.3 Fujitsu's EA promotion

Fujitsu's EA promotion activities started with its participation in the EA model project of the Ministry of Economy, Trade and Industry (later handled by the Ministry of Internal Affairs and Communications), which started in the autumn of 2002. This project continued until the end of 2004 as a key project for determining the EA guidelines of the Japanese government. A large number of organizations participated in this project, including Fujitsu, and some of the participants were especially involved with a study on reference models. The results of this project were used, for example, by Fujitsu to create its own TRM. In addition, in July 2003, Fujitsu released Japan's first EA service. The service, called the Administration System Optimization Service, has been successfully applied to a variety of business situations.

For human resource development, which is a prerequisite for EA promotion, Fujitsu started three internal EA training courses in the autumn of 2003 to train 400 employees. Then, in 2004, Fujitsu started providing customers with a two-day practical course that evolved from that training and has received favorable responses about the course. Furthermore, in collaboration with an NPO organization, ITC-METRO,[1] from 2005, Fujitsu started providing education for IT coordinators using Fujitsu-version textbooks.

Through the above activities, to establish an EA methodology in which Fujitsu's collective strengths can be fully utilized, Fujitsu compiled manuals (SE handbooks) by combining its expe-

rience in the projects of government agencies by using the SDAS modeling technique and other tools and methodologies with which Fujitsu has expertise. Based on this methodology, in July 2004, Fujitsu announced a consulting service called Business and System Optimization Consulting. Fujitsu responded to about 100 inquiries regarding this service and subsequently won about 30 subscriptions. Because enterprises pursue returns on investments, EA development tends to be considered an excessive burden. For this reason, when conducting business, it is necessary to understand each customer's particular situation and propose a practical way of introducing an EA. Fujitsu's EA is intended to serve exactly this purpose and is also distinctive on this point.

3.4 Characteristics of Fujitsu's EA

This section describes the position of EA in enterprise activity and the characteristics of Fujitsu's EA that are based on this position (**Figure 3**).

3.4.1 Position of EA in enterprise activity

When strategically aligned with each other, a management strategy for responding to changes in the management environment and an IT strategy for coping with the IT evolution will contribute to enterprise-wide optimization. The role of EA is to control the enterprise-wide optimization of business operations and systems by acting as an intermediary between information systems and such a strategic alignment. The EA components include, first of all, principles, then architecture models visualized from these principles, standards for controlling and making architecture models efficient, control organization and rules for running the entire EA smoothly, and
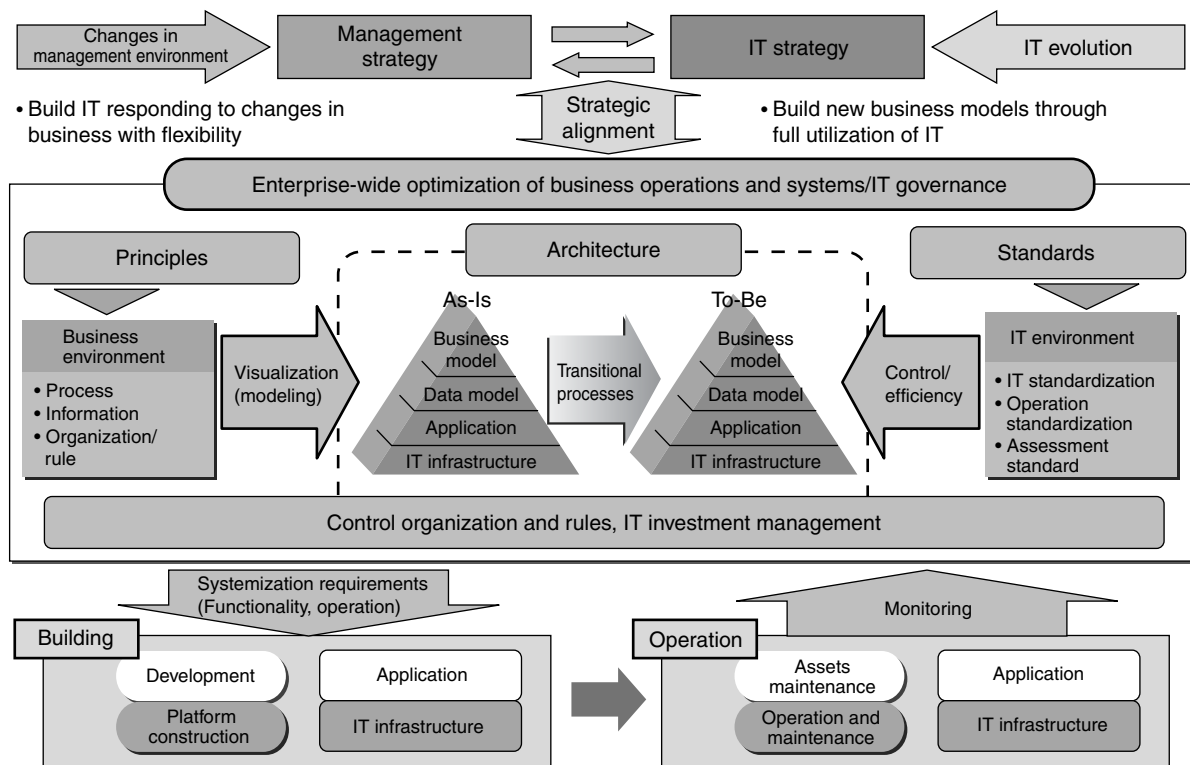

Figure 3
Positioning of EA in enterprise activity.

finally IT investment management. As can be seen, EA is a powerful mechanism for IT governance. Thanks to the above role of EA, further-optimized system requirements can flow into the building phase, whereas EA can be improved by receiving monitoring information from the operation phase.

However, if viewed from a different angle, EA placed in such a context is equal to the activity of improving the total development of existing systems, which requires a huge amount of time and investment. Consequently, while acknowledging the beneficial effects of an EA, many enterprises are reluctant to introduce it.

3.4.2 Characteristics of Fujitsu's EA

Fujitsu's EA has the following characteristics that help to quickly and efficiently produce effects based on the above realities.
1) Provision of a method of realizing IT governance

Fujitsu formed an organization for promoting IT governance throughout the entire Fujitsu Group and provided guidelines on IT investment management to promote IT management inside the Group. Based on the experienced gained as a result, Fujitsu can provide a very effective method of realizing IT governance.
2) Support for rapid development of EA

An EA methodology was developed based on Fujitsu's experience in EA development. Through this methodology, Fujitsu helps customers to rapidly develop an EA by standardizing the process of EA building and making it efficient. In addition, as a methodology for the rapid introduction of Phase 2's To-Be model, which is difficult to develop, Fujitsu developed a consulting technique called "Short EA" based on Executive Planning Guide (EPG), which is a mission-oriented planning technique developed by Fujitsu.
3) Seamless cooperation with development and operation

An EA serves no purpose unless it seamlessly cooperates with development and operation.

Fujitsu attempts to realize seamless cooperation between EA and tools and methodologies for development and operation such as SDAS and TRIOLE using documentation and templates to make them consistent. In particular, as shown in **Figure 4**, Fujitsu's version of TRM arranges domains in place so they can connect as is to the infrastructure platform of TRIOLE.

3.5 Decreased management risk by EA

In recent years, we have seen leading companies that were pioneering new markets with their excellent business models have their foundations shaken and their brand images degraded due to security problems such as personal data leakages and system failures caused by computer viruses, and there seems to be no end to such occurrences. Furthermore, since the Anti Data Leak Law was enacted in Japan, security problems have become a serious management risk.

To prevent security problems, not only individual preventive measures need to be made available on information systems, but also internal control needs to be put in place over entire information systems. "Internal control" means a framework built for reducing the occurrence of frauds and errors that hinder the achievement of business objectives pursued by an organization and for reducing their impact when they occur. Fujitsu thinks that to establish internal control over information systems as a whole, the introduction of an EA, which helps obtain an overview of information systems from the viewpoint of enterprise-wide optimization, will become mandatory. Specifically, internal control mechanisms will be applied to entire information systems indirectly by standards, guidelines, and decision-making processes that are clearly defined in an EA.

In addition, it is important to ensure compliance with laws and regulations for reducing management risk. In the U.S., the Sarbanes-Oxley Act of 2002, born of the lesson of the Enron business scandal, mandates enterpris-
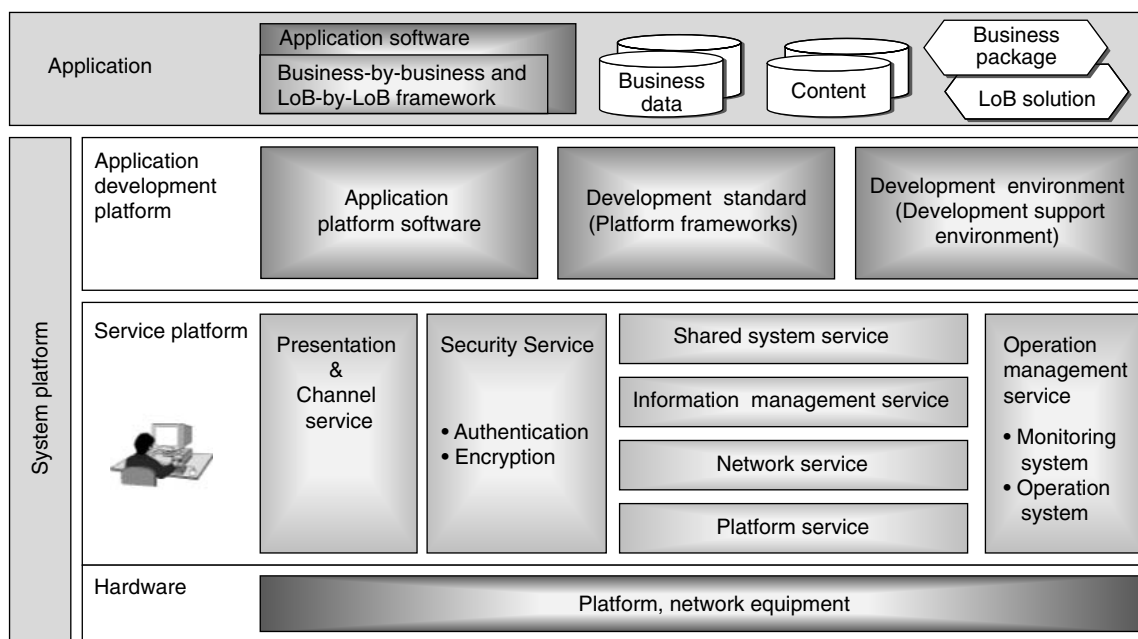
Figure 4
Framework of Fujitsu version TRM.

es going public on the U.S. stock market to put in place and assess internal controls. Also in Japan, the Japanese version of the Sarbanes-Oxley Act is scheduled to be enacted in 2008, and the introduction of internal control audits to ensure its implementation is also scheduled. Enterprises listed on the stock market are now seeking ways of responding to this act. To respond to internal control audits, the introduction of an EA is most effective because control over an entire information system and control over individual applications must be made transparent to auditors.

It should be noted that the Committee of Sponsoring Organizations of the Treadway Commission (COSO)[2] framework published in 1992 in the U.S. is often used for presenting how internal control should be. As shown in **Figure 5**, to make internal control effective, this framework requires that the three elements of risk assessment, control, and monitoring be repeated continuously and that the control environment, information, and communication affecting these elements be properly established and implement-

ed at the same time. Fujitsu strives to upgrade its EA methodology so its EA can be a basis for the above activities in the future.

4. Relationship between EA and SDAS

EA is concept-driven; it does not specify particular methods or tools. For this reason, customers attempting to develop an EA are confronted with the question of how and what to start. Therefore, when implementing the EA building process, Fujitsu recommends to customers an EA into which SDAS tools and methodology are effectively incorporated. We would like to stress that the concept of SDAS pervades Fujitsu's EA methodology.

From the SDAS side, however, EA is positioned as an entry point that connects management strategy and system requirements analysis. It is necessary, in particular, to use the EA entry point in cases where, prior to the analysis of requirements on individual systems, company-wide consistency must be considered and a grand design for a To-Be state must be created.
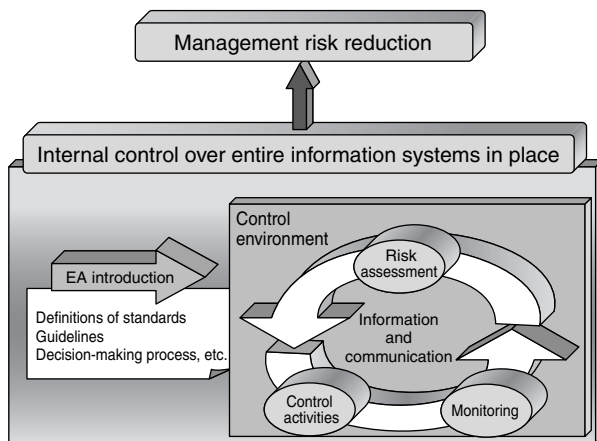
Figure 5
Reduction of management risk by EA.

EA and SDAS thus complement each other very strongly.

The following describes the contributions of SDAS in the EA building process, by giving examples of two deeply related phases.

1) Phase 2: Architecture modeling

In EA, modeling is performed across the four tiers from BA to TA. Fujitsu's EA gives an example of the modeling artifacts shown in **Figure 6**.

Workflow diagrams are mainly used in the BA model phase. However, after collecting specific examples, we found that modeling is sometimes adversely affected due to differences in the personalities of the modelers because 1) the descriptions are inconsistent because there are no conventions for creating them and 2) there is no procedure for the modeling work.

Therefore, we applied a business process modeling technique, "Valuevision Modeling Methodology (VMM)," provided by SDAS for generating models that provide the information stakeholders need to reach a consensus about system development, while minimizing the personality influence of people generating the models.

In the DA model phase that follows, the essential problems of an enterprise are identified. The complexity and magnitude of information

handled by today's enterprises are serious challenges in the development of an EA because a huge amount of time and human resources are needed to cover all the relevant information.

In order to solve this problem, SDAS provides a business data modeling technique that adopts the concept of Kaname Analysis.[note] By using kaname entities and kaname events, which are described in the paper, "Use of Business Modeling in Requirements Definition Phase," elsewhere in this special issue, we can clearly distinguish main parts from accessory parts, thereby clarifying an IT system's structure. This improves efficiency in the DA model phase.

2) Phase 3: Developing transitional processes

Transitional processes for moving from the developed As-Is model to the Target model and the To-Be model are developed in this phase. It should be noted that it is not easy to develop processes because of the huge number of existing systems. Fujitsu provides the TransMigration Services based on its know-how of rebuilding systems with flexibility while effectively utilizing existing systems. The diagnosis phase of this service provides investigation and analysis methods such as asset analysis for analyzing available assets and Proof Of Concept (POC) for verifying the validity of transitional methods. By applying these methods, transitional processes can be developed that are more efficient and present fewer risks.

5. Relationship between EA and SOA

Fujitsu released a solution structure based on SOA in July 2005. From the EA side, generally speaking, SOA can be recognized as a methodology optimized in SA. However, if conceived as business data modeling and business process modeling for realizing services aligned with the concept of SOA, SOA should be described

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note)   "Kaname" is a Japanese term that means a nail or the point where the ribs of a Japanese fan are secured.

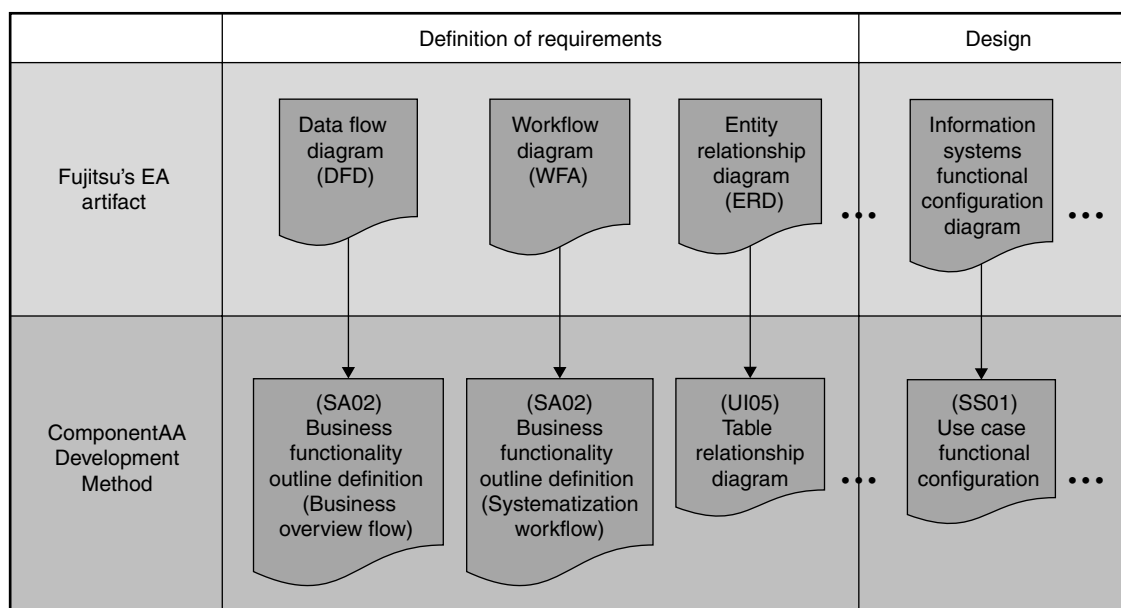|	Definition of requirements			Design	
Fujitsu's EA artifact	Data flow diagram (DFD)	Workflow diagram (WFA)	Entity relationship diagram (ERD) ● ● ●	Information systems functional configuration diagram	● ● ●
ComponentAA Development Method	(SA02) Business functionality outline definition (Business overview flow)	(SA02) Business functionality outline definition (Systematization workflow)	(UI05) Table relationship diagram ● ● ●	(SS01) Use case functional configuration	● ● ●

Figure 6
Seamless cooperation with EA artifacts.

as the basic concept that pervades the architecture modeling of EA.

EA and SOA will continue to improve and evolve, interrelated with each other as essential approaches that should be considered when constructing a change-tolerant IT system.

6. Conclusion

This paper introduced EA, Fujitsu's approach to EA, the relationship between the decision processes of EA and SDAS, and the relationship between EA and SOA.

In recent EA business, there have been many requests for the application of an EA approach to the optimization of infrastructures. To achieve this, it is necessary to have a viewpoint that is long-term and intended for enterprise-wide optimization when considering the optimization of infrastructures and operations. It is also necessary to ensure long-term usefulness of application assets, which are separate from

infrastructures. The EA approach is effective for meeting these needs. Fujitsu developed and is testing an infrastructure optimization grand design called the EA/OPENframework as a methodology for realizing these needs. Moreover, we hope to develop a more effective EA approach by strengthening the linkage with SDAS.

References
1)   IT Coordinators Association. (in Japanese). *http://www.itc.or.jp/index.html*
2)   The Committee of Sponsoring Organizations of the Treadway Commission (COSO). *http://www.coso.org/*

Hiromi Matsuyama, *Fujitsu Ltd.*
Mr. Matsuyama received the B.E. degree in Information Engineering from Kyusyu University, Fukuoka, Japan in 1977. He joined Fujitsu Ltd., Tokyo, Japan in 1977, where he has been engaged in research and development of EA at Fujitsu. He is a member of the Japan Society for Systems Audits (JSSA).