Business Oriented Development of the IT Landscape: Architecture Design on a Large Scale

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ABSTRACT

The paper outlines enterprise architecture as a means of business IT alignment, the respective domains, and fundamental design techniques. It is based on three basic views on architecture. The component view describes the elements of architecture and their relationships. The communication view shows how the elements interact with one another. The distribution view describes how the elements are distributed in terms of location or organizational assignment. Key element of architecture design is to account for interdependencies among the building blocks of architecture. Blueprints are introduced as a means in planning the deployment of architecture on a large scale. Blueprints give a comprehensive view on the building blocks and how the interact. They show the effects of architecture design between business, application, and infrastructure architecture. The main stakeholders and their respective usage of the design techniques are outlined.

Keywords: business IT alignment, enterprise architecture, views, blue prints, stakeholders.

1. ENTERPRISE ARCHITECURE DEVELOPMENT AS A MEANS FOR BUSINESS IT ALIGNMENT

1.1 Enterprise Architecture Domains

Architecture is a commonly used term in the design of information systems. Yet, it is used very differently in scope ranging from the architecture of computer systems to information systems architecture. IEEE Standard 1471-2000 defines architecture as „.. the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution" (IEEE 2000). We summarize the understanding of architecture in "architecture is the art and practice of designing and building structures".

Enterprise Architecture comprises the entire business with all its constituents. The alignment of the business and organizational design of the enterprise with the IT architecture is fundamental. However, understanding and structuring of the basic elements differs (see the discussion in Buhl and Heinrich 2004). The wide range of different domains and scope of enterprise architecture as well as its high complexity are characteristics of enterprise architecture.

The architecture domains introduced in this paper follow the basic structuring of the Open Group (TOGAF 2003) and details the respective domains in architecture building blocks in order to give a comprehensive overview of all constituents of enterprise architecture.

The *business architecture* describes the fundamental organisation and requirements of the business based on business strategy and objectives. It is composed of the following four building blocks:

The business model gives a high level view on the nature of the business in terms of products & services offered in the market, the value chain, business partners, market channels utilized, and the combination of resources and information for generating value add.

The organizational architecture describes the organizational design of the enterprise and the principal cooperation with customers and suppliers.

The process architecture classifies and describes all processes of the business and their respective value adds. It is the core building block of the business architecture.

The process architecture can be classified in the core business processes customer relationship management, supply chain management, product life cycle management and the management and support processes (see usage in figure 8).

The information architecture shows the logical structure of all information entities like products, business partners, logistic information etc.

The IT architecture is composed of the application - and infrastructure architecture.

The *application architecture* gives an overview on all applications supporting the processes of the business with the building blocks enterprise applications, portal & information management platform, data repositories, and EAI Services.

The *infrastructure architecture*, also referred to as technology architecture, comprises the software, hardware and network infrastructure required for operations of all applications. Infrastructure building blocks are basic services (e.g. Email, Telco), workplace services, server systems & storage, and the network. Security is integral part and described in an overlaying structure.

With this architecture definition in mind, it should be obvious that Enterprise Architecture is more than the collection of the constituent architectures. The interrelationships among these architectures, and their joint properties, are essential to the enterprise architecture.

In difference to TOGAF and META Group 2002 the Information Architecture in the above framework is not described as a separate architecture domain. It is split in a building block of the business architecture in terms of logical information structures and a building block of applications architecture in terms of implementation of data repositories. This provides for a clear distinction of the business oriented description of the enterprise architecture and the derived technological implementation (for an overview on other enterprise architecture frameworks see Lapkin 2004a and b).

This paper can only give an outline on the domains of enterprise architecture framework and sketch the main building blocks at a high level. All building blocks are detailed down to the level of modules, systems and components. The framework gives a comprehensive description of all relevant elements of enterprise architecture providing a principal structure and classification schema used as a reference for architecture development.

An Enterprise Architecture however, includes not only the three domains for the "as is" architecture (baseline architecture) and the target architecture. It contains also a strategic information base with a clear definition of business objectives and strategy.

The strategy is needed for the transitional processes in order to implement new technologies in response to the changing business needs. That means the enterprise architecture includes also the process to create, update and manage the evolution of the architecture domains in line with business strategy. The design of business architecture determines the development of the IT architecture.

The following listing sketches some objectives to be pursued with enterprise architecture (Aranow 2002, p. 9f., Masak 2005, p. 9f., Meta 2002, p. 6f., 49f., Günzel/ Rohloff 2003, p. 424, TOGAF 2003):

- Strategy and business orientation - enabling, leverage of IT, new business models
- Transparency - complexity and dependencies of architecture building blocks

- Communication between business and IT community - different people from management to IT experts involved
- Planning - target oriented, steering of I&C program with strong impact and to secure compliance to corporate standards
- Synergies - develop & implement the I&C landscape in a systematic manner and to utilize synergies
- Adaptability - dynamic development of market, business, and technology, provide for scalability and growth

Enterprise Architecture is a means to support business and IT alignment. Architecture planning is the ground for the development of the IT landscape and at the same time provides the agility to react fast to market requirements.

1.2 Overview on the Architecture Framework

An architecture description is a formal description of a system, organized in a way that supports reasoning about the structural properties of the system. It defines the building blocks and components that make up the overall system, and provides a plan from which products can be procured, and systems developed, that will work together to implement the overall system.

The IEEE-Standard "Recommended Practice for Architectural Description of Software Intensive Systems" (IEEE 2000) can be used as a basis for an architecture description: every system has an architecture, which can be recorded by an architectural description. The architectural description is organized into one or more constituents called (architectural) views. Each view addresses one or more of the concerns of the system stakeholders. The term view is used to refer to the expression of a system's architecture with respect to a particular viewpoint (Bachmann 2000, Clements et al. 2003).

In contrast to information systems architecture, which is widely discussed under the aspect of a single information system being integrated in an organization and aligned with business processes, enterprise architecture takes the entire IT landscape into focus. In comparison architecture is understood as city planning and not only as planning the architecture of a house (Gartner 2002, Burke 2003). It requires the definition of development plans for an entire area and not only the construction plan for a building. The development of the IT landscape in contrast to the information system architecture of a single system is architecture design on a large scale. It requires adequate features for architecture description.

Essential requirements for "architectures in the large" (compare Dern 2003, p. 81-83) are:

- Reduction to core entities and construction principles
- Balance of abstraction and specialization
- Representation of mutual dependencies
- Integration of architecture in the large and in the small

In the following we will show how an architecture framework and three distinct views on architecture support the reduction to core entities and construction principles. Blueprints give overview on the IT landscape and show interdependencies between the building blocks of architecture. Views and blueprints can be combined for large and small scale architecture development. The figure 1 depicts the architecture framework and the corresponding techniques for architecture description. It is based on the principal elements of the architecture framework for information systems described by Sinz (Sinz 1997, p. 3). The framework is based on the following elements:

Views: Each enterprise architecture domain can be described taking a specific view, which looks at the architecture, its structure and elements from a specific perspective.

Relationship/ dependencies between the enterprise architecture domains can be described using the concept of blueprints.

Standards are an essential element being used for all architecture building blocks which provide for inter-changeability, ease of across system communication etc.

Besides the use of standards, identification and usage of commonly recognized pattern is also an important objective for architecture design.

We focus on the introduction of three distinct views for enterprise architecture and the description of architecture dependencies with the means of blueprints. Pattern and standards are not described in this paper.

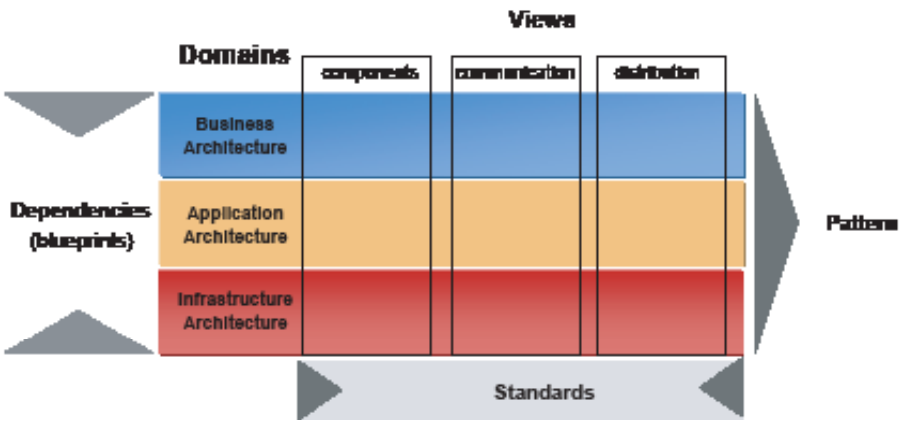
2. TECHNIQUES FOR ENTERPRISE ARCHITECTURE DESIGN

2.1 Views on Architecture

The principle of views is the basis of every reasonable architecture description and the need for multiple views in architecture descriptions is widely recognized in the literature. The IEEE standard 1471 (IEEE 2000), however, describes only the concept of views, stakeholders and concerns. Because of the wide range of opinions on selecting appropriate views, the standard does not make any statements on selecting views, the notation or name of views.

There exists a variety of views in different architecture frameworks. Data-, function-, process oriented views, and dynamic aspects are often named, sometimes supplemented by an organizational and resource view (e.g. for different views see the information system architectures discussed in Bernus et al. 1998). Zachman (1987, p. 291) was one of the first to state "There is not an information architecture but a set of them" and he introduced different views on architecture. This work was continued over the years (Sowa/ Zachmann 1992, Zachman framework). It comprises more than 30 views in a matrix with data, function, network, people, time, and motivation in scope from planning to implemented architecture. The main drawback is the fact that there are too many views included in it. The framework is a mix of views, domains of enterprise architecture, and different stakeholders.

Figure 1. Architecture framework and architectural description



Taking a close look on the diversity of views, we identified three basic views which are sufficient to describe all relevant aspects of enterprise architectures:

Component view: The view describes the logical and functional structure of the architecture in scope. All building blocks and their systems and components are described in terms of composition, structure and relationships among one another. The component view allows for different level of detail. Components, systems, subsystems, building blocks can be grouped or decomposed. The segmentation of the diagram is in building blocks based on the respective architecture in scope.

Communication view: The view describes the communication (interaction) between systems and components. The relationship among the systems is decomposed in the interaction of components within a system and to other systems. Different types of communication can be described with distinct notation for communication lines. The segmentation of the diagram is in communication areas based on the respective architecture in scope.

Distribution view: The view describes the allocation of systems or components in terms of geographical or organizational distribution. The diagram is segmented in organization or location based on the respective architecture in scope.

Figure 2 gives an overview, which illustrates the basic look of these views. An aggregated view on architecture is required which goes beyond the semantics of modelling techniques like UML, thus a notation specific for the purpose of architecture design has been developed (see figure 4 for more details).

These three views can be applied to all domains of enterprise architecture. However, the segmentation of the diagram is selected according to the appropriate context of the domain and chosen level of detail. In the following section we

Figure 2. Three views on Architecture (principal layout)

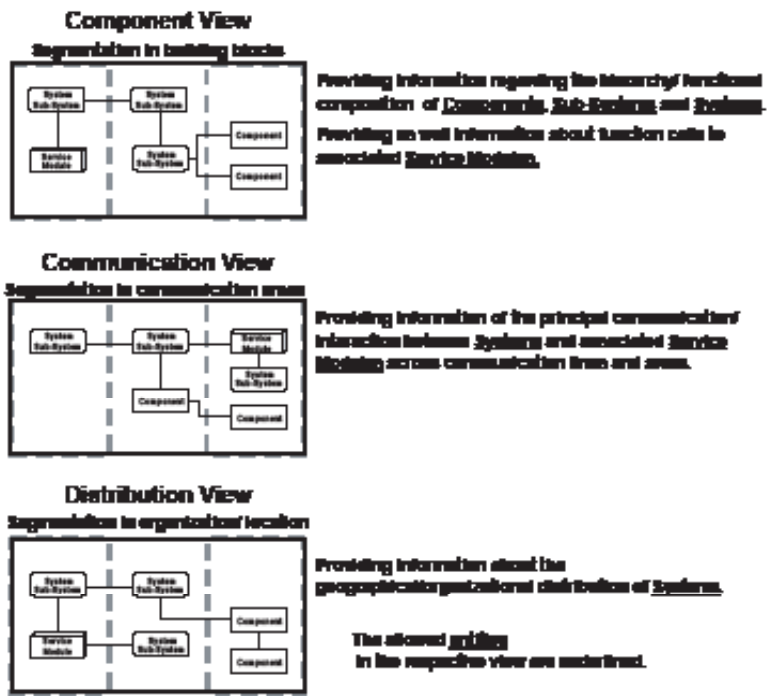
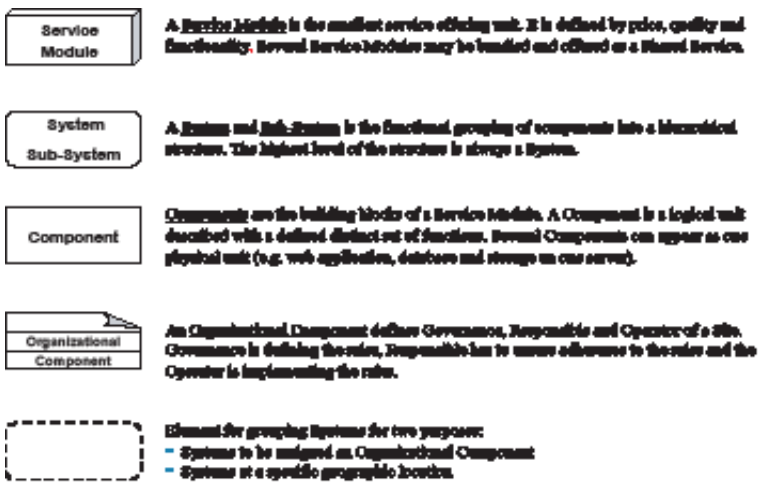


Figure 3. Notation for architecture views (extract)



illustrate the use of the views for the domain of infrastructure architecture using the example of an Email Service.

The high complexity of enterprise architectures can be reduced by taking particular views which focus on specific aspects of architecture. The three views facilitate the reduction to core entities and construction principles as well as the understanding of their behaviour.

One objective among others in the description of architecture is to identify pattern in order to establish standards for the design of architecture (Buschmann et al. 1996). These standards can be derived from these views for components, communication or distribution.

For the design of architecture a "Service Oriented Architecture" (SOA) approach is followed. Basically, IT architecture can be always seen as providing services to the business, e.g. an application supporting a business process or office and communication services at the workplace. This perspective puts the value add of IT into the focus. Consequently the building blocks of the architecture framework are structured in service groups, core services, and service modules. The example of an Email Service is used to demonstrate the description of this service using the three views. It is not only to show how these views describe the Email Service in all its aspects but also to outline the notation and features of these views. Figure 3 gives an extract of the notation of the essential elements.

Figure 4. Component view (example Email Service)

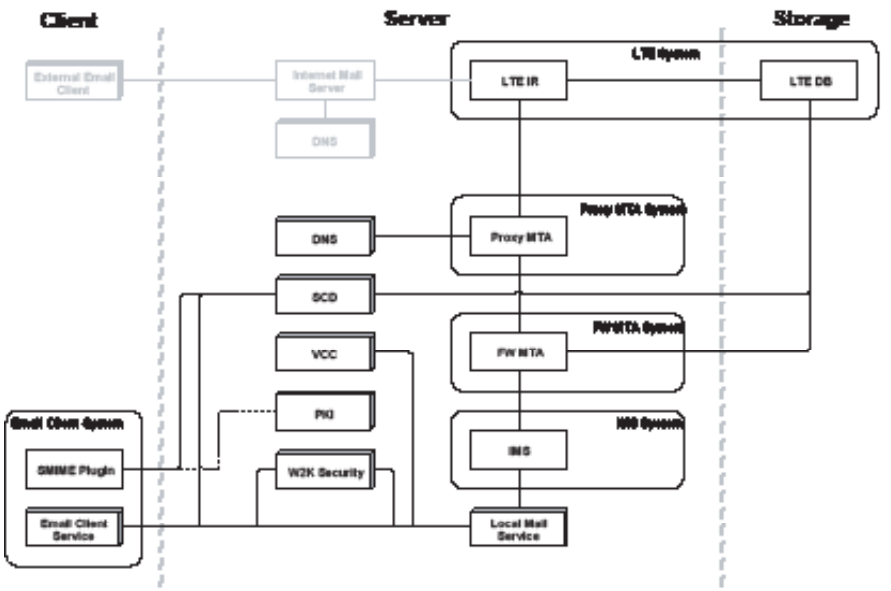
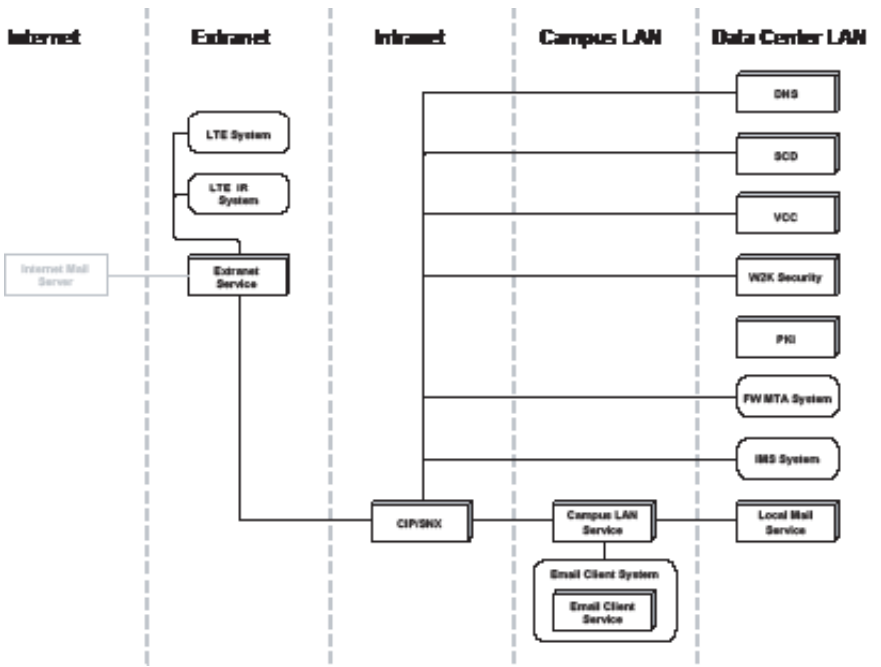


Figure 5. Communication view (example Email Service)



The component view is used to convey the functional and logical structure of architecture. As depicted in figure 4, the view is divided vertically into three major parts: client systems, server systems, and storage systems (infrastructure building blocks). All service modules, systems, and components are described in terms of composition, structure and relationships among one another.

The communication view describes the interaction between the service modules, systems, and components of the Email Service. The diagram is segmented in the communication areas Internet, Extranet, Intranet, Campus LAN, and Data Center LAN.

The distribution view describes the allocation of service modules, systems, or components in terms of geographical or organizational distribution. The distribution view is divided horizontally into three major parts. The segmentation of the diagram follows the company's organization in corporate, group, and region. In addition organizational responsibility is assigned which defines Governance, Responsible, and Operator of a Site. Governance is defining the rules, Responsible has to ensure adherence to the rules, and the Operator is implementing the rules.

The Email Service example illustrated the use of the three views for infrastructure architecture. The same principles for the design of the views are applied for applications architecture using the respective building blocks for the segmentation of diagrams. The views can be used at any level of detail for the decomposition of the chosen part of architecture (building block, service module, system). The combination of the architecture descriptions derived can be used for an integration of architecture in the large and in the small.

2.2 Dependencies of Architecture Building Blocks

Enterprise Architecture is more than the collection of the constituent architectures. The inter-relationships among these architectures, and their joint properties, are essential to the enterprise architecture. Thus, the architecture domains should not be approached in isolation. Key element of architecture design is to account for interdependencies among the building blocks of architecture. Blueprints are introduced as a means in planning the deployment of architecture on a large scale. Blueprints give a comprehensive view on the building blocks and how the interact.

Figure 6. Distribution view (example Email Service)

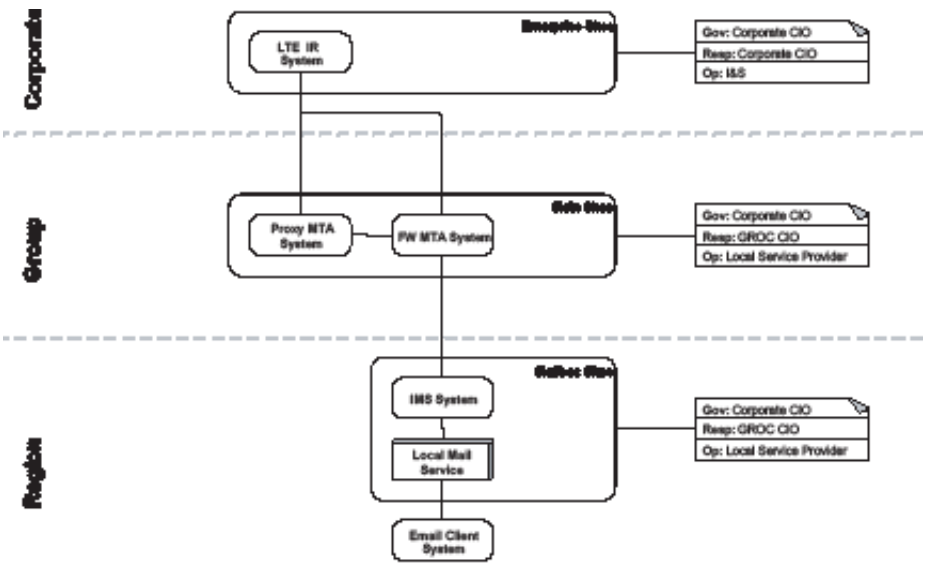
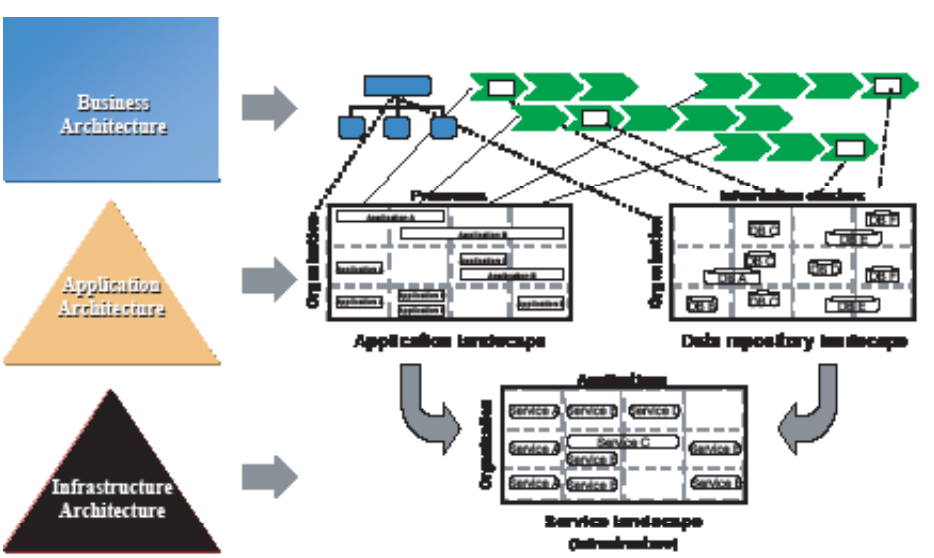


Figure 7. Main blueprints for IT architecture development



They show the effects of architecture design between business -, application -, and infrastructure architecture.

In the focus of enterprise architectures is the alignment of business and IT. In other words, the design of the business architecture determines the IT architecture which has to support and enable business. The building blocks of business architecture, with the process architecture as the core, define the frame for the design of the IT landscape. The dependencies between the different architectures can be described in blueprints. A blueprint is a plan which describes the deployment of an architecture building block across the enterprise. It pictures the landscape of this building block in a matrix of two business dimensions.

The Figure 7 illustrates the derivation of main IT blueprints from the organization and process architecture.

The application landscape describes for each business process how it is supported by applications. The second dimension shows the deployment in organizational units, like divisions, business segment etc.

The data repository landscape describes the deployment with databases and how they support defined information clusters of the information architecture. The second dimension shows the deployment of the databases in organizational units.

The service landscape shows the deployment of infrastructure services and the support of applications. The second dimension shows the deployment in organizational units.

In general, different types of blueprints can be generated depending which dependency of business -, applications -, and IT infrastructure architecture or respective building block is in focus. Also, the matrix dimensions can be chosen at different level of detail. However, the experience in architecture projects shows that a high level is sufficient in order to derive decisions for architecture development. Generating to detailed blueprints involves a lot of resources and time without enriching the decision base in the same degree. The three blueprints introduced provide a good information base for management decisions. The following section gives an example of an application landscape for Siemens Medical being worked out in a corporate architecture project.

Blueprints for application landscape are in the main focus in order to show IT support for business. The figure 9 gives an example of an "as is" application landscape of the medial solution group of Siemens AG. The applications in use are mapped to level 1 business processes of Siemens. Second dimension of the matrix are the divisions of medical solution.

In a number of projects these types of blueprint have been proven to give a transparent overview on the application landscape and are a sound basis to derive architecture decisions. At a glance one can see processes not supported by applications or redundancies where more than one application is in place for a process. Blue prints are used for presentation of "as is" as well as target architecture. The blueprint of the target architecture describes the deployment plan to implement IT strategy. From the gap analysis of "as is" and target architecture IT projects are derived. Finally, the projects are prioritized and the overall IT program is defined in order to implement the architecture.

3. ARCHITECTURE DESIGN TECHNIQUES AND STAKEHOLDERS

The scope of enterprise architecture and the architecture development process, ranging from strategic formulation to implementation, in mind it is obvious that a number of people coming from different organizational backgrounds and disciplines are involved. Figure 9 outlines the main stakeholders involved in planning, development, and implementation of enterprise architectures. It shows their basic roles and usage of architecture design techniques (see Dern 2003, p. 108f., META 2002, p 69f., 205f., 333f., TOGAF 2003). In addition to the techniques discussed in the prior chapter, methods for IT strategy definition and implementation are included in this overview due to the fact that this is the major reference for architecture development.

The stakeholders like CEO/CFO; CIO, IT strategy planer, and program manager are involved in the business/ IT strategy and decisions for direction, objectives

Figure 8. Blueprint example of "as is" application landscape medical group Siemens AG

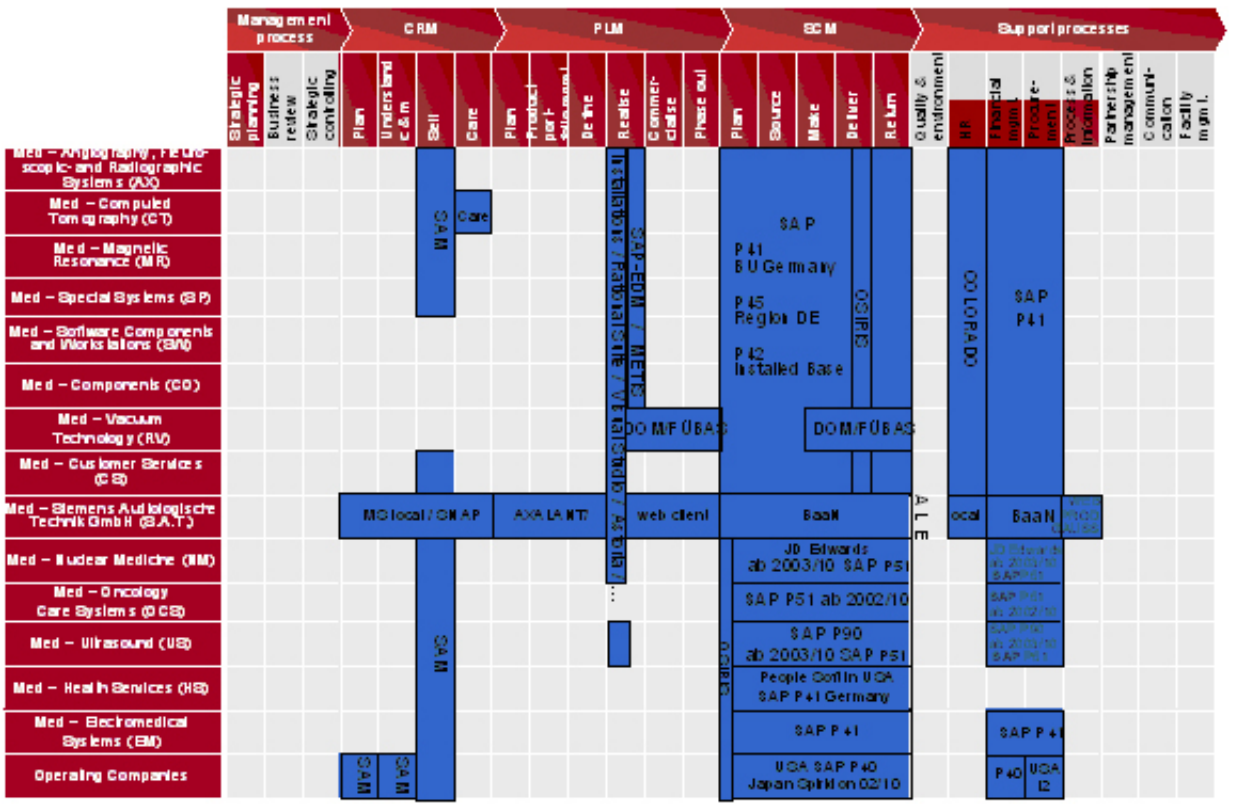
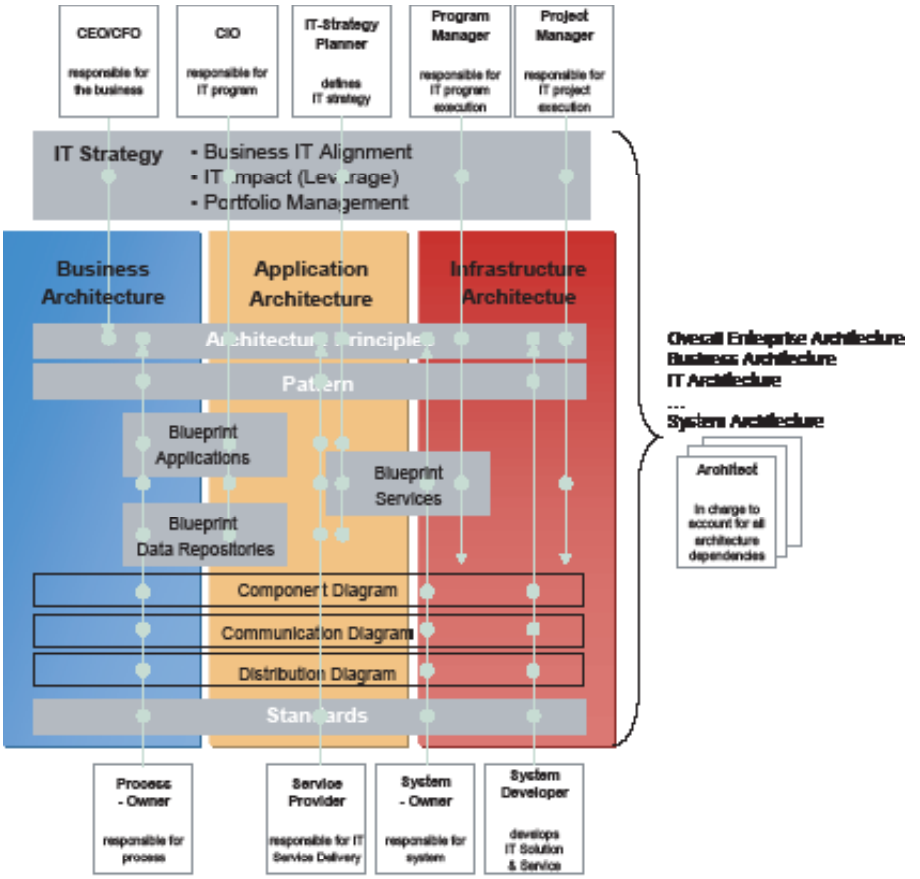


Figure 9. Architecture design techniques and stakeholders



of architecture, and IT program. They merely use methods of business IT alignment, IT impact, portfolio techniques and blueprints. Architecture principle and pattern are partly used.

The central role plays the enterprise architect who leads the architecture development and coordinates all respective activities. He is responsible for as is/ target-architectures and the dependencies among architectures. In addition, there are other domain related architects involved. Responsibility of architects can be on diverse domains ranging from enterprise - to system architecture. Architects use the entire range of techniques with different levels of detail depending on their respective domain.

Process owners focus on blueprints which show how processes are supported by applications and services. Principles and patterns for business architecture are also used.

Service providers use blueprints for an overview of the IT landscape and to allocate services. Principles and patterns are also used.

System owners and system developers use component -, communication - , and distribution diagrams with focus at system level. Defined principles and pattern are basis for their work.

Thus, these techniques are used differently by the stakeholders depending on the respective scope of work. The different ways of architecture description are an important means of communication among the stakeholders involved in the architecture development process and the alignment of business and IT. In order to generate different views of architecture, all architecture documentation is stored in a repository. The Corporate modeler (Casewise 2006) is used and enhanced with additional features for architecture description. The IT Navigator (IT Navigator 2002) was developed for analysis and assessment of architecture (blueprints, IT project portfolios etc.).

However, architecture development is very much management and communication among the different parties involved and not only technical construction. The techniques introduced are embedded in a well defined architecture development process. Within the scope of this paper only an outlook on the main stakeholders could be given. Architecture management and process are fundamental for a business oriented, sustainable development of enterprise architecture. Project experiences in this area will be addressed in a separate paper.

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