Extracted from the first chapter of a book "Enterprise Architectures and Integration Using SOA" by A. Umar, NGE Solutions, 2010. Please send your comments and suggestions to umar@amjadumar.com.

1 Enterprise Architectures and Integration for Strategic IS Planning

Executive Summary

Enterprise architectures and integration is a crucial task for the public as well as private sectors. In particular, governments need to develop an overall architecture that captures the people, processes and technologies activities and specifies how all these activities will work with each other in a smooth and integrated manner. To succeed in egovernment, the architecture must be based on a strategic plan and explore a large number of people, process and technology issues and eliminate surprises. This short tutorial gives a quick overview of the vast body of knowledge that entails a typical enterprise architecture, integration and strategic planning process and presents a conceptual framework for further exploration of this important area. It also briefly describes how the computer aided strategic planning, architecture, controls and education (SPACE) environment can be used in practice for such problems.

1.1 Introduction

Modern enterprises in the public as well as private sector represent networks of autonomous firms cooperating with each other to achieve common business goals. In this climate, a firm's supply, production, logistics and distribution networks need to be architected in an integrated and flexible fashion to quickly respond to fluctuating market conditions and frequent mergers, acquisitions, and outsourcing operations. To survive and thrive in this rapidly changing environment, modern enterprises need to establish flexible enterprise-wide architectures that can quickly integrate and deliver needed services. For example, when a manufacturing company acquires multiple companies with widely varying systems based on different technologies of different vintages, an enterprise wide architecture is needed that makes the acquired and the existing systems work smoothly with each other.

Enterprise architecture (EA) and more importantly an integrated enterprise architecture (IEA) is a key tool for competitive advantage because it smoothly inter-weaves the IT operations with the organizational business strategy. In addition, it is important to show how an IEA can be developed effectively, instead of just preaching that it needs to be done. This chapter establishes the underlying principles of enterprise architecture (EA), the importance of integration in EA, and the role that service oriented architecture (SOA) can play in developing an integrated enterprise architecture. In addition, a systematic methodology is proposed that can be used in practice to develop IEAs. Finally, a computer aided IT planning, integration, security and administration (PISA) toolset is introduced to support the methodology.

To better understand the complex interactions between business and IT and how IT supports the business, a very simple view is presented in Figure 1-1. This view of an enterprise is presented in terms of three high level layers and their role as drivers and enablers of an enterprise:

- Business focused layer that concentrates on business strategies, services and business processes:
- Business plus technology focused layer that deals with enterprise business applications
- Technology focused layer that provides the IT (information technology) infrastructure

Business strategies represent the long range game plan to win in the marketplace. Business strategies align the business products/services, processes, and several other activities to survive and succeed in the marketplace**.** The term business service and business process are frequently interchanged. For the purpose of this book, we will use the following definitions;

- **Business service** (BS) is something that is delivered to the customer. For example, dry cleaning service, house renovation service and online banking represent things that are delivered to the customer, usually for a fee. A business service may be delivered to internal or external customers. For example, a payroll service is delivered to the employees of a company. Businesses usually deliver products, services or both to its customers.
- **Business process (BP)** is a collection of *activities* that are required to achieve a business goal – the goal may be a business service. At a basic level, a BP can be represented as a flowchart that specifies the orchestration of activities needed to complete the goal. For example, for a payroll *service*, several BPs have to be carried out (e.g., pay has to be computed, deductions have to be considered, overtime may need to be calculated, etc).

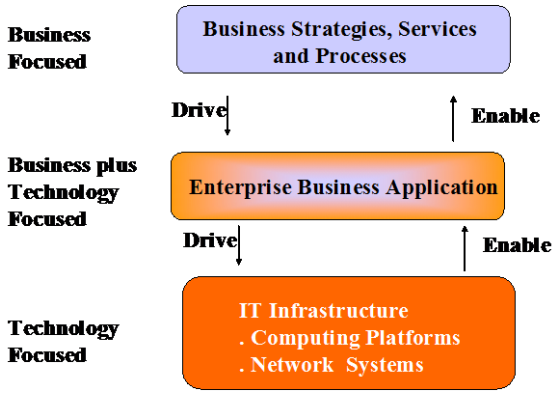

Figure 1-1: Key Components of an Enterprise

As we will see, the simple but elegant view presented in Figure 1-1 will lead us to the following starter definition of an Enterprise Architectures:

> **Enterprise architecture (EA)** = Business architecture + application architecture + technology architecture (computer platform architecture + network architecture)

Key Concepts

- Business strategies, applications, and IT infrastructure are the three essential components of an enterprise
- An enterprise architecture (EA) shows components of an enterprise, what do they do, and how do they interface/interact with each other

- Enterprise architecture (EA) = Business architecture + application architecture + technology architecture (computer platform architecture + network architecture)
- Integrated enterprise architecture (IEA) = EA with focus on integration. Integrated enterprise architecture provides an inventory of the business and IT resources and how they work with each other smoothly and seamlessly (hopefully!).
- IEA promises many benefits that include: identifying what resources exist; improving integration among resources; facilitating business process improvement, and creating speed and efficiency in meeting changing business needs through IT.
- SOA is an effective way to develop an IEA. SOA provides a standards-based conceptual framework for flexible and adaptable enterprise wide systems.
- A high level methodology is very useful in developing an IEA. The methodology presented in this chapter consists pf individual plans that can be developed and then integrated together into an enterprise wide architecture.

1.2 Enterprise Architecture and Integration Concepts

1.2.1 What is an Architecture?

Architectures play a vital role in modern information systems because they show how the individual systems tie together to satisfy the overall requirements. Many views on architectures exist at present (see, for example, [Askit 2001, Caruso & Umar 2003, Clemens 2002, Herzum 2000]). It is not our objective to give a comprehensive discussion and comparison of architecture definitions (see the sidebar "Architectures: Glossary and Definitions"). Instead, we adopt the following simple but highly operational definition of architecture:

Definition: An architecture of a system is a structure that describes three things:
- Components of the system (what are the pieces of a system?),
- Functions performed by the components (what do they do?), and
- Interfaces/interactions between the components (how do they work with each other?).

This definition is consistent with the IEEE 610.2 definition of an architecture: "The structure of the components, their properties, relationships, and the principles and guidelines governing their design and evolution over time."

Within the context of information systems, several types of architectures have emerged over the years (e.g., business architectures, database architectures, computing architectures, network architectures, software architectures). In all of these cases, it is useful to remember what are the components of the system, what they do, and how they interface/interact with each other. For example, a business architecture would show the business components (e.g., the business processes), what they do (e.g., satisfy customer needs) and how they interface/interact with each other.

Architectures: Glossary and Definitions

Building Construction Architectures: The structural abstractions (e.g., blueprint) and styles (families of related common variations) that define a class of structure (e.g., a cathedral) or a particular structure (e.g., my house). Architecture usually focuses on the big picture and not the details of what color my rug is or specific pictures on my wall, though such details can be viewed as architectural since they could be consonant or dissonant with the architecture's theme. There is no clear dividing line.

Application Architectures*:* Application architectures are broad architectures of the domain/application of interest and, more narrowly, sometimes application generators for specific domains.

Software Architecture: A static framework or skeleton (structure or set of conventions) that provides the form of a software system and the conventions, policies, and mechanisms for composing itself with subsystems, or component parts, that can populate the architecture. The architecture defines how the parts relate to each other including constraints governing how they can relate. An abstract framework is one that has not been instantiated with specific subsystems.

Other Glossaries:
- Gio Wiederhold's glossary of I3 architecture terms (www-db.stanford.edu/gio/1996/glossary.ps).
- DoD DISA terminology (www.disa.mil/disasub.html).
- NIIIP Reference Architecture: Concepts and Guidelines - Glossary (www.niiip.org/public-forum/ntr86-010html/Rashort-8.html).

Source: Craig Thompson and Frank Manola, "Component Software Glossary", www.objs.com, Glossary sponsored by the Defense Advanced Research Projects Agency and managed by the U.S. Army Research Laboratory under contract DAAL01-95-C-0112. 1997

1.2.2 What is an Enterprise Architecture and Why is it Important? [1]

An enterprise architecture (EA), based on the aforementioned definition of an architecture, shows components of an enterprise, what do they do, and how do they interface/interact with each other. Basically, an EA is a consolidation of business and technology that can be of great value to the corporate management as well as CIOs. Here are some possible values of EA [Cardwell 2008, Koch 2005, Rico 2006]:

- EA aligns IT to business and leads to integration of business and technical processes. Basically, an EA is a road map that presents how all aspects of the IT program are aligned with the organization's strategic goals.

[1] This discussion has been greatly influenced by the research paper "Enterprise Architecture Leads to IT ROI and Competitive Advantage" by Jennifer Gronwaldt, Pennsylvania State University- Harrisburg, December 8 2008

- Properly executed, "an EA can clarify and help optimize the interdependencies and relationship among an organization's business operations and the underlying IT infrastructure and applications that support these operations" [Cardwell 2008, pp.49].
- EA facilitates the CIO's performance and supports the deliverables by the CIO and the IT organization. It provides an explanation of how IT is used to enable the business processes and business strategies.
- Review of EA documents can reveal gaps and duplication and can also support impact analysis. EAs facilitate enterprise planning and problem solving views at different layers (business, applications, and IT infrastructure).
- EAs can be used to document the present method of operation (PMO) as well as the future method of operation (FMO). The differences between PMO and FMO lead to gap analysis and a planning tool about how to 'get from here to there'.
- EA can be used to evaluate the quality of IT services. return on investment (ROI) from IT can be derived by uncovering where, how well, and for what end IT is being used.
- The process of developing the EA creates opportunities for continuous business process improvement. An EA is developed in a similar manner to how a business process hierarchy is developed, as both are a visualized understanding of the relationship between people, process, information and technology. In some cases, the careful examination of business processes required in developing the EA, leads to the instances when some of the business processes are actually written down.
- Development of an EA presents an opportunity for collaboration between IT and other business functions. It also requires support from the top management -- investment of time and resources plus commitment to the changes inherent to the discoveries resulting from the EA process have to be authorized. An ideal EA initiative can emerge from the joint support of the CIO and CEO, or other chief operations or financial officers.

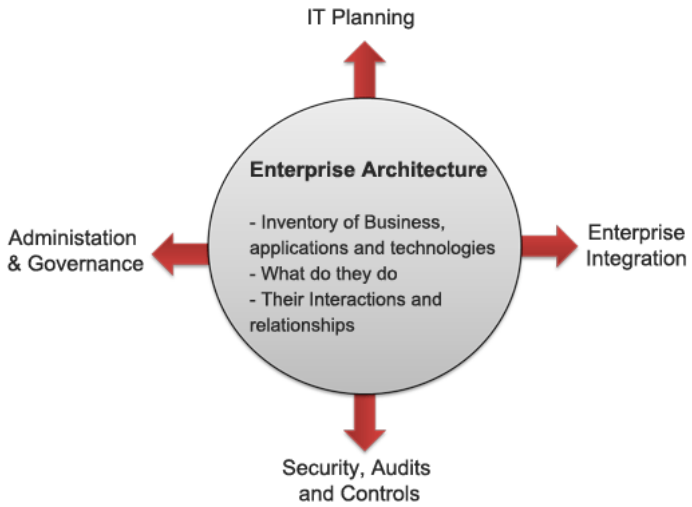

Figure 1-2: Conceptual View of an Enterprise Architecture and its Benefits

Figure 1-2 shows a conceptual view of an EA and its benefits in terms of four broad categories (planning, integration, security, and administration – PISA). This conceptual view is the foundation of the PISA toolset described later. EAs, however, present many challenges to the organization. Development and maintenance of an EA can be a long and expensive undertaking. It is important to measure ROI of an EA effort. For ROI estimates, tangible measurements of the costs and benefits need to be identified. The costs of establishing an EA can be organized into distinct classes such as financial improvement, constituent services, and reduced redundancy. The benefits have been listed

above. Monetizing the different types of costs and benefits facilitates the demonstration of ROI. Besides ROI, considerable effort is needed to make sure that the EA efforts are successful. For example, CIOs and CTOs can be removed from the actual development and the use of the EA document, especially in large organizations. In such cases, a group of architects, each focusing on a different dimension, generally report to a chief enterprise architect, who in turn, reports to the CIO

A great deal of information about enterprise architectures is available. Here are some key sources:

- The Open Group Website (http://www.opengroup.org)
- Zachman Institute for Framework Architecture (ZIFA) Website: (www.ZIFA.com) ::
- EA Portal at www.enterprise-architecture.info
- Enterprise Architecture Center of Excellence (EACOE) website (http://eacoe.org)
- Gartner Group (www.gartner.org) Enterprise Architecture Practice

Case Study: FDA Uses Enterprise Architecture to Standardize and Save

The Food and Drug Administration (FDA) needed to develop a plan for consolidation of its IT infrastructure across eight division centers and identify standard software applications to be utilized for common business needs. The FDA turned to Enterprise Architecture (EA) to serve as the methodology to achieve its desired state of efficiency and effectiveness. FDA maximized its infrastructure by replacing single-use environments with platforms shared across application system boundaries and consolidated IT operations from multiple buildings to two major locations by employing homogenous platform architecture.

EA driven IT consolidation has allowed the FDA to use fewer resources while operating more efficiently and providing better services. Key benefits of this project include: increased cost savings (over $10 million redundant IT related costs eliminated), documented and standardized business processes (over 85% of agency-wide processes are now documented), consolidation of IT infrastructure resulting in less applications (for example the number of correspondence tracking systems were reduced from 24 to 2), improved communication, and lastly improved decision making.

Source: Federal Enterprise Architecture Program Management Office, Link: http://www.whitehouse.gov/omb/egov/documents/FDA_FINAL.pdf

Benefits of Enterprise Architectures – Views of a CTO

In a 2004 article for the Zachman Institute for Framework Advancement (ZIFA), General Motors CTO Tony Brown, lists the reasons below as what he considers to be the top advantages of implementing EA:

- Readily available documentation of the enterprise
- Ability to unify and integrate business process across the enterprise
- Ability to unify and integrate data across the enterprise and to link with external partners
- Increased agility by lowering the 'complexity barrier'
- Reduced solution delivery time and development costs by maximizing reuse of enterprise models
- Ability to create and maintain a common vision of the future by both the business and IT

communities driving continuous business/IT alignment

Source: [Cardwell 2006]

1.2.3 From Enterprise Architectures to Enterprise Integration

Development and maintenance of an EA, as suggested so far, is a worthwhile effort. However, how does it impact *enterprise integration* – an area of particular interest in the competitive marketplace. Most organizations are struggling to integrate their systems to maintain a competitive edge. The drive for enterprise wide integration is not new. Mergers and acquisitions, for example, introduce numerous scenarios when systems from one company need to mesh with the systems of the new corporate "friends". However, as the enterprises move towards the outer edges of the enterprise model shown previously in **Error! Reference source not found.**, the lack of integration matters more. For example, the threat of losing customers to competitors who can service their customers faster and cheaper because their order processing system is nicely integrated with payment and shipping system is real. To survive in the fiercely competitive market, several companies have embarked on streamlining initiatives to cut product development time and to reduce product delivery time. To achieve this, enterprise-wide integrated systems such as the following are needed (see [Kalakotta 2002a, Carter 2007] for numerous examples and case studies):

- Procurement systems that link order processing with payment, inventory management and shipping
- Manufacturing systems that link suppliers, designers, product managers, and production planners in a uniform manner.
- Customer support systems that link customer service with customer relationship management, marketing and sales.
- Health information networks that link various hospitals, doctors, pharmacies and health insurance providers
- Supply chain management systems that link several suppliers with the material requirement planning (MRP) systems of consumers

Two sidebars ("Case Study: Bharti Airtel Enterprise Architecture Framework" and "Case Study: Bombardier Aerospace Adopts Flexibility") illustrate flexible enterprise architectures in practice.

How can an EA help in enterprise integration efforts? Enterprise integration means making independently designed enterprise systems work together. For enterprise integration, the goal is to provide standardized high-quality customer service across the entire firm's service channels. Multi-channel integration is critical because customers expect consistent service when they interact with a company, no matter which channel they use. Multi-channel integration is also a critical issue for any business striving to maintain its competitive advantage [Kalakota 2002a]. As we will see later, most definitions of enterprise integration touch on similar if not common concepts related to *working together*, *sharing*, *interacting*, and *collaborating*. Naturally, a well documented EA with clearly specified interfaces and interactions between various business and technical components, provides the basis for well integrated systems.

Enterprise integration can be at several layers (e.g., business process integration, application integration, platform integration). However, enterprise application integration (EAI) receives most of the attention due to the following main reasons:

- Lack of integration between enterprise applications is very visible to the customers and business partners. For example, if an order processing system is not integrated with a payment system, then the customer has to place an order on one system and then go back and pay by using a totally different system – possibly having to re-enter all information again.
- Many of the enterprise applications can be "legacy" applications that are old, unstructured, and monolithic. According to Webster, "legacy is something *of value* that is passed along to the next generation". Dealing with legacy applications has been a dominant concern of IT management for many years. If possible, the IT management would like to keep the legacy systems intact because they provide vital services (e.g., billing) that are very risky to disrupt. However, something must be done about these systems because these systems are inflexible and are becoming increasingly expensive to maintain especially in the modern enterprise scenarios.

Example: Developing Architecture of a City – Lessons for IS Architects

Development of integrated architectures for enterprise applications that span organizational units and enterprises is similar to establishing design of a city for an ever-changing and ever-evolving industrial and residential population. We have to worry more about how the individual parts of the city will be known to the city dwellers and how will they be interconnected (i.e., the infrastructure needed), instead of how the individual buildings will be designed internally. We only establish policies, rules and guidelines for the building externals and focus more attention to the bigger issues of access and flows between the buildings (i.e., all buildings must be accessible). In a similar vein, integrated architectures of enterprise applications is like designing many mini applications that need to interact with each other for corporate business goals. The emphasis is on identifying the interfaces of the applications, and the infrastructure needed to make this application operable as an enterprise-wide as well as, if needed, inter-enterprise application.

1.2.4 Enterprise Architectures and Integration – A Closer Look

As stated previously, an enterprise architecture describes the enterprise building blocks (the business layer, the application layer, and the technology infrastructure layer), what they do and how do they interface/interact with each other. Let us use Figure 1-3 for a closer look at enterprise architectures. This figure shows a more detailed view of the enterprise building blocks (business processes needed for the business, enterprise applications that automate the business processes, computing platforms and middleware services that support the applications, and the network services that interconnect the various platforms in an enterprise). These building blocks are represented as horizontal layers – higher level layers are more business oriented and lower level layers are more technology oriented. Different types of architectures at different layers can be envisioned as shown in the vertical bar of Figure 1-3. For example, business architecture represents the architecture at business process layer, enterprise application architecture represents architecture at application layer, etc. Thus an enterprise architecture represents all the architectures at all layers of an enterprise, i.e., it is the vertical bar in Figure 1-3. Based on this, we can introduce the following definitions of enterprise architectures:

Definition 1. Enterprise Architecture = architecture of architectures.

Definition 2. Enterprise Architecture = Business Architecture + Application Architecture + Computing Platform Architecture + Network Architecture

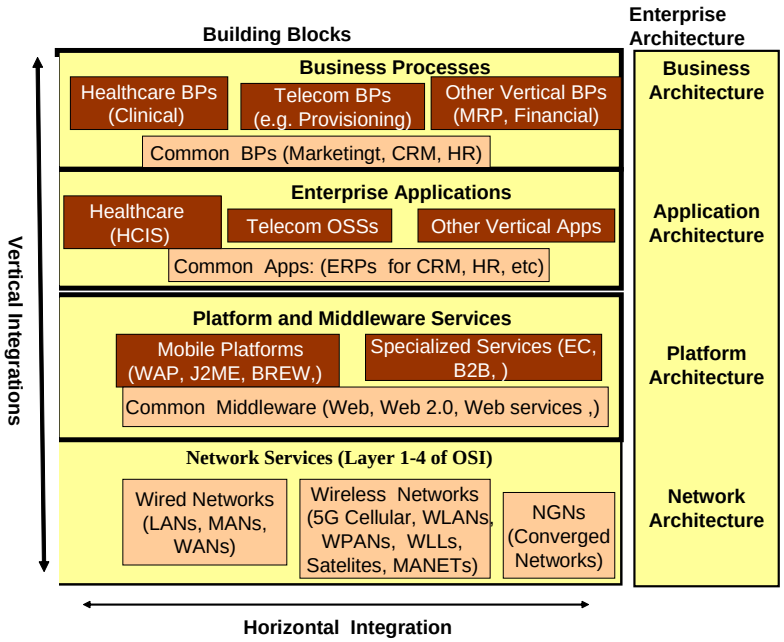

Figure 1-3: Building Blocks of Enterprise Architecture and Integration

Let us now include the integration consideration. The objective of an *integrated* enterprise architecture is to show how *well* all the business plus technical components work together to serve the enterprise needs. Development of an integrated enterprise architecture, referred to as integrated architecture in this book for simplicity, generally starts with documenting the organization's strategy and goals. The integration process concentrates on the interactions and the interfaces between the enterprise structural components, at the following layers shown in Figure 1-3:

- Business architecture that basically describes the business processes and how they interact/interface with each other.
- Application architecture that shows the various application software packages and how they interact/interface with each other through messages and data flows. This may include an information model that shows how the information flows between various software components.
- Computing platform architecture with interactions and interdependencies between different operating systems, system software packages and middleware services located on various desktops, servers, and mainframes.
- Network architecture with Intranet, Extranet, Public Internet and network devices interconnected through various connectivity devices and gateways.

An EA diagram such as Figure 1-3 serves as a very effective framework for enterprise wide integration -- facilitating vertical as well as horizontal integrations:

- **Vertical integrations** show a business architecture that is integrated with technology architecture (enterprise applications, platforms and networks) of a company or a division of a company. It combines business, applications and IT infrastructure components into a solution for a particular situation (typically known as a "silo"). An example of vertical integration is a supply chain management ERP system that automates all supply chain processes and operates on Linux platforms.
- **Horizontal integrations** show how processes and technologies at the same layer are integrated. For example, the integration of business processes in sales with business processes in supply

chain represent a horizontal integration at business process level. Similarly, enterprise application integration represents how different ERPs within an organization seamlessly work each other and inter-enterprise (B2B) application integration architectures represent supply chain management application integration across multiple enterprises. As another example, smooth transition between wired and wireless networks (e.g., roaming support between a cellular phone, a Wi-Fi LAN and a wired corporate Intranet) represents a horizontal network integration.

- **Mixtures** represent an integrated architecture that is a combination of vertical architectures that interconnect different layers as well as the horizontal architectures at the same layers of an enterprise. In many practical cases, mergers and acquisitions lead to these integration scenarios because many organizations have vertically integrated systems but when two or more organizations merge, multiple vertical architectures need to be integrated horizontally – a real headache. This is known as the "information silo" problem, as mentioned in the Bombardier Aerospace case study previously.

Based on this discussion, we can introduce the following definitions of *integrated* enterprise architectures:

Definition 3. Integrated Enterprise Architecture = Horizontally Integrated Enterprise Architecture + Vertically Integrated Enterprise Architecture

Definition 4. Integrated Enterprise Architecture = Enterprise Architecture + Integration Technologies (for vertical plus horizontal integrations)

Sayings About Good Architectures

"We shape our buildings and afterwards our buildings shape us" -- *Winston Churchill*

"While any single product is apt to become quickly outdated, a well-designed and open-ended architecture can evolve along with critical technologies, providing a fixed point of stability for customers and serving as the platform for a radiating and long-lived product family" -- *C. Morris and C. Ferguson, "How Architecture Wins Technology Wars", HBR, March-April 1993*

1.2.5 An Example – Frank's Furniture Store (FFS)[2]

1.2.5.1 Example Overview

We will use Frank's Furniture Store, New York City (NYC), as an example to illustrate the key points in the balance of this chapter. FFS is a small store with big ideas. Frank started selling kitchen and bedroom furniture 5 years ago and wants to expand aggressively in the next 3 years. He currently has 80 employees in NYC and is partnering with a mover to deliver the items. His plans are:

1. Next year he wants to acquire a small manufacturing shop so that he could design, build, sell, and repair custom built furniture. He also wants to open five furniture outlets, in different parts of the country, to sell his furniture. He expects to double the size of his company next year.

[2] This example is based on a real life retail store.

2. In two years, Frank wants to diversify into a wide range of other products (e.g., living room and office furniture, paintings). He also wants to start partnering with other retail stores and manufacturers. The parts and components will be brought from suppliers located overseas to his manufacturing site.

Frank is a good businessman but is not very technical. He keeps track of all information on a MS Word file and also uses an MS Excel spreadsheet occasionally. Currently, all communications are through phone but Frank is pursuing an MBA and is really intrigued by using IT for selling, purchasing and outsourcing. He is especially interested in integrating and automating the procurement processes (e-procurement) and supply chains to provide custom-built furniture quickly.

He has no idea what he is getting into. Besides his MBA, he has been attending management seminars on use of IT in business. He does not completely understand it but he is convinced that it is something very good (they would'nt be teaching courses in this area if it was not good!). He simply cannot wait to put everything he is learning to work. His goal is to eventually become a major digital corporation that will serve as a virtual store for multiple shops so that potential customers order a variety of products through him. He will receive the orders and try to fill them, if he can. Otherwise, he will route the order to one of his business partners. He is fascinated by the idea of exploiting IT to compete in the marketplace.

He knows about many failures (dot bombs) and wants to be aggressive but cautious. For example, he knows about the failure of Furniture.com (see the sidebar "Case Study: Furniture.com Goes Out of Business") and wants to make sure that he does not follow the same route. Basically, his goal is to significantly grow his business by using IT in an innovative manner. He also wants to make his operations more efficient and less expensive. He wants to use the Furniture.com model without the problems. He needs help in developing an EA and an overall IT plan that includes business processes, applications and the enabling IT infrastructure.

Case Study: Furniture.com Goes Out of Business

Furniture.com was reviewed by CIO Magazine in the article "Furniture.com," Jan. 15, 2000. The company was selling furniture over the Web and promised Web shoppers 24-hour browsing and six- to eight-week delivery times on everything from table lamps to 10-piece bedroom ensembles. The company reported $22 million in net revenues for nine months ending September 2000 and attracted 1 million users a month. But the increase in usage also increased customer dissatisfaction. Customer complaints filed with the Better Business Bureau (BBB) in Worcester, Mass., jumped from one in 1999 to 149 in 2000 (most brick-and-mortar companies get three to four complaints a year). The most common complaints had to do with delivery problems, product quality and bill disputes.

The main problem was that the company management built the Furniture.com brand very well but they did not create the infrastructure needed to support it. The company under-estimated the logistics and costs involved in shipping such a bulky commodity cross-country and did not build a good way to track orders -- the company ended up tracking orders manually. Furniture.com also created a cancellation policy that was too expensive. The customers could, for example, cancel orders right until delivery day. Thus when six-week delivery turned into six-month delays, many orders were cancelled. Furniture.com closed down and filed for bankruptcy in November, 2000.

Reference; "The Changing Landscape of e-Business -- The Survivors" by Stephanie Overby, May 1, 2001 Issue of the CIO Magazine.

1.2.5.2 Sketch of an Enterprise Architecture for FFS

It is a good idea to start by developing a high level EA for FFS based on the discussion so far. This EA would comprise of a business architecture, an application architecture and an IT infrastructure architecture. The composite EA would show the business processes of FFS, the applications that automate the business processes, and a technical specification that shows what pieces of information will be stored where and in what format, how the customers can locate the furniture and order them, and how the employees can ship them and settle payments, etc. This will also include platform and network details such as Web technologies being used, how is mobile computing being used, what type of enterprise-wide network services are being provided to the customers and employees, etc.

Let us first start with business architecture and integration. Figure 1-4 shows a business process pattern (BPP) that could serve as a basis for a business architecture for FFS. Specifically, this figure shows a BPP for retail industries that captures a very high level view of enterprise business processes (e.g., procurement, sales and marketing) and the key interactions between these processes. This high level business view is a good starting point for an integrated business architecture because it shows the supplier/partner focused BPs (e.g., production, supply chain management, distribution) and their interactions/interfaces with other BPs of the enterprise. For example, this figure can be used to answer the query: if distribution BPs are reengineered, what other BPs will be affected It can also help a business develop a BPO (Business Process Outsourcing) strategy, an enterprise application strategy (i.e., what BPs to automate), and an integration strategy. BPPs provide a powerful tool for representing a wide range of enterprises in different industry segments. Additional information, as separate documents linked from this diagram, to represent corporate goals and strategies can easily upgrade this diagram into a solid business architecture.

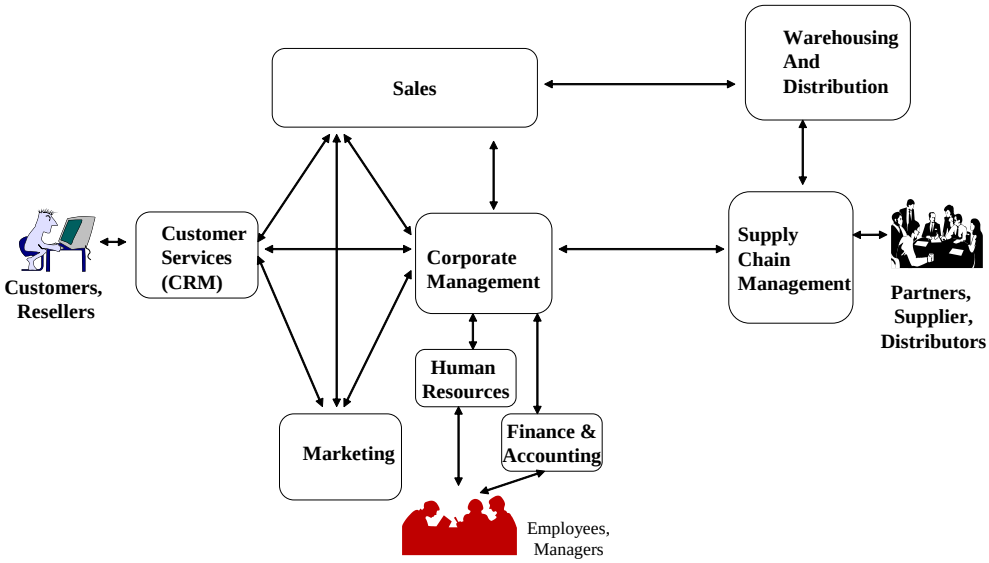

Figure 1-4: Sample Business Architecture of a Store like FFS

Application architectures show the application components, the interrelationships between these components, their allocations, and their coordination paradigms. Application architectures at enterprise level raise several portability and interoperability issues because they tie several "local" applications together to satisfy business requirements. A complete application architecture gives enough information to the implementers so that they can build and deploy a system. Figure 1-5 shows a possible logical application architecture of the FFS. Through color coding, it shows what applications reside where (headquarter, retail site) and which ones are outsourced. This architecture does not show any infrastructure components and thus is a Technology Independent Model (TIM) of the system.

Platform (infrastructure) architectures provide the set of technologies (middleware, networks, operating systems, hardware, etc.) that glue together the application pieces across an enterprise. For example, the enterprise applications may use a combination of middleware such as Web technologies, Web Services and database gateways that operate over the Internet across Windows, Linux, UNIX and mainframe platforms. Figure 1-6 shows a sample solution architecture that translates the given logical application architecture into a physical architecture that includes infrastructure components such as Web servers, networks, VOIP systems, etc. This is a Technology Specific Model (TSM) for FFS.

Thus the three diagrams presented in this session capture the essence of an EA for FFS, albeit at a high level. This EA can be used to develop current and future IT plans. We will go through the details of these architectural components later in this chapter.

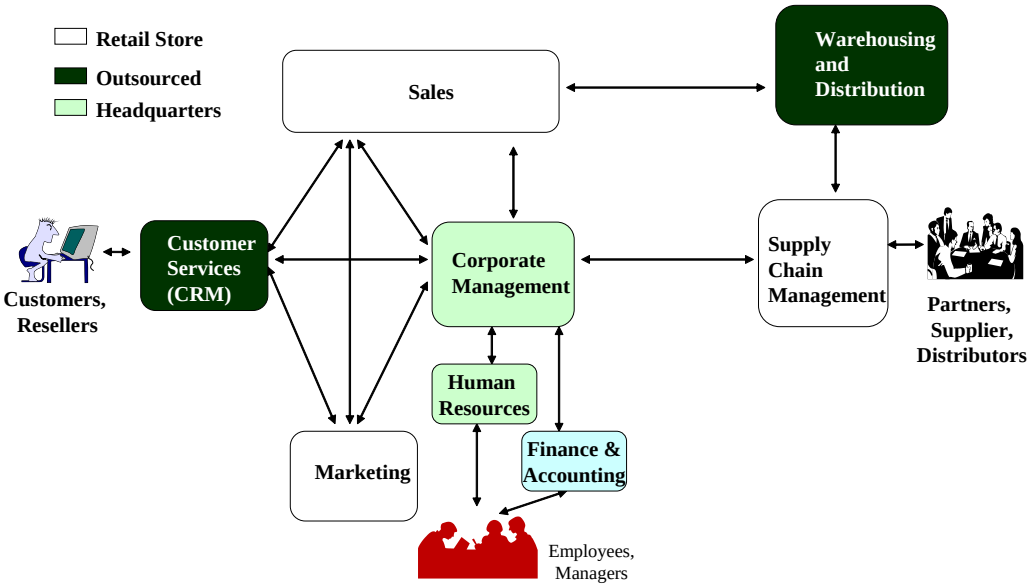

Figure 1-5: Logical Application Architecture (Technology Independent Model) of FFS

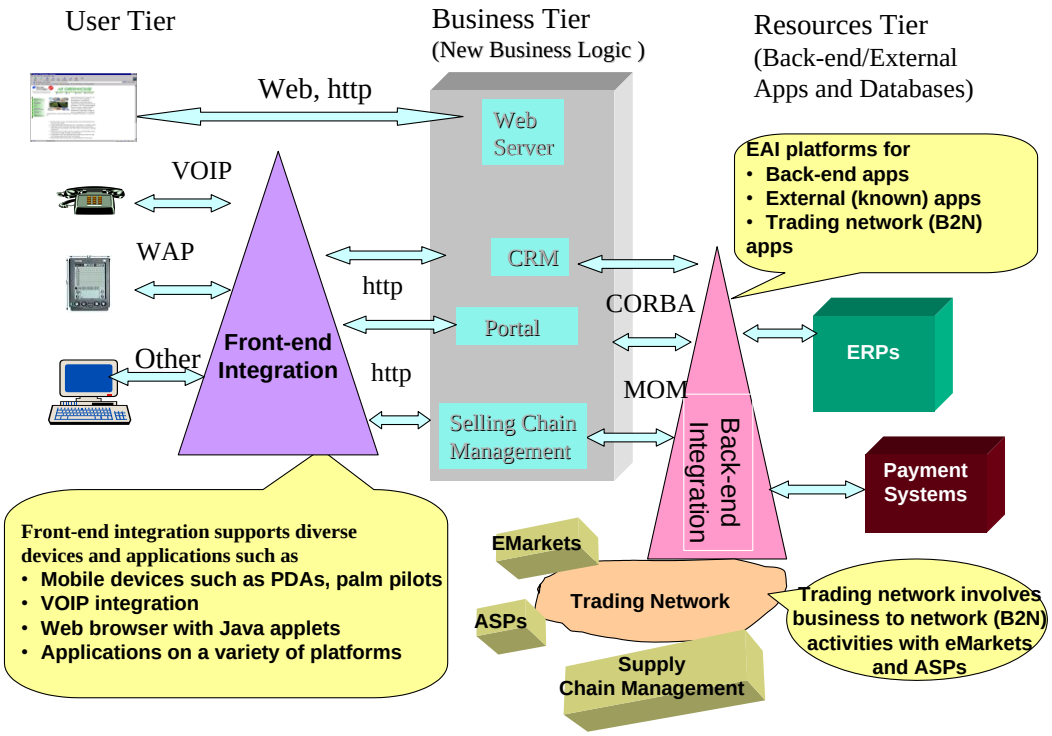

Figure 1-6: Solution Architecture - Physical Architecture with Technology Choices (Technology Specific Model)

1.3 Enterprise Architectures and Integration Through SOA

EA of an integrated corporation comprises of a very diverse array of processes, technologies and frameworks. In particular, different enterprise architecture frameworks have been proposed over the years. They include Zachman, Martin, Spewak, Gartner and others. See the article by [Sessions 2007] for a very good comparison and analysis of the top four EA methodologies. These frameworks represent EAs through different types of diagrams and artifacts such as UML diagrams, data flow diagrams, process diagrams and natural language descriptions. This book proposes that SOA (Service Oriented Architecture) provides an elegant framework for representing and implementing an integrated EA. As we will see, SOA provides a loosely coupled architecture which allows business services to discover and communicate with each other over a standards-based infrastructure and thus leads to enterprise-wide flexibility and adaptability,

1.3.1 A Service Oriented View of Business

All businesses provide a set of services. Some services are provided to the customers (B2C), some to other businesses (B2B) and some to the employees (B2E). For example, Figure 1-7 shows a very high level view of a retail store that provides marketing, sales, customer support, and many other services (some are customer facing, some are supplier facing, and some are employee and management facing. In the highly fluid business environment of today, some of these services are provided by other service providers (outsourcing agencies, business partners, etc). For example, in this organization, customer services, marketing, human resource (HR) management, and finance and accounting (F&A) services are provided by other service providers (SPs). The task of the enterprise management is to find the best service providers (SPs) to run the firm. In addition, a company can change its business by adding new services from new SPs. For example, a wired telephone company can add a wireless service provider, a manufacturing company can add a retail outlet provider, etc. In addition "service bundles" can be created by different SPs to meet user needs and to compete for user business. The idea is that companies may add, delete, change and merge SPs that provide the best services to compete.

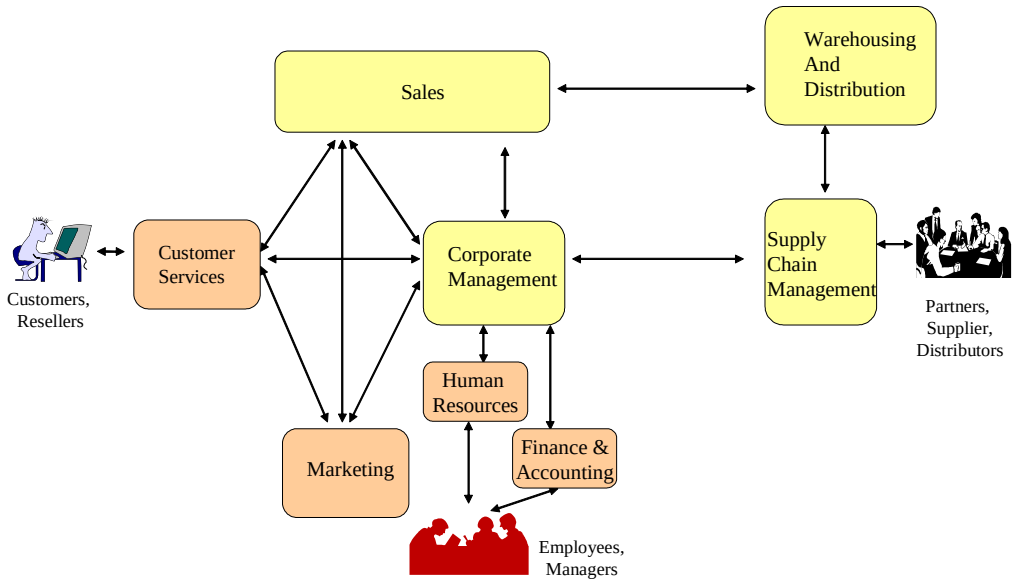

Figure 1-7: Service Oriented View of a Retail Store (Darker Blocks mean Outsourced/Rented Services)

How can enterprise software support this service-oriented business climate? The answer is that business software is developed as *business components* that can be assembled with other business components to provide business services. For example, a large grained business component (BC) -- a software package from PeopleSoft -- could provide the HR business service (BS). Similarly another BC from SAP could support the marketing BS and the like. A company could choose, assemble and run these BCs from different suppliers to support its BSs. A company could also replace a BC from PeopleSoft with a BC from SAP to provide better services, if needed. More interestingly, an order processing BC residing in Atlanta could check the inventory managed by a BC in Detroit or Singapore. This implies the following:

- There is a BC that provides a set of business services -- this is the service provider
- The services are well defined so that other BCs can understand them
- BCs have well defined interfaces so that they can work with each other
- BCs from different suppliers can be used to provide a business service
- An IT infrastructure (middleware service) exists that allows services provided by components to be advertised, discovered, selected, and invoked over the Internet

The following sections provide a few more details of the key components of SOA. Chapter 9 provides technical details of SOA and detailed discussion of how SOA can be used to architect and integrate enterprise wide systems is given in Chapters 10 through 13.

1.3.2 Service Oriented Architecture (SOA) at a Glance

Service-oriented architectures (SOAs) rely on services and the components that provide the services as the fundamental elements for developing applications. The main idea of service oriented architectures is that the applications should be thought of in terms of the services they provide and the individual components that actually deliver the services. The services can be combined into aggregate services and similar components can be combined into applications. Thus a bank, for example, provides a set of services (e.g., deposits, withdrawals, fund transfers) and these services are provided through components that can be combined into banking applications.

Definition: A service-oriented architecture is based on the following three fundamental features:

- **Reusable Components:** It is important to decompose business applications into business components (BCs) in such a fashion so that as many components as possible are general purpose (i.e., reusable) and as few as possible are special purpose. It is highly desirable to create common services and components that can be reused to serve many different requests.
- **Web-Services Enablement.** The components must have well defined service interfaces that can be stored in a directory so that service clients (SCs) can query an interface directory to discover and invoke the needed service providers (SPs). Although older technologies can be used for service definition and discovery, Web Services (WS) is the favored enabling technology at present. We will discuss WS in chapter 7. Due to the reliance of SOA on Web Services, Gartner calls it WOA (Web Oriented Architecture).
- **Enterprise Service Bus (ESB):** Instead of point to point communications between service clients and service providers, a loosely coupled common middleware infrastructure must be used for communications, brokerage, security, directory and administration services needed throughout the enterprise. This infrastructure is called Enterprise service Bus (SB). We will discuss ESBs later.

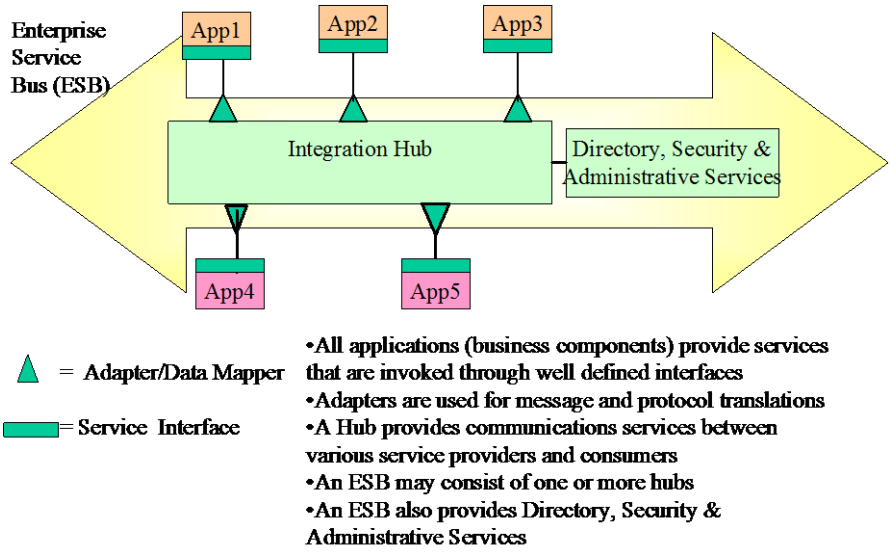

Figure 1-8: Conceptual View of SOA and an Enterprise Service Bus (ESB)

These somewhat naïve requirements lead to a very powerful architecture which can support and promote highly flexible and reusable business services for the current and future enterprises. Figure 1-8 shows a conceptual view of an SOA-based architecture supported by an ESB.

1.3.3 How SOA Can be Used in EA (Enterprise Architectures)

SOA can be used in developing and building an integrated enterprise architecture. Specifically:

- Business architecture can be represented in terms of business services (BSs). This view was represented in Figure 1-7
- Application architecture can be represented in terms of a set of business components (BCs) that automate business services (BSs)
- IT infrastructure can be represented in terms of the ESB that shows how different infrastructure services support the business services and business components.

Figure 1-9 presents an SOA oriented view of an enterprise architecture. It shows different application and an ESB as a collection of hubs that are interconnected to each other. In addition, each hub serves a subset of applications. For example, a hub is dedicated to handle the front-end of an enterprise and thus can be viewed as a 'Portal Hub'. Similarly there is a B2B Hub to handle all B2B traffic. Many other hubs can be envisioned to handle, let us say, a data warehouse, a division of a company, or even a newly acquired company. In reality, a hub could be a server that is dedicated to a specific type of application or users. A small company may start with one hub but as the organization grows, more hubs can be added to the ESB. In addition, each new acquisition can be assigned a hub. This allows a great deal of business flexibility and control. We will discuss different aspects of an ESB in chapters 9, 10 and 11.

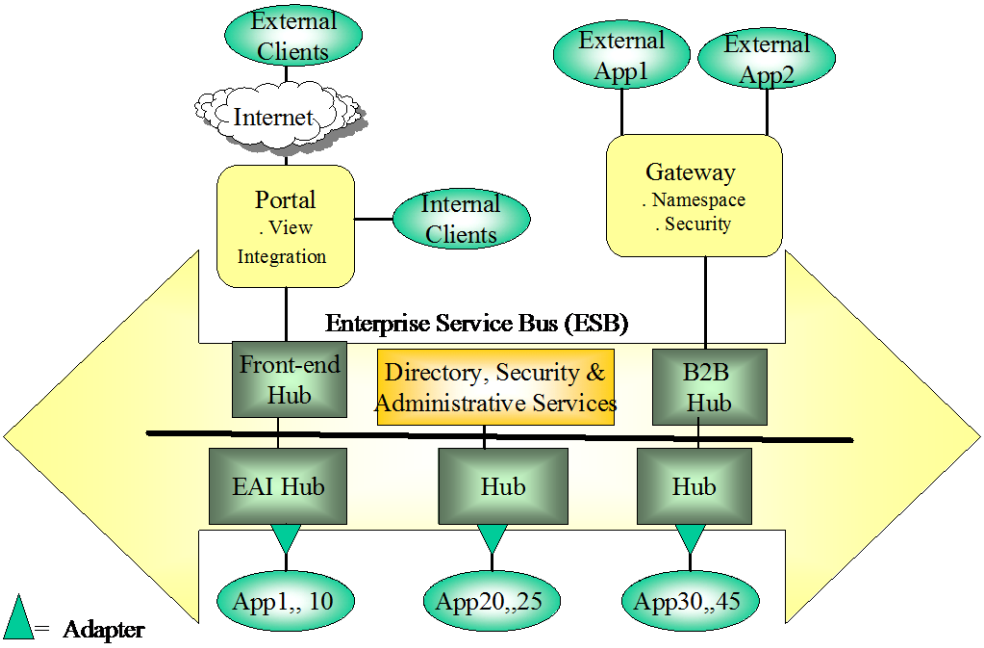

Figure 1-9: SOA Oriented View of EA

B2B trade spans a large set of activities such as supply chain management, B2B emarkets, and business networks such as hospital information networks. In addition, coalitions and the popular 'cloud computing' paradigms introduce several B2B scenarios. SOA can play a major role as the enabler of B2B trade. For example, the ESB Directories can serve as brokers for discovering and invoking new services for B2B trade. Figure 1-10 shows a possible B2B integration architecture based on SOA. The key player in this scenario is the B2B integration bus that enables communications between the organizations. The main advantage of this approach is that as new players join the B2B trade, they are added to the B2B registry (directory of B2B partners) and are discovered by the participants when they search the registry. We will discuss B2B trade extensively in Chapter 12.

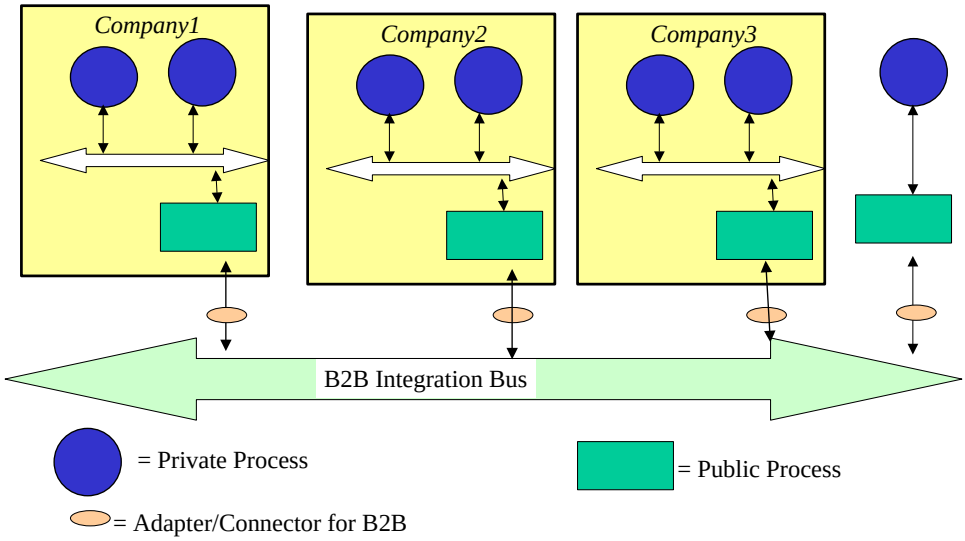

Figure 1-10: B2B Integration Architectures

While not perfect and not a panacea, SOA does provide an elegant architectural framework that can be used to describe an EA and also to integrate the various components of an enterprise, internally and externally. In fact, SOA supports the currently popular cloud computing paradigm (see the sidebar "SOA for Cloud Computing").

SOA for Cloud Computing

Cloud computing (CC) is becoming popular at present for flexible, robust and inexpensive computing services – mostly from service providers ("cloud vendors"). Although definitions vary widely, the main idea of CC is that all IT-related capabilities are provided "as a service" (e.g., software as a service (SaaS), platform as a service (PaaS), Infrastructure as a service (Iaas), etc. Different providers, residing in the cloud (e.g., the Internet) can provide these services. This allows the users to access a very wide range of technology-enabled services from the Internet without ownership, control, knowledge, or technical expertise of the complex IT infrastructure.

SOA, in principle, promotes the cloud computing" paradigm. In particular, an ESB can be viewed as an infrastructure cloud that provides the infrastructure capabilities (integration servers, directories, routing, and security) needed to run enterprise applications.

SOA Main Sources of information

- IBM System Journal, Service-Oriented Architecture Special Issue, Volume 44, Number 4, 2005.
- IEEE Computer Society Technical Committee on Services Computing - www.servicescomputing.org.
- Bieberstein, N., et al, "Service-Oriented Architecture (SOA) Compass: Business Value, Planning, and Enterprise Roadmap", IBM Press, Oct 2005.
- Barry, D., "Web Services and Service-Oriented Architectures: The Savvy Manager's Guide", Morgan Kaufmann, 2003.
- Carter, S., "The New Language of Business: SOA & Web 2.0", IBM Press, 2007
- SOA Portal at http://www.service-architecture.com/
- IBM site on SOA (www.ibm.com/soa)
- Sun site on SOA (www.sun.com/soa)
- Comm. Of ACM, Special Issue on Service Oriented Computing, Oct. 2003.

1.4 High Level Methodology for Integrated Enterprise-Wide Architectures

1.4.1 Overview

The discussion so far has mentioned several decisions and choices that need to be made during an enterprise architecture and integration effort. A methodology is needed to guide the system developers through these decisions. Before proceeding with details, we should acknowledge that formal methodologies have had mixed results [Inmon 1993, Mowbray 1995]. The appeal of a methodology is that it directs the developers down a reasonable path with pointers for what to do, in what order to do it, what to produce, and what to expect as inputs. However, many methodologies fail because of their linear flow of activities, rigidity in prescribed set of activities, and emphasis on diagramming tools.

Figure 1-11 shows a high level methodology that displays how individual plans can be developed and then integrated together into an enterprise wide integrated architecture. This methodology consists of several stages that address several areas of focus (e.g., enterprise focus, IT infrastructure focus, integration focus and management focus). Different areas of focus are needed for different types of business scenarios. Table 1-1 shows four broad scenario types in terms of new or existing business services which need to be introduced for existing or new sites/organizational units. This table also indicates the primary areas of focus for each scenario type. As implied in the title of this book, we will focus on enterprise and integration areas in this book. We will work through this methodology briefly here by using Frank's Furniture Store (FFS) to illustrate the key points. The discussion is intentionally at a high level to highlight the main features of the overall methodology. Details will be covered in the rest of the book (after all, this is only the first chapter!)

This methodology has several important features. First, it includes all stages needed to build a comprehensive EA -- it covers all building blocks of the EA framework shown in Figure 1-3 and also adds management and security considerations). Second, the methodology is asynchronous – the stages can be invoked whenever enough input is available, thus more than one stage can be executed in parallel. Third, this methodology is intelligent because many inferences are used between the stages and utilizes a knowledgebase that provides patterns and COTS (commercial off-the-shelf) information. Finally, the needed plans are developed gradually in different stages and captured in the knowledgebase (KB), thus later stages can learn from previous decisions.

Although this methodology can be, and has been, used manually, its features allowed us to build an automated toolset (described in the next section) that "gets smarter" as the user proceeds through the various stages. For example, in a manual methodology, the KB is just a collection of documents that the user can refer to. However, in an automated system, the KB is a database that contains an extensive repository of patterns, COTS information and previously generated plans. This KB can be queried, updated, and utilized by a family of "automated consultants" to infer and suggest solutions quickly etc (see the discussion of PISA later).

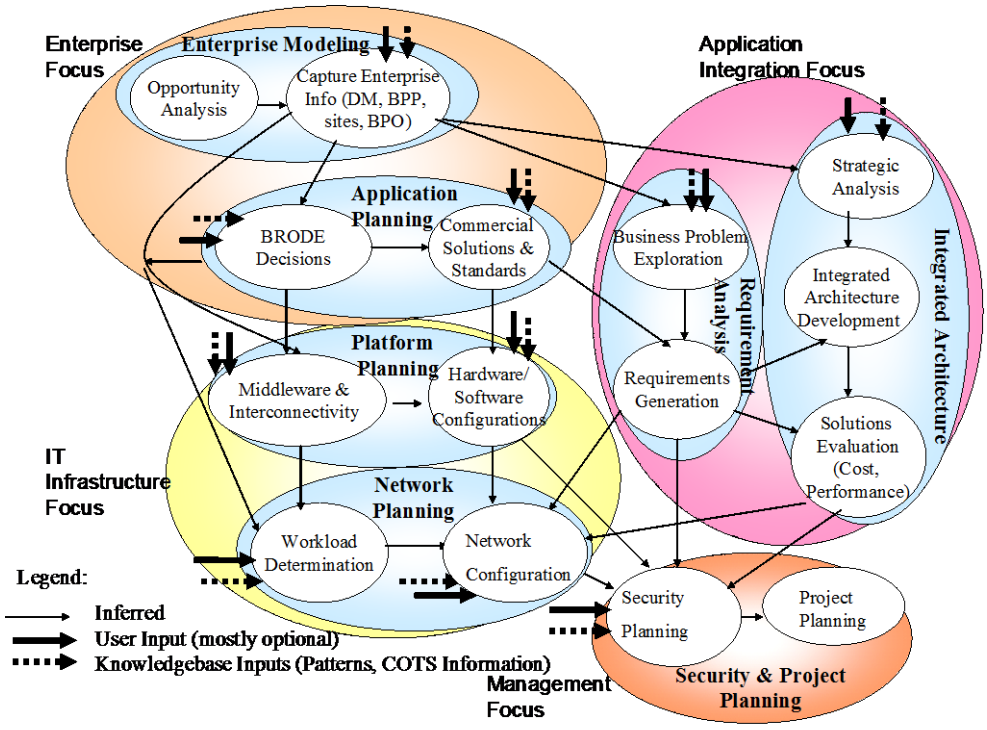

Figure 1-11: Conceptual View of Enterprise Architecture Methodology

BRODE = Buy-Rent-Outsource-Develop-Extend
EBP = Enterprise Business Pattern
WBS = Work Breakdown Structure

Table 1-1: Sample Architecture and Integration Scenarios

	New Site or Organizational Unit	Existing Site or Organizational Unit
New Business Services	**S1**: New services(s) for a new site **Example:** New division in Chicago focusing on a new set of business services (e.g., healthcare service) **Primary Focus:** Enterprise systems plus IT infrastructure needed at the new site.	**S2:** New services(s) for an existing site **Example:** New business services (e.g., equipment repairs) for an existing manufacturing company **Primary Focus:** Enterprise systems. It may be assumed that the needed IT infrastructure already exists.
Existing Business Services (Expanded/ Modified)	**S3**: Existing business services(s) for a new site **Example: E**xisting services (e.g., customer support) to be offered through an offshore site. **Primary Focus:** IT infrastructure. Needed enterprise systems may already exist.	**S4:** Existing business services(s) for an existing site **Example:** Existing business services (e.g., purchasing) of an existing company to be re-engineered for flexibility. **Primary Focus:** Enterprise systems plus integrated architecture focusing around purchasing.

1.4.2 Enterprise Focus Stages

The enterprise focus is on two stages: *enterprise modeling* stage starts with a quick business opportunity analysis and captures the needed enterprise information, and *application planning* develops a strategy to automate the business processes. This area of focus is discussed in detail in the Enterprise Module of this book (chapter 1 through 4), a quick overview is provided here.

1.4.2.1 Enterprise Modeling

The objective is to create a model of the company to capture essential information such as company type, company size, workgroups (WGs) such as departments, company sites, and allocation of WGs to sites. The most important part of the enterprise model is to capture the key business services (BSs) and business processes (BPs). Some services are provided to the customers (B2C), some to other businesses (B2B) and some to the employees (B2E). For example, Figure 1-12 shows a very high level view of a retail store like FFS that provides marketing, sales, customer support, and many other services (some are customer facing, some are supplier facing, and some are employee and management facing).

In the highly fluid business environment of today, some of these services are provided by other service providers (outsourcing agencies, business partners, etc). For example, in this organization, customer services, marketing, human resource (HR) management, and finance and accounting (F&A) services are provided by other service providers (SPs). The task of the enterprise management is to find the best service providers (SPs) to run the firm. In addition, a company can expand and transform its business by adding new services from new SPs. For example, a wired telephone company can add a wireless service provider, a manufacturing company can add a retail outlet provider, etc. In addition "service bundles" can be created by different SPs to meet user needs and to compete for user business. The idea is that companies may add, delete, change and merge SPs that provide the best services to compete. We will see more detailed views of Figure 1-12 in chapters 2 and 3.

After identifying the needed business services, the management needs to make the following decisions:

- Decide which business services/processes take place at each location.
- Include business outsourcing, i.e., determine which BSs/BPs take place at the outsourced sites.
- Assign employees to sites. The number of employees at each site helps determine the type and "intensity" of work performed at each site.

Figure 1-13 shows a sample enterprise model that is developed after these decisions for FFS. In addition to the three company sites, it also shows an outsourced site because the company wants to outsource some services. The model shows what services are performed at what sites (e.g., marketing in New York, human resource management at an outsourced site, and manufacturing in Chicago).

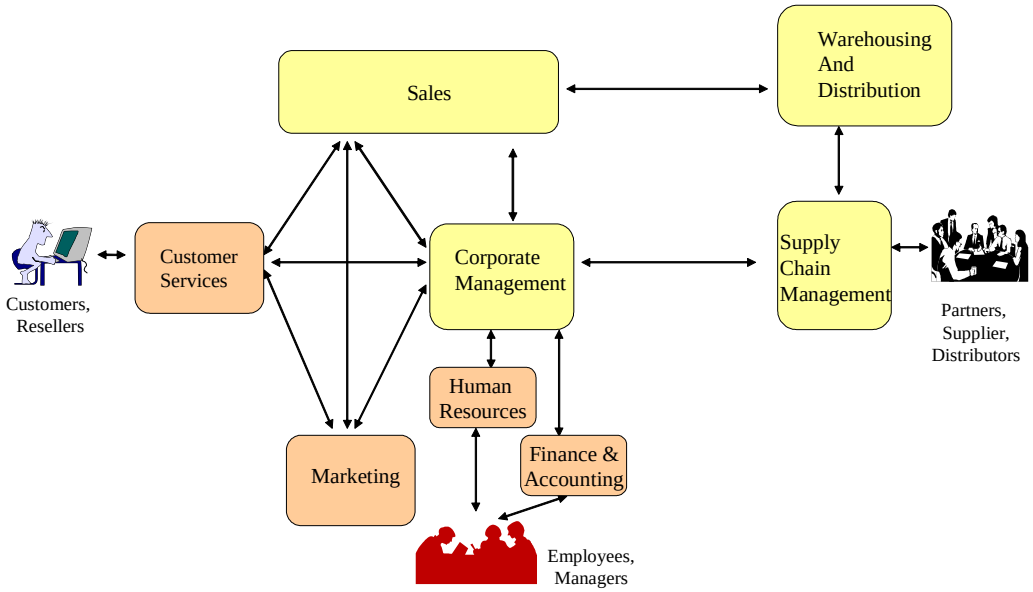

Figure 1-12: View of a Retail Store (Darker Blocks mean Outsourced/Rented Services)

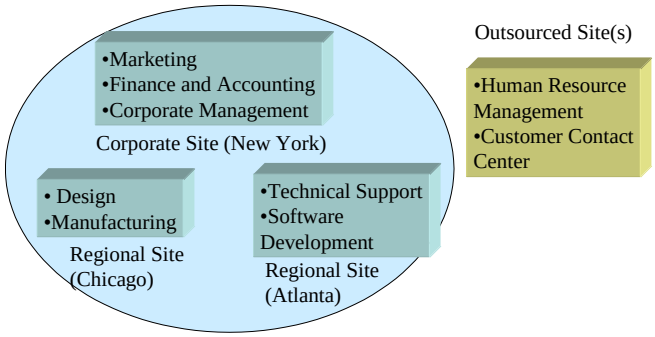

Figure 1-13: A Sample Enterprise Model

1.4.2.2 Application Planning

The objective of this stage is to identify the applications A1, A2… An that are needed to automate the business processes BP1… BPn identified in enterprise modeling. To identify the complete set of business processes (BPs), the following approach may be used:

- List all BPs that support the B2C, B2B, B2E, and other business interactions
- Keep the focus at enterprise level activities that are vital to the business. Consulting firms use "Heat Maps" to identify vital services. Heat maps are based on the Critical Success Factors [Rockart 1982] methodology. CSF instructs the managers to focus on those processes that are *critical to the success of the business*.
- Reduce duplication by clustering similar BPs into one. For example, if the same BP is used for customers as well as business partners, then it is better to cluster the two BPs into one.
- It is highly desirable to question, eliminate, and restructure business processes/services to improve organizational efficiency. This is the main idea of business process re-engineering (see chapter 2).

In reality, one or many applications may be needed to support a given business process. and a given business process may need multiple applications. For example, a customer information system may support many business processes such as purchasing, marketing, and payment. Similarly, purchasing business process needs support of many applications such as order processing, inventory management, shipping/receiving, and payment packages. The result of this step is a table that may resemble Table 1-2. Tables of this nature can be extremely revealing and are used in some IS planning methodologies such as IBM's Business System Planning [IBM 1978]. For example, the following table indicates the following:

- Application 2 does not support any business processes. This may mean that an application was developed without any business reason or it supports an outdated business processes
- Business process 2 is not supported by any application. This may indicate that this business process can be directly supported by the IT infrastructure or that this BP is being ignored.
- Application 5 supports 3 BPs. Thus replacement/enhancement of this application should be done very carefully.

Table 1-2: Applications to Support Business Processes

	Business Process1	**Business Process2**	**Business Process3**	**Business Process4**
Application 1	X			
Application 2				
Application 3			X	
Application 4			X	X
Application 5		X	X	X

Once the key applications have been identified, the next main activity is to develop an automation strategy with different options of buy, rent, outsource develop in-house, or extend-re-use (BRODE). It is also desirable to determine how the BRODE strategies could be implemented. For example, it is important to select the COTS (commercial-off-the-shelf) application packages that can be bought and identify application service providers (e.g., Corio and SAP) for rental and outsourcing. Finally, it is highly desirable to sketch an SOA-based architecture. These decisions can be made by using the following steps (see chapters 2, 3 and 4 for details):

1. For each BP, identify which ones will be done manually and which ones will be automated. In addition, for the automated BPs, determine an automation strategy (buy, outsource development, in-house development, or reuse). For example, if inventory management is to be automated then you can either buy an inventory management application package, or rent an inventory management service from an application service provider (ASP), etc.

2. For each option, explore the commercially available solutions (e.g. for buying, investigate and select the inventory management application packages available in the marketplace).

3. Develop sketch of an SOA-based application architecture.

Figure 1-14 shows a sample result of this stage for FFS. This example shows that FFS will buy CRM (Customer Relationship Management) and MRP (Materials Requirement Planning) software packages, rent a finance and accounting system, develop its own wireless messaging system for furniture tracking through a software development house. The application plan is based on SOA principles, i.e., all applications are treated as business components that communicate with each other through an Enterprise Service Bus (ESB). This implies that purchased, rented and developed applications have to be "SOA compliant". Please note that no details about the connectivity platform are provided in this stage – that will happen in a later stage. As mentioned previously, the ESB at this point is an "infrastructure cloud" that supports the applications.

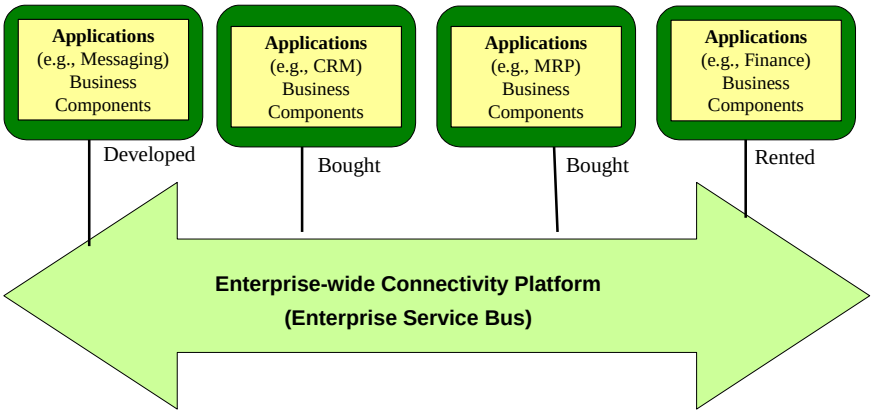

Figure 1-14: Sample Enterprise Application Plan

1.4.3 IT Infrastructure Focus Stages

IT infrastructure (platform) planning is concerned with determining the most appropriate technologies needed to *enable* the enterprise applications needed by the company. Examples of such enabling technologies are the Web technologies (including Web 2.0 and Web Services) used in corporate intranets, computing platforms on which the applications will reside, wireless and wired networks which connect all the computing platforms in an Intranet, and "Extranets" which connect many businesses for B2B trade. Details about the enabling IT infrastructure, especially Web technologies, can be found in the IT Infrastructure Module (chapters 5 through 8) of this book, a snapshot is presented here.

IT infrastructure planning can be subdivided into two broad stages; *computing platform planning* that supports the applications and *network planning* that interconnects these platforms with each other and the end-users. Computing platform planning consists of the following steps:

- Determine the middleware and Web services needed to interconnect the widely dispersed applications, users and databases,
- Identify the computer platforms, including servers, that will support the automation strategy and the application plan determined in the application planning stage.
- Decide which applications and databases will reside at which computing platforms (e.g., servers) at each site.
- Handle the software/hardware interdependencies (e.g., can a Windows application run on Linux platform, can an IIS server be installed on an XP machine, etc.)

Figure 1-15 shows a sample computing platform for FFS. The applications have been allocated to four different computing platforms -- each computing platform consists of computer hardware (e.g., Pentium processor), an operating system (e.g., Linux), some system software (e.g., MS Access), and middleware (e.g., Internet Explorer or Microsoft .NET Framework). These computing platforms are interconnected through a network that is defined later.

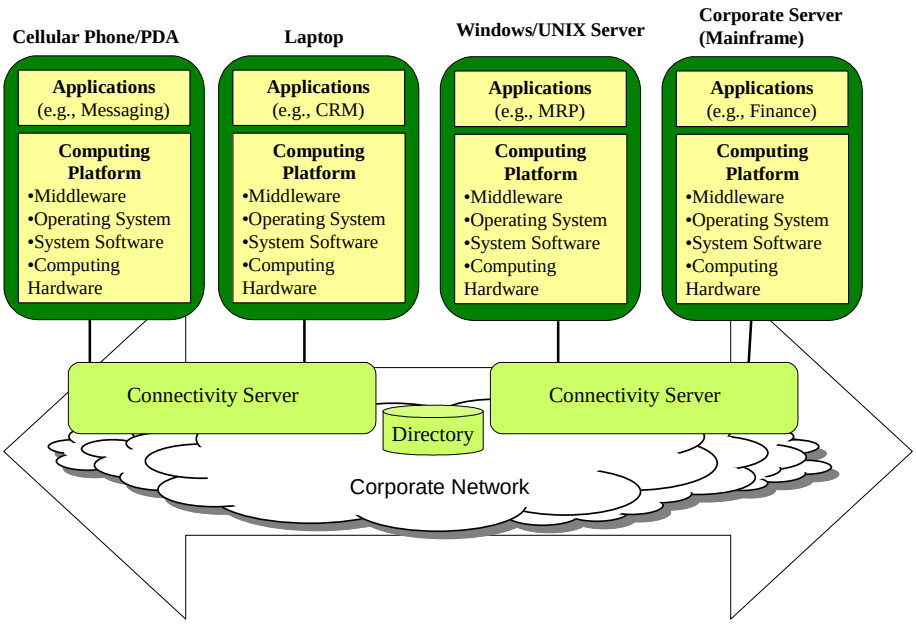

Figure 1-15: A Sample Computing Platform

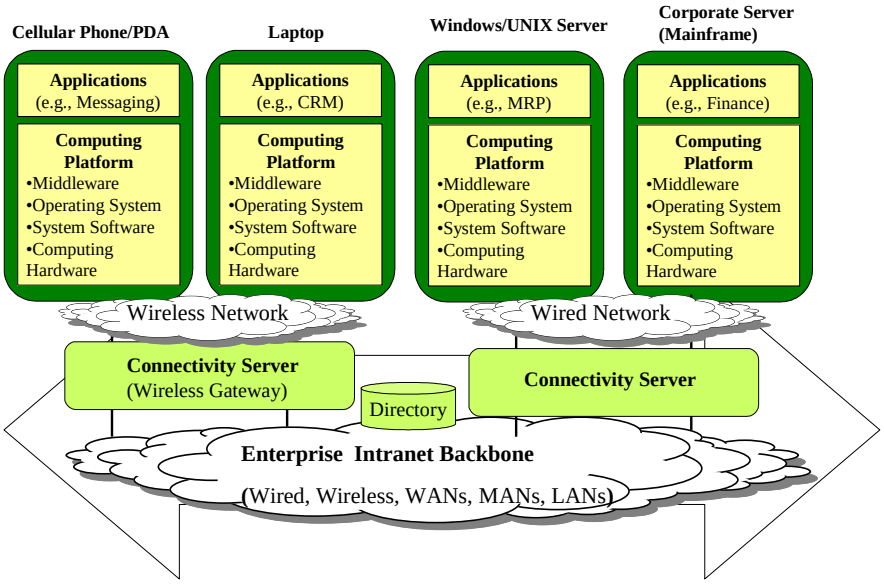

Figure 1-16: Sample Network Configuration

Network planning develops a network configuration that interconnects the computing platforms by using wireless as well as wired network elements. Figure 1-16 shows a sample network plan for FFS. Network planning involves three major tasks. First, determine the workload at each site based on the work activities at each site. Second, develop a network configuration and estimate the bandwidth needed by using queuing network models. This involves, for example, network capacity planning for the internal plus external networks depending on the type of connection (wired/wireless) and the

network traffic patterns. Finally, the type of connections and the commercially available network solutions need to be developed. Detailed network planning is beyond the scope of this book.

1.4.4 Integrated Architecture Focus Stages

The main objective of integrated architecture planning is to assure that all pieces fit together to form a working solution within the performance, security, and cost constraints. To illustrate the main issues addressed, let us consider the following situation for Frank's Furniture Store. (FFS). To improve sales, the company needs a very flexible online purchasing (OP) application that is based on SOA. The company needs help in addressing the following issues: what other applications interface with OP, how will they be impacted if OP is transitioned to SOA, what happens if OP is outsourced and hosted elsewhere in the cloud, how will OP be accessed from a wide range of user devices, what will be the most appropriate integration strategy (access in-place, data warehousing, or migration) to mesh OP with other FFS applications, what type of integration technologies will be most suitable, and what will be the cost of transitioning OP to SOA?. Additional issues include: are there commercial-off-the-shelf products that can be used for OP, what type of middleware technologies are needed to support different architectures, which ESB (enterprise service bus) platform should be used, what are the performance and security tradeoffs when different components of this application participate in B2B trade, and what type of cost/benefit analysis need to be considered while evaluating these alternatives. These are non-trivial questions that require a great deal of time and effort to answer. The following discussion presents the main ideas. Details can be found in the Integration Module (Chapters 9 through 13).

1.4.4.1 Exploring the Integrated Architecture Problem to Develop Requirements

The main focus is on developing a sketch of an integrated architecture to understand how the different applications and systems will interact and interface with each other at an enterprise level. The emphasis is on capturing the interfaces of the applications, and the infrastructure needed to make selected applications operable at enterprise as well as at inter-enterprise levels. Enterprise application architectures typically have to satisfy the requirements of the Internet age because these applications operate in an environment where thousands of Internet users can possibly access the needed resources. Specific requirements may include:

- Internet Scale: Tens of thousands of users instead of hundreds, 24x7 not 9-to-5
- Internet connectivity: Unpredictable open Internet replaces the safety of the LAN
- Multiple customers: Security and load balancing between multiple customers
- Multiple configurations: Managing diverse user profiles and configurations
- High-volume infrastructure: Providing scalable services to diverse populations

The pattern shown in Figure 1-17 provides a good starting point. This pattern assumes that the application consists of N large grained components that are arranged in several tiers: front-end integration, business logic, backend integration, back-end apps, and external (B2B) apps. This architecture pattern also includes the following integration components:

- BCs (Business Components) are the software modules that imbed the business logic of the application and provide business services.
- FICs (Front-end Integration Components) are the adapters that allow different types of user devices (e.g., mobile, handheld) to invoke the BCs.
- BICs (Back-end Integration Components) are the adapters that BCs use to interact with different back-end and external applications.

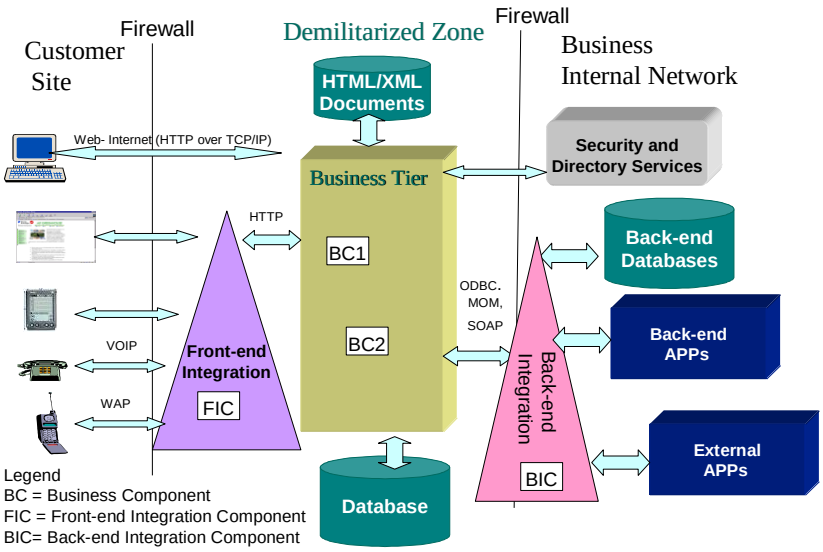

Figure 1-17: SOA-based Architecture Pattern

Determination of these integration components depends on several other factors such as hosting options and integration strategies used for internal and external (B2B) applications. To illustrate these options and their impact on integration, let us go back to the online purchasing (OP) application of FFS. If FFS decides to rent an online purchasing system from a cloud provider (e.g., use Amazon.com's purchasing system), then the back-end integration is the responsibility of the provider. However, if the order processing app is rented from an ASP but inventory and shipping reside at FFS site, then remote integration between ASP and FFS needs to be considered.

1.4.4.2 Integration Strategy and Architecture Development

The objective of this step is to develop an integrated architecture configuration that is detailed enough to reveal the complexity of the proposed architecture. This complexity, as we will see later, can be translated into cost, performance and security estimates for evaluating the proposed configuration. The complexity depends largely on the type of architectural strategies and the number and type of integration components (front-end, back-end) needed for each architectural configuration. The main consideration in developing a configuration is to choose between the following strategies for the *target applications* (applications of concern within an integration project, e.g., OP for FFS):

- **Outsourcing (remote hosting):** decide where the target applications will reside: customer site, service provider site, or a mixture.
- **Access in Place**: integrate without modifying any applications. Just access them by using adapters/mediators.
- **Data Warehouse**: build a "shadow" system to house the frequently accessed data. This is especially useful for BI (Business Intelligence) applications.
- **Migration**: re-architect and transition the target applications gradually or replace it suddenly.

Discussion of these strategies and the evaluating factors can be found in Chapter 10. The next main consideration is to translate the architecture *A* into plausible solutions (*S1, S2,,Sn*) with appropriate commercial-off-the-shelf (COTS) packages. For COTS selection, the architect has to search the COTS products available in the marketplace and select the most appropriate solution based on cost constraints, the services needed and the technical interdependencies (for example, a .NET application does not work well in a Linux environment). For SOA, the architect has to evaluate the commercially available ESB platforms from vendors such as IBM, Microsoft, BEA systems, Iona Corp and others.

Figure 1-18 shows result of this analysis for FFS. In the case of FFS, the company has decided to use the Access-in-Place strategy. In addition, it has been decided that the overall SOA-based integrated architecture consists of an ESB that is populated with an IBM Websphere ESB server for corporate services and two Microsoft Biztalk 2006 servers for departments. The individual ESB servers are logically interconnected through a directory server that that routes the traffic between the servers. See chapter 10 and 11 for more details on the ESB functionalities.

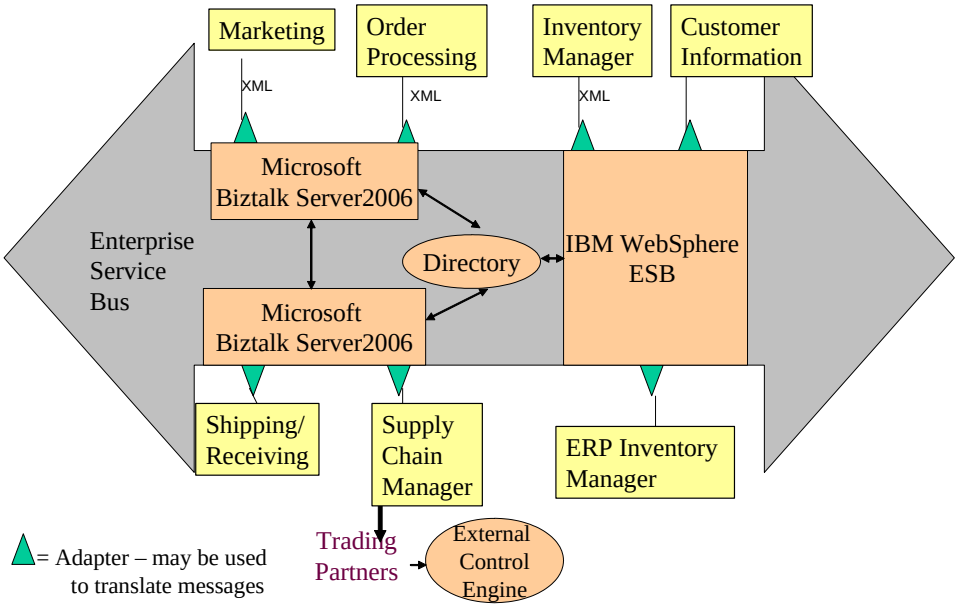

Figure 1-18: SOA Architecture for FFS (Frank's Furniture Store)

1.4.4.3 Integrated Solution Evaluation

In this stage, the solution *Si*, as a result of COTS selection, is evaluated for cost, performance and security issues. For cost estimation, the effort needed to integrate systems depends on the cost of the ESB servers plus the number and nature of integration components (FICs, BICs) identified in the previous stage. From this, rough estimates of effort and cost can be obtained by using techniques similar to function point analysis [Garmus 2000]. A performance analysis of the proposed architecture can be conducted through analytical queuing models [Kleinrock 1976]. For security analysis of the architecture, risk analysis through security patterns [Kienzle 2001] can be used. A very detailed discussion of cost, performance and security analysis can be found in chapter 12 and also in [Umar & Zordan 2008].

The main results of these analysis can be captured in a table that shows the estimated cost, security, and performance for different potential solutions S1, S2,,,Sn. This table is used to evaluate and choose the most suitable solution. Table 1-3 shows such a table for FFS. The analyst can look at Table 4 and go back and generate other solutions if the results so far are not acceptable. If a suitable solution is found, then the analyst can select the choice.

Table 1-3: Sample Analysis of Candidate Solutions for FFS

Choices	Estimated Costs ($)	Performance	Security Issues	Comments
Access-in-Place	$120K (it is relatively cheaper to install an ESB and adapters)	2 seconds. (adapters introduce delays)	ESB & adapters may be targets for attacks & need to be secured	May need to migrate in future
Migrate and replace with an ERP	$500K million (it is expensive to completely replace a system with an ERP system)	1 second (no adapters are needed, hopefully, for an integrated ERP system)	Security can be designed for the new system from scratch	Migrations are typically expensive and require staff training
Data Warehouse	$200K (it is expensive to convert data and construct a data warehouse)	0.7 seconds (data level access is usually faster due to no overhead)	ETL needs to be protected, data level access needs protection	Data warehouses create duplicate data that needs to be synchronized

1.5 Computer Aided Planning, Architecture, Controls and Education – The SPACE Environment

SPACE (Strategic Planning, Architecture, Controls, & Education) is a smart decision support environment that supports smart services, cities, governments and enterprises. It is a "one-stop shop" that supports the entire Learn-Plan-Do-Check cycle instead of one narrow area. SPACE provides extensive informational, educational and management resources by using the following three capabilities displayed in Figure 1-19:

a) **Patterns Repository** that contains core knowledge about 150+ countries, 100+ services from more 12+ sectors (e.g., health, education, public safety, public welfare, transportation) and technologies (e.g., network technologies, computing platforms, security and integration technologies.

b) **Games and Simulation Tools** that provide links to a wide range of games and simulations, case studies and tools needed by the users who want to explore the various resources in more detail.

c) **Decision Support Tool – The Planner** for the specialists and officials in governments and the private sectors who need to actually plan, implement, and manage the needed ICT initiatives. The Planner produces detailed strategic plans for a wide range of egovernment services based on best practices and standards. The Planner can be used very effectively to educate as well as assist the government officials of developing countries to accelerate progress in crucial areas. Besides strategic planning, the Planner offers capabilities for acquisitions through RFPs and project management.

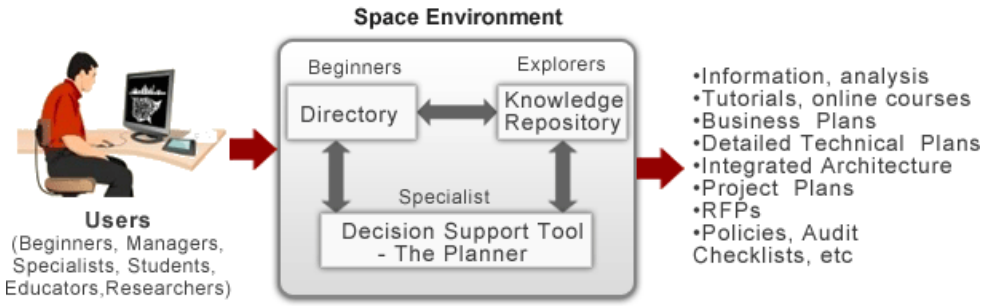

Figure 1-19: Conceptual View of SPACE Environment

Figure 1-20 shows an overall architectural view of the SPACE Environment. It shows the key components of SPACE and its interactions with external components. Specifically, SPACE supports public (government) as well as private industry sectors by interacting with a wide range of components.

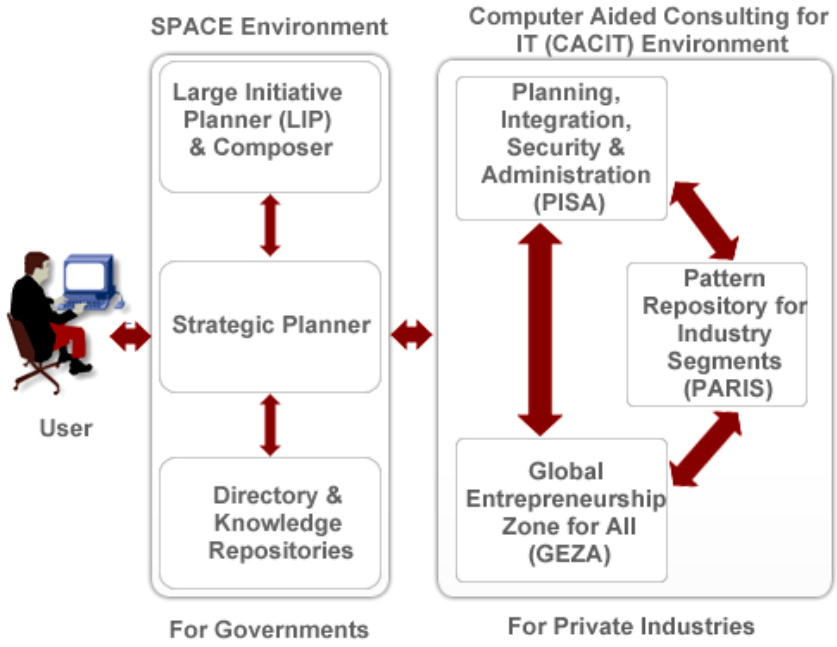

Figure 1-20: SPACE Environment – A More Detailed View

As shown in Figure 1-20, the users (government agencies, Non Government Organizations, or other organizations) develop strategic plans, RFPs (Request for Proposals) and project management plans by interacting with the SPACE Environment, a. new system primarily intended to support government services. SPACE provides these services by using the Planner that guides the users through various decisions as discussed previously. The Planner uses the following capabilities to handle user requests:

- SPACE resources (Directory and Knowledge Repositories) as described in this document.

- Specialized modules such as Large Initiative Planner (LIP) to handle initiatives such as MDGs and digital cities, and Composer for developing composites and interagency services. These capabilities have been discussed previously.
- Integration and aggregation of the external information already available in portals such as the United Nations Public Administration Network (www.unpan.org) and the UN-GAID website (www.un-gaid.org). In addition, we will provide access to useful educational and training materials .

SPACE also supports the private sector by leveraging an existing Computer Aided Consulting Environment that primarily concentrates on the private sector. Specifically, SPACE has been successfully integrated with a comprehensive environment that suppots private sectors. This environment is based on research in using computer aided planning for best practices [16-21] and consists of. detailed planning tools, displayed in Figure 5. Currently these tools consist of:

- **A detailed planning system for private sectors called PISA** that can be used to quickly build real life business scenarios and then guides the user through IT planning, integration, security and administration tasks by using best practices. PISA supports 18 industry segments that include many within the scope of public administration (e.g., education, energy, health, and transportation) and provides basic capabilities for composing larger and more complex scenarios that include multi-region offices, supply chains, mergers, acquisitions and business networks. This comprehensive tool also provides extensive capabilities for integrating different systems by using SOA (service oriented architecture) and supports open interfaces so that gaming and simulation tools can be easily plugged in.
- **A knowledge portal for entrepreneurship, called GEZA**, that provides a set of knowledge services ranging from starting a business to international partnership and outsourcing opportunities. GEZA capabilities include business solutions for developing and implementing business strategies, a comprehensive yellowbook directory of SMB portals, an outsourcing center for service providers and consumers, an international center for doing business internationally, an education center for entrepreneurs, and links to PISA for IT solutions and to PARIS for industry patterns.
- **An industry pattern repository called PARIS** that houses business patterns for more than 20 industry segments including education, healthcare, transportation, telecom, and manufacturing. PARIS provides overviews, examples, specializations and sources of information for each industry segment; examples and best practices of how ICT is being used effectively in different industry segments; business process patterns, requirement patterns and information model patterns in UML; and interfaces to support PISA advisors and GEZA services.

PISA, GEZA and PARIS collectively can be and have been used for educational as well as consulting services. Instead of several disconnected tools that address parts of the problem, the detailed planning environment captures the complex interdependencies between the business and technology building blocks of real life situations. The users can directly invoke the needed tools or access them through business games and simulations supported by textbooks and course materials.

For additional details, please visit the SPACE website at www.space4ictd.com.

1.6 Summary

Integrated enterprise architecture provides an inventory of the business and IT resources and how do they work with each other. Such an inventory promises many benefits that include: identifying what resources exist; improving integration among resources; facilitating business process improvement,

and creating speed and efficiency in meeting changing business needs through IT. These benefits directly impact the overall organizational performance and competitive advantage. However, it is not clear how exactly to develop such architectures.

In this chapter, we have given an overview of enterprise architectures and integration and have discussed how SOA can be used in developing an integrated enterprise architecture (IEA). We have also proposed a systematic methodology that can be used to develop IEAs. In addition, a comprehensive toolset, called PISA (Planning, Integration, Security and Administration) has been presented to develop IEAs for practical situations. PISA can also be used as a teaching tool for this book. We have introduced a case study (XYZCorp) that will be used throughout this book to show how the knowledge gained can be used to address practical problems.

1.7 Review Questions and Exercises

1) Scan the literature and find at least three definitions of an enterprise architecture

2) Scan the literature and discuss three examples of companies that have used innovative approaches for enterprise architectures. Also find at least one company that has failed in this area.

3) List the main benefits, in order of priority, and risks of an EA.

4) What is difference between EA and IEA. Explain through an example.

5) Scan the literature for enterprise integration projects and categorize the examples as vertical, horizontal or mixture integration efforts. ;

6) In your view, what is the main strength of SOA to deliver business value? What is the main weakness (risk)? Give three specific examples to illustrate the use of SOA in enterprise architecture and integration. .

7) Visit the SOA sites at IBM and other SOA players and create a list of resources available from such sites.

8) Compare and contrast PISA with at least two industrial products. You should visit the PISA Website (ngepisa.com) to familiarize yourself with the PISA toolset first.

9) Suppose that you have been asked to develop a two day management training program in enterprise architecture and integration.. What topics will you cover in this program and what automated tools, besides PISA, will you use ?

10) Access some websites such as emarketer.com, fedex.com and others to find the latest statistics on ebusiness growth and decline and some innovative IS projects in the field.

11) Access Startupfailures.com and identify the main causes and lessons learnt from dotcom failures.

REFERENCES

[1] Adams, J., et al, "Patterns for e-Business: A Strategy for Reuse", IBM Press, October 2001.

[2] Alexander, C., "The Timeless Way of Building", Oxford University Press, 1979
[3] Alexander, C. et al , "A Pattern Language", Oxford University Press, 1977
[4] Askit, M, (editor), "Software Architectures and Component Technology ", Kluwer International Series in Engineering and Computer Science, 2001.
[5] Brodie, M. and Stonebraker, M., "Migrating Legacy Systems", Morgan Kaufman, 1995
[6] Boehm, B., and Abts, C., "COTS Integration: Plug and Pray". Computer, vol. 32, no. 1, 1999, pp. 135-138.
[7] Buchanan, R. & Soley, R., "Aligning Enterprise Architecture and IT Investments with Corporate Goals. Meta Group/OMG white paper. http://www.omg.org/registration/META-OMG-WP-Public.pdf, 2002.
[8] Burton, F. et al, "An Application of Expectancy Theory for Assessing User Motivation to Utilize an Expert System", *Journal of Management Information Systems*, Vol. 9, Issue 3, pp. 183-199., 1993.
[9] Buschmann, E., et al, "Pattern-Oriented Software Architecture, Vol. 1: A System of Patterns", John Wiley, 1996.
[10] Carter, S., "The New Language of Business: SOA & Web 2.0", IBM Press, 2007
[11] Caruso, F. and Umar, A., "Architectures to Survive Technological and Business Turbulances", ISF Journal, May 2003.
[12] Cardwell, G., "The influence of Enterprise Architecture and process hierarchies on company success", Total Quality Management & Business Excellence, 19(1/2), 47., 2006.
[13] Chesbrough, H. and Spohrer, J., "A Research Manifesto for Service Science", *Comm of ACM*, July 2006, pp. 35-40.
[14] Clemens, P. and Klein, K., "Evaluating Software Architectures", Addison Wesley, 2002.
[15] Cummins, F., "Building the Agile Enterprise", Elsevier Science Publications, 2008
[16] Davis,E. and Spekman, R., "Introduction to the Extended Enterprise: Gaining Competitive Advantage through Collaborative Supply Chains", Prentice Hall, 2003.
[17] Ericksson, H. and Penker, M., "Business Modeling with UML – Business Patterns at Work", John Wiley, 2000.
[18] Fellenstein, C., "On Demand Computing: Technologies and Strategies", IBM Press, 2004
[19] Ferdinandi, P., "A Requirements Pattern: Succeeding in the Internet Economy", Addison-Wesley, January 2002.
[20] Fox,M. and Gruninger, M., "On Ontologies and Enterprise Modelling", International Conference on Enterprise Integration Modelling, 1997
[21] Gamma, E., et al, "Design Patterns", Addison Wesley, 1994.
[22] Garmus, D., "Function Point Analysis: Measurement Practices for Successful Software Projects", Addison-Wesley, 2000.
[23] Gammelgård, M., Simonsson, M., Lindström, Å. (2007). An IT management assessment framework: evaluating enterprise architecture scenarios. Information Systems and eBusiness Management, 5(4), 415.
[24] Gruman, G., "The Four Stages of Enterprise Architecture:, CIO, 20(5), 1., 2006.
[25] Hagge, L. and Lappe, K., "Sharing Requirements Engineering Experience Using Patterns", IEEE Software, January-February 2005, pp. 24-31.
[26] Herzum, P. and Sims, O., "Business Component Factory", John Wiley, 2000.
[27] Hevner, A., et al, "Design Science in Information Systems Research", MISQ, Volume 28, Number 1, 2004, pp. 75-105.
[28] Hohpe, G. and Woolf, B., "Enterprise Integration Patterns : Designing, Building, and Deploying Messaging Solutions", Addison-Wesley, 2003.
[29] IBM e-Business Framework website http://www-106.ibm.com/developerworks/patterns/
[30] IBM Corporation, "Business Systems Planning", 1978, GE20-0527.
[31] Inmon, W.H., "Developing Client/Server Applications", QED Publishing Group, Revised edition, 1993.
[32] Kalakotta and Robinson, *M-Business*, McGraw Hill, 2002a
[33] Kalakotta and Robinson, "E-Business 2.0", Wiley, 2002b
[34] Kidd, P., "Next Generation Enterprise Model", Revised September 2000, http://www.CheshireHenbury.com.
[35] Kienzle, D., and Elder, M., "Security Patterns for Web Development", DARPA Contract No: F30602-01-C-0164, June 2001. Weblink: http://www.scrypt.net/~celer/securitypatterns/final%20report.pdf.

[36] Kamogawa, T., Okada, H. "A Framework for enterprise architecture effectiveness", Services Systems and Services Management, 2005. Proceedings of ICSSSM '05. 2005 International Conference, 1(1), 740- 745, 2005.
[37] Kerr, J. M. (2007). "An Architecture for the Future", CIO, 20(10), 1., 2007
[38] Koch, C. (2005). "A New Blueprint For The Enterprise", CIO, 18(10), 1., 2005.
[39] Kleinrock, L., "Queuing Systems - Vol. 2", John Wiley, 1976.
[40] Lindström, Å., Johnson, P., Johansson, E., Ekstedt, M., Simonsson, M. "A survey on CIO concerns-do enterprise architecture frameworks support them?", Information Systems Frontiers, 8(2), 81-90, 2006.
[41] Linthicum, D., "Enterprise Application Integration", Addison-Wesley Information Technology Series, 1999
[42] McAfee, A., " Enterprise 2.0: The Dawn of Emergent Collaboration", MIT Sloan Management Review, Vol. 47, No. 3, Spring 2006, pp. 21-28
[43] Mentza, G. et al, "Knowledge Services on the Semantic Web", CACM, , June 2007
[44] Mowbray, T. and Zahavi, R., "The Essential CORBA: Systems Integration Using Distributed Objects", John Wiley, 1995.
[45] Pastore, R., "GM's Cure for Complexity; GM CTO Tony Scott tells CIO how his IT group achieves simplicity and ROI", CIO, 17(22), pp. 46-48, 2004.
[46] Pohle, G., et al, "The Specialized Enterprise: A Fundamental Redesign of Firms and Industries", IBM Institute for Business Value study, November 2005, http://www-935.ibm.com/services/us/index.wss/ibvstudy/imc/a1009224?cntxt=a1000401
[47] Rico, D. F., "A Framework for Measuring ROI of Enterprise Architecture". Journal of Organizational and End User Computing, 18(2), I-XII, 2006. .
[48] Rockart, J., "The Changing Role of the Information Systems Executive: A Critical Success Factors Perspective", Sloan Management Review, Vol. 24, No. 1, pp. 3-13, 1982.
[49] Sessions, R., "A Comparison of the Top Four Enterprise-Architecture Methodologies", ObjectWatch, Inc.May 2007, http://msdn.microsoft.com/en-us/library/bb466232.aspx
[50] Shah, H., El Kourdi, M. "Frameworks for Enterprise Architecture", IT Professional Magazine, 9(5), 36-41., 2007
[51] Todd, P. and Benbasat, I., "The Use of Information in Decision Making: An Experimental Investigation of the Impact of Computer-Based Decision Aids", MIS Quarterly, Vol. 16, No. 3 (Sep., 1992) , pp. 373-393
[52] Umar, A., "IT Infrastructure to Enable Next Generation Enterprises", *Information Systems Frontiers Journal*, Volume 7, Number 3, July 2005, pp: 217 - 256
[53] Umar, A., "Intelligent Decision Support for Architectures and Integration of Next Generation Enterprises ", *Informatica, V. 31, No. 14, pp. 141-150,* July 2007
[54] Umar, A. et al, "Computer Aided Consulting for Small to Medium Businesses", IRMA, (Information Resource Management Association) Conference, San Diego, May, 2005.
[55] Umar, A. and Javed, A., 'Network Security Design for the Next Generation Enterprises', eSociety 2006 Conference Proceedings, Dublin, July 2006
[56] Umar, A. and Khalid, K., 'IT Planning for the Next Generation Enterprises', eSociety 2006 Conference Proceedings, Dublin, July 2006Zachman, J., "A Framework for Information Systems Architecture", IBM Systems Journal, V,. 26. N. 3, 1987.
[57] Zachman, J., "A Framework for Information Systems Architecture", IBM Systems Journal, V,. 26. N. 3, 1987.