(Draft May 7, 2010)

1 Strategic IT Planning, Integration, Security and Administration – An Overview

Note: This draft white paper is based on a chapter of a future book "Strategic IT Planning in the Digital Age" by A. Umar. In its present form, this paper is work in progress that will be considerably refined in the next round. Please send your comments and suggestions to aumar@harrisburgu.edu.

1.1 Introduction

Modern enterprises need to plan and integrate their IT (information technologies) services quickly and correctly to compete and survive. Specifically, IT managers need to a) recognize organizational opportunities to use information technology, b) determine the resource requirements (IT services plus the organizational services) to exploit these opportunities, and c) develop strategies and action plans for realizing these opportunities in an integrated manner. The IT managers need to be guided through the maze of intricate choices while operating in heterogeneous environments with technologies of different vintages from different suppliers creating complex situations. Typical challenges faced by the IT managers are:

- How to understand the business strategies and to align IT with the business strategies
- What business processes (BPs) should be automated and re-engineered to compete and succeed
- What type of IT infrastructure (application packages, computing platforms, and network services) are needed to support the BPs
- How to integrate new applications with the existing, including legacy, systems by using concepts such as SOA (service oriented architectures)

1.2 Conceptual Framework and Key Building Blocks

1.2.1 Conceptual Framework

Figure 1-1 shows a conceptual framework that will guide the discussion in this section. This framework shows enterprise business processes/strategies, enterprise applications, platform services and network services as different horizontal layers. In addition, these horizontal layers represent highly interdependent building blocks that must be properly secured, integrated, and managed/governed (represented as vertical bars that cut across different horizontal layers of the framework). We will use this framework to establish the interrelationships between different technical and business aspects of modern enterprise and to define some basic terms. We start from the top layer

(business strategy and processes) and proceed to lower layers. The discussion then moves to the vertical bars of security, management and architectures that cut across all layers.

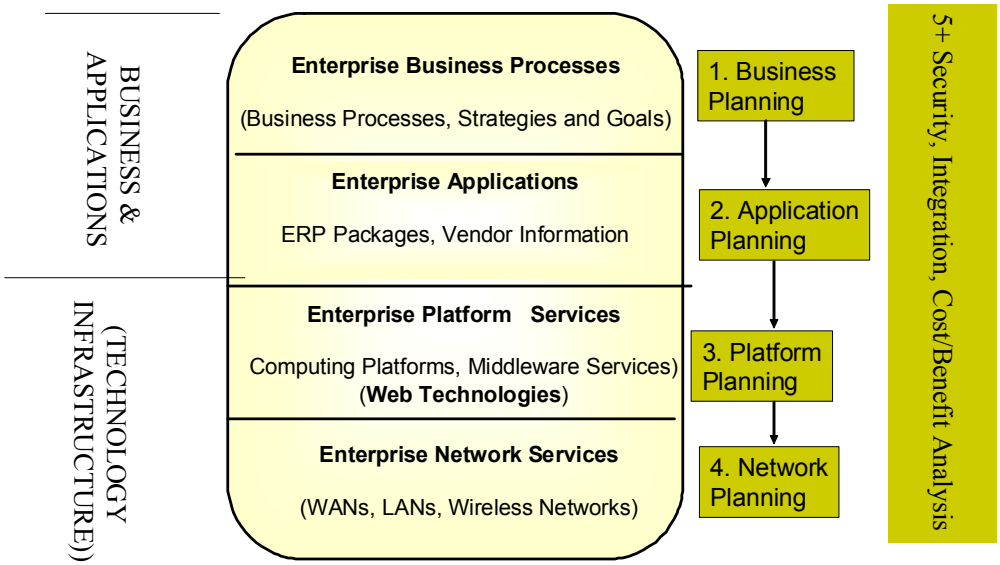

Figure 1-1: A Framework for Discussion

This framework helps us to develop a very simple planning methodology (darker blocks on the right) that consists of the following major steps:

Step1: Business planning that concentrates on business and strategic issues

Step 2: Application planning that establishes the business applications (automated business processes) needed to support the business strategies

Step 3: Computing platform planning that determines the needed computing hardware/software

Step 4: Network planning that establishes how all the pieces will communicate remotely with each other

Step 5+: Security, integration and administration planning that concentrate on how all the layers will be properly secured and administered

The following discussion will use this simple planning methodology to get us started. We will develop a more general approach later.

1.2.2 Business Strategies – How to Succeed in the Competitive Marketplace

1.2.2.1 Getting Started on Business Strategies

Simply stated, strategy is a game plan to win. But how can good business strategies be developed? Figure 1-2 shows a few classical models to get us started. Traditional business strategies started with core competencies that drove the products/services which were delivered to the target customers. This model, while used by many companies for centuries, has the weakness that it does not allow you to respond to the changing market conditions in which your core competencies may not be valuable.. The new model starts with examining customer needs, developing products/services to satisfy these needs, and then relying on the competencies of service providers by outsourcing and partnering for product development. These models are shown in Figure 1-2a.

This does not mean that the traditional model does not work. In fact, both models work at different times. The trick is to know what model works when. The new model implies a great deal of flexibility because customer needs change very quickly. This model heavily relies on outsourcing because outsourcing gives flexibility (if your business needs change, you get new service providers). It also implies heavy reliance on information technology (IT) to quickly understand and respond to customer needs. Basically, information technology must be aligned with the business needs of an organization. For example, Michael Hammer [Hammer 1990] defines and promotes business process reengineering (BPR) as the use of the power of modern IT to radically redesign business processes in order to achieve dramatic improvements in performance. In essence, IT must enable the organization to survive and prosper in the competitive global economy. While there is a general agreement on the importance of aligning IT with business, the approaches and views differ widely. This short discussion is intended to establish an overall context within which the issues related to IT planning and integration can be presented.

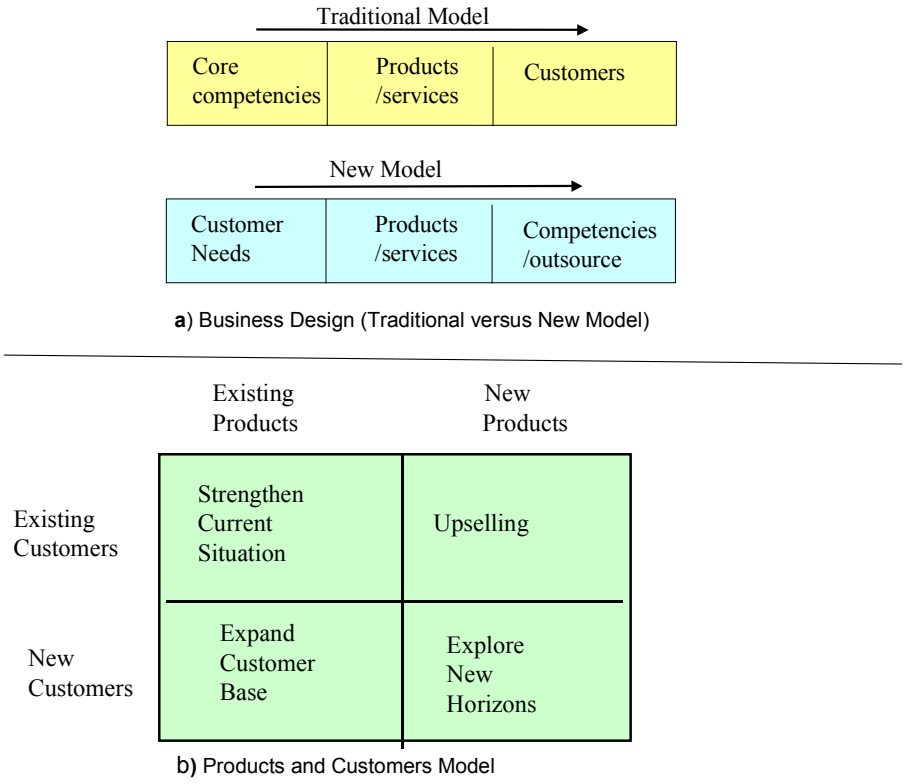

Figure 1-2: Basic Models for Establishing Strategies

Another common approach is based on two factors: products (existing, new) and customers (existing, new). The basic idea is presented in Figure 1-2b. To be successful, companies need to consider all four cells of Figure 1-2b. Naturally, existing products for existing customers need to be strengthened -- this is a firm's base. However, firms cannot survive without introducing new products and attracting new customers. It is also desirable to expand existing customer base by selling existing products to new customers and also "upsell" by introducing new products to existing customers. The riskiest undertaking is when you are exploring new horizons by introducing new products for new customers. The challenge faced by companies is to understand and exploit the confluence of trends in customers

(e.g., speed of service demanded by the customers and appeal of self service), organizational trends (e.g., outsourcing and continued innovation), and technology trends (e.g., integration of user views and back-end systems, broadband and mobile networks, component-based software).

The main question is: which cell should a company focus on? A variety of models have been developed for establishing strategies. The choices depend on the type of industry. In some industries with established products, a company may choose to spend 75% of its budget on strengthening the current situation while in others (e.g., telecom), a company may spend more money in exploring new horizons. See [McNurlin 2001] for more details. Perhaps the best known models to provide further guidance are the Porter Models that are briefly reviewed next.

1.2.2.2 Porter Competitive Forces Model

Porter Models were introduced by Michael Porter first in 1980 and then later in 1985 [Porter 1980, Porter 1985]. The first model, known as the competitive force model is used most heavily. Porter's basic idea is that companies must contend with five competitive forces: threat of new entrants, bargaining powers of customers and buyers, buying power of suppliers, substitutes for your products and services, and the intensity of rivalry among competitors (see Figure 1-3). He then proposes three strategies to succeed: differentiate your products and services, be the lowest cost provider, and find a niche. Five years after this very simple yet elegant model, Porter proposed a Value Chain model suggesting that to be successful, companies must add value at every step of creation, development, sale, and after-sale. This model also became very popular.

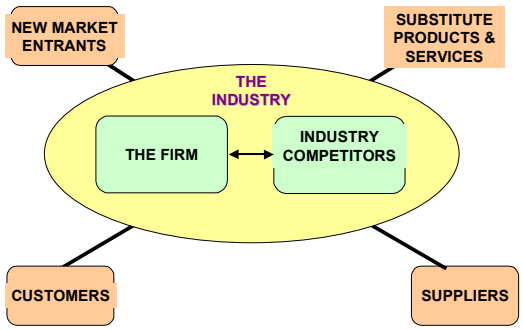

Figure 1-3: Porter's Competitive Force Model

Let us use the following examples to illustrate the Porter's Competitive Force Model.

- The US Post Office Services, circa 1980, had no competition. Federal express was a new market entrant that came up with the overnight delivery services and became a competitor to the Post Office Services. Other entrants such as UPS also became competitors to the Post Office Services. While positioning to compete with the new entrants, the Post Offices had to face a substitute service -- the e-mail. As we all know, e-mail is a substitute for paper mail and even telephone calls. Thus the new entrants and the substitute services cannot be ignored.
- Rand McNally has been printing maps until 1916 and has been the leader in maps ever since. The company publishes a very successful Rand McNally Road Atlas that has sold 150 million copies. However, as the digital economy developed at the beginning of the 1990s, Rand McNally's management did not understand the full impact of the new Internet and other computer-related developments. In particular, new startups such as MapQuest came out of nowhere and became a chief competitor in the new on-line map environment. New management was brought in to create a web site (RandMcNally.com) to put Rand McNally maps and address-to-address driving directions on the Web. Despite several attempts at gaining the online map and end-to-end directions business, Rand McNally has a long way to go to catch up to its more digital-savvy

competitors. Thus new entrants such as MapQuest armed with substitute products (online maps) and additional services (e.g., online directions) have successfully competed with a market leader. Obviously, the changes in customer attitudes (many customers are comfortable with the idea of printing maps and directions online) have helped the new entrants.

Companies need to continuously watch out for new entrants and substitute products and themselves develop new products to stay in business. While developing strategies, the following few principles are worth keeping in mind (see [Kalakota 2000] for an expanded discussion of these and other related principles):

1. Technology should not be an afterthought in forming business strategy but a cause and a driver. In fact, "electronification" of current and future systems must be part of a business strategy.

2. Streamlining the flow of information is more important than that of products. This is essential because the information surrounding a product and service is more important than the product itself in this information age.

3. You must be able to overthrow outdated business design to avoid failure and develop new business design that relies on outsourcing to attract and retain customers.

4. Business design of the future should be highly reconfigurable and technology should be used to innovate, entertain, and involve the customer experience.

It is beyond the scope of this discussion to discuss business strategies in detail. The following sidebars summarize the main ideas from a few of my favorite papers. The sidebar "Porter's Thoughts on Internet Strategy" summarizes Mike Porter's views on the good and bad news associated with the use of Internet for business strategies. "How Home Depot Created a New Market" sidebar shows how Home Depot succeeded in a very competitive marketplace by addressing the needs of homeowners. The sidebar "Disruptive Technologies – When NOT to Listen to Your Customers" presents a very important view by Christiansen on how some companies fail because they keep listening to their existing customers. Several books, such as [Kalakota 2000, Sawhney 2001, Whyte 2001], and journals/magazines such as Journal of Business Strategy, Harvard Business Review, Sloan Management Review, the CIO Magazine, and Information Week should be consulted for detailed insights. In addition, consulting firms such as IDC (www.IDC.com) have published a series of reports on business strategies. .

Porter's Thoughts on Internet Strategy

Some argue that the Internet renders strategy obsolete. Michael Porter contends that the opposite is true. In fact, Internet weakens profitability and lowers entry barriers for newcomers, thus it is even more important for the companies to distinguish themselves through strategy. The winners, according to Porter, will be the companies that view Internet as a complement to the traditional ways of competing.

Internet is a powerful enabling technology that can be used, wisely or unwisely, as part of any strategy and in any industry. The main question facing the companies is how to deploy the Internet. In general, the companies that succeed will be the ones that use Internet as a complement to the traditional ways of competing and not those that separate their Internet initiatives apart from their established operations. Traditional companies as well as dot coms can benefit from the Internet by making it a tool for distinctive strategies. Thus the Internet makes strategies more essential than before.

Most of the Internet benefit should be measured in terms of the economic value it creates in the real

companies. Economic value is the gap between price and cost and reflects the profitability of a company. Creating revenues, reducing expenses, and even new customers is not an evidence of economic value. Reducing cost, for example, does not show profit if you have to reduce prices dramatically to stay competitive. It is not good to point to the success of Internet tool providers as a sign of success. In fact, in many cases, tool developers do quite well in the periods of experimentations even though the experiments themselves are not very successful.

To determine how the Internet creates economic value, Porter suggests two fundamental factors: a) the industry structure, which determines the profitability of the average competitor; and b) sustainable competitive advantage, which allows a company to outperform the average competitor. For example, the Internet has opened new markets for potential profits but it is difficult to maintain a competitive edge because everyone can enter the new marketplace also

The paper goes through a detailed analysis of the Internet on these two factors and lists six principles of strategic positioning:

- Start with the goal of long term profitability.
- Deliver a value proposition that is superior to the competition.
- It must provide distinctive value chain, i.e., provide value at every step of design, manufacturing, distribution, and sales.
- Products and services should be willing to give up some features to provide added values in others, i.e., tradeoffs must be part of the strategy.
- Define how all the products and services of a company fit together.
- Provide continuity of direction, i.e., do not disrupt services and products without giving them a fair chance.

Source: Porter, M., "Strategy and the Internet", Harvard Business Review (HBR), March 2001.

How Home Depot Created a New Market

Home depot has revolutionized the do-it yourself market in North America. It has become a more than $25 billion company that has created 130,000 new jobs in more than 1000 stores across the United States. Home Depot succeeded in creating a new market by converting home-owners into do-it yourselfers. The main idea is that home owners do not like to wait for contractors to arrive at all odd hours and charge top dollars for jobs that are not well done. Instead the homeowners would like to do things themselves, if possible. Home Depot enabled these homeowners to do their own thing and hired trained staff, many are ex contractors, to help the customers in buying the right products and give "how to" advice.

Source: Kim, W.C., and Mauborgne, R., "Creating a New Market Space", HBR, Jan-Feb, 1999.

Disruptive Technologies – When NOT to Listen to Your Customers

Many leading companies fail to stay at the top of their industries when markets or technologies change. IBM dominated the mainframe market but missed the minicomputers by several years even though minicomputers are much less sophisticated than mainframes. Digital Equipment Corporation (DEC) dominated the minicomputer market due to its Vax machines but missed the smaller PC market Apple computers led the user friendly computers but lagged behind 5 years its competitors to bring its portable computers to market.

The main reason for many of these failures is that the companies stay too close to their existing customers while new customers and products are emerging. For example, Xerox built large copying machines for copying centers. When asked, the copying centers did not see any need for smaller copier machines. Similarly IBM talked to its mainframe customers to see if minicomputers and desktops could be of use to them -- IBM found that these customers wanted more mainframe features instead of smaller machines.

Managers must be aware of the disruptive technologies that do not initially meet the needs of their existing customers. Disruptive technologies such as small copying machines in the era of big copying machines must be looked at as new products/services for new customers.

Source: Bower, J. and Christiansen, C, " Disruptive Technologies; Catching the Wave", HBR, Feb 1995

1.2.3 IT Strategies – How to Align IT with Business Strategies

Once a company has established a business strategy then the needed IT and organizational systems are developed to realize the strategy. For example, Dell established and implemented integrated systems with partners that produce a customized PC to minimize the time to start using the PC. Similarly, Amazon.com developed technologies such as OneClick and business partnerships with many bookstores so that the customers could quickly select and purchase books from a very large virtual bookstore.

Different views and models for aligning IT with business needs have been discussed widely in the management literature. For example, Peter Keen [Keen 1993] proposes a "fusion map" between the information technology, business processes, people. and management. Keen's basic premise is that top management challenge is to make sure that technology, business processes, and people are meshed together, instead of being dealt with as separate elements in planning and implementation. Keen's "fusion map" describes the steps to enable such a strategy. William Davidson [Davidson 1993] presents a three phase transformation approach to effectively utilize information technology to re-engineer business. His three-phase transformation process starts with structured automation of existing activities, builds on this automation to extend and enhance the original business, and then redefines the business itself (e.g., spawns new businesses).

While the models and approaches differ between IT management scholars, the basic principles of aligning business and IT are the same. Let us discuss a model presented by Henderson and Venkataram [Henderson 1994] to illustrate the key concepts. This model is accepted in the IT management research community and has been used by many researchers as a framework for further work (see, for example, [Luftman 1996, Luftman 2002]). In addition, this model has been adopted by IBM for management training and is used by the IBM Consulting Group. The basic Henderson-Venkataram model views business and IT in terms of strategy and infrastructure (see Figure 1-4). The four closely interacting components of this model are: business strategy, IT strategy, business infrastructure, and IT infrastructure.

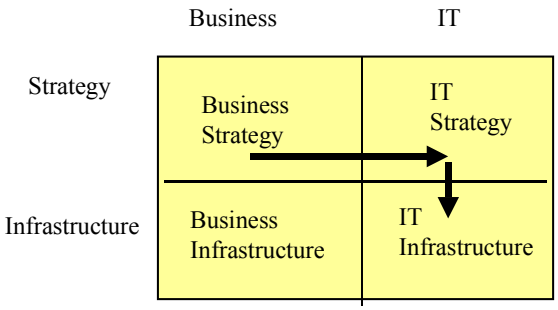

Figure 1-4: Henderson-Venkataram (H-V) Strategic Alignment Model

Henderson-Venkataram (H-V) propose that IT can be aligned with business by involving not less than three components of the alignment model. The effort can be initiated (driven) from any component and then involve the other two. For example, the following scenarios for aligning IT with business processes can be envisioned (see Figure 1-5):

- Business strategy -> IT strategy -> IT infrastructure. In this case, the business strategy drives the IT strategy, which in turn influences the IT infrastructure. This common approach is depicted in Figure 1-5a.
- Business strategy -> Business infrastructure -> IT infrastructure. In this case, the business strategy drives the business infrastructure, which in turn influences the IT infrastructure (Figure 1-5b). This is the traditional BPR model.
- IT strategy -> Business strategy -> Business infrastructure. In some cases, the IT strategy drives the Business strategy, which in turn influences the Business infrastructure. This scenario, shown in Figure 1-5c, is used in cases where organizations initiate new businesses due to their expertise in IT (this is happening in the telecommunications industry where the Baby Bells are entering the Internet market to take advantage of their networking know-how).
- IT strategy -> IT infrastructure -> Business infrastructure. In this case, the IT strategy influences the IT infrastructure which in turn influences the business infrastructure Figure 1-5d).

These scenarios show some of the interactions between IT and business. Naturally, other scenarios and interactions can be envisioned. An extensive discussion of these scenarios with different applications can be found in [Luftman 2002, Luftman 1996].

Here are some general observations and guidelines to move forward:

- Real strategic and sizable business gains do not result from re-engineering only the applications but come from the combination of business re-engineering along with the supporting application re-engineering.
- IT should be used to enable business decisions and processes. Make sure that there are clear business drivers before you get carried away with the technology.
- Many new technologies that claim to eliminate existing N technologies themselves become N+1.
- The life cycle for the reason for undertaking an effort should be longer than the life cycle of the undertaking itself. In other words, if you undertake a two year reengineering effort to save hardware cost, but hardware costs change in 6 months, you may be looking at a very tough year and a half.
- Distribution is not always good. Replacing a mainframe with multiple PCs may be like replacing a horse with 100 chickens to pull a cart. You face similar coordination problems!
- There is a thin line between vision and hallucination. You should know when you cross it.

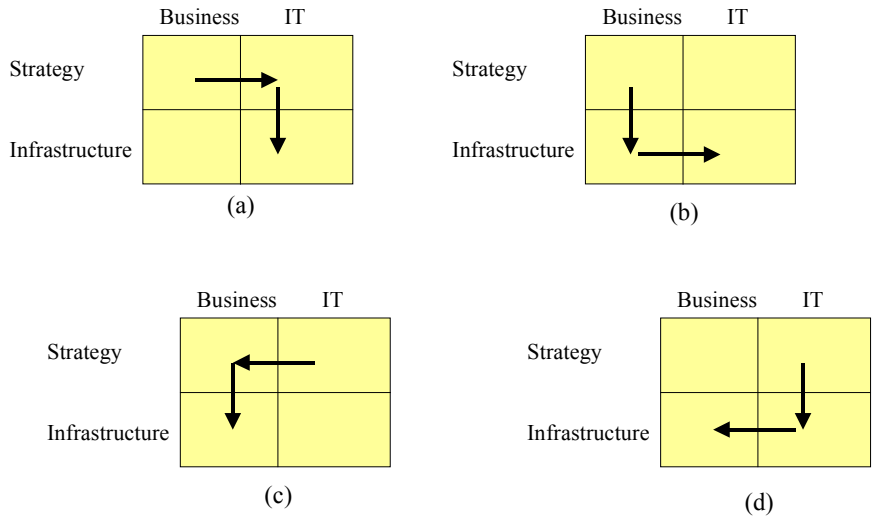

Figure 1-5: Aligning IT with Business - A Few Scenarios

1.2.4 Overview of Planning in Enterprises

1.2.4.1 Levels and Types of Planning

Lets now consider planning and attempt to understand how it relates to business strategies and IT alignment discussed so far. Planning determines what needs to be done (the objective), outlines the steps and the sequence of steps to accomplish the objective, and lists the time and effort needed to meet the objective. The result of a planning process is a document, a ***plan***, which is a repository of information about the approach, the steps, the resources needed and the time frame for an effort. Within this general framework, several levels and types of planning exist in real life and enterprises. We all remember planning a vacation, planning a family relocation from one city to another, or planning a wedding (there are professional wedding planners also -- there is a movie by that name starring Jennifer Lopez).

In enterprises, there can be several types of planning efforts (business, IS, IT infrastructure) at several levels (strategic, tactical, operational). These planning efforts cover different horizons (strategic plans are longer range than tactical or operational ones) and have different areas of focus (business plans concentrate on business issues while IS and IT infrastructure plans focus on information systems and technologies). These plans also support and feed into each other (IS plans support business plans and strategic plans feed tactical and operational plans).

Table 1-1 shows the various levels and types of plans with interrelationships between them. The reality is quite different than this almost idealized view. In many real life cases, one big plan exists (if at all) that includes all levels and types. In most cases, corporate attention is paid to strategic planning

and the tactical/operational plans are left to the individual business unit management. Our focus is also on strategic planning.

Table 1-1: Planning Types and Levels

	Business	Information System	IT Infrastructure
Strategic Plan(3-5 years)	Strategic business planning Goal: What new markets to get into in the long run	Strategic IS planning Goal: What ISs will be needed to support the strategic business plan	Strategic IT infrastructure planning Goal: What type of IT infrastructure will be needed to support strategic IS plan
Tactical Planning (1-2 years)	Tactical business planning Goal: What to do with the existing products and services	Tactical IS planning Goal: How to support the tactical business plan through IS. and also the strategic IS plan	Tactical IT infrastructure planning Goal: How to support the tactical IS plan through IT . and also the strategic IT plan
Operational Planning(6months-1 year)	Operational business planning Goal: How to deliver the products and services to existing customers	Operational IS planning Goal: How to support the operational business plan through ISs. and also the tactical IS plan	Tactical IT infrastructure planning Goal: How to support the operational IS plan through IT . and also the tactical IT plan

1.2.4.2 Relating Business Strategy to IT Planning

Figure 1-6 shows a broader view of the three major levels of IS planning in enterprises. This view puts the IS planning in context along with other systems of the organization and also shows a fourth "development" level for completeness. At the highest level, as stated previously, is the business strategic planning which determines the enterprise services to be provided. At the next level, the strategic systems (financial, engineering, manufacturing and information systems) are planned. The infrastructure (facilities, equipment, human and IT infrastructure systems) needed for the services are planned at the third level. The actual development and support is conducted at the fourth level. Consider, for example, a startup company that wants to build and sell network products. The business strategy of this company is to use "just in time" assembly processes to minimize on-hand inventory. Towards this goal, the company will have to develop manufacturing facilities and processes, among other things. On the IS side, the company will need to develop applications (e.g., inventory control, materials requirement planning) that will support the company goals and minimize the delays between steps to assure just in time processes. The major planning processes and the interrelationships between the planning processes are displayed in Figure 1-6 Our main interest is in the information systems related processes (highlighted borders in Figure 1-6).

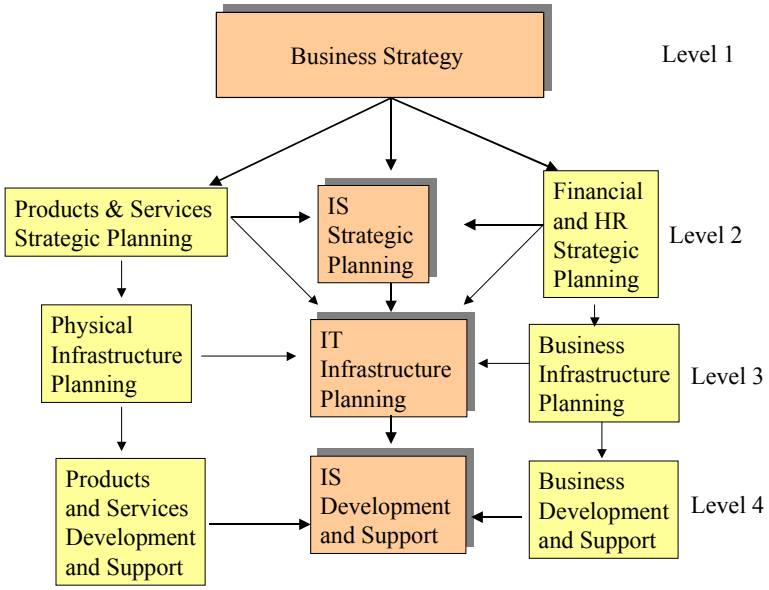

Figure 1-6: Planning Levels -- A Simplified View

To reduce complexity, let us now synthesize the three levels of planning into an enterprise-wide information system (IS) plan which must satisfy the following requirements:

- Business requirements that drive the entire IS initiative.
- Application functional requirements, which state the things done by the applications being used in different parts of an enterprise.
- Application interconnectivity requirements which establish the mechanisms of information exchange between applications at different enterprise sites such as remote logon, file transfer, distributed database management, and cooperative processing.
- Management control, security, interoperability, portability and integration requirements to make the applications independent of the underlying distributed computing platforms so that changes in the platforms do not necessitate modifications of the application systems.
- Physical network response time, availability, and cost requirements imposed by the end users and management throughout the enterprise.
- Network growth and interconnectivity requirements between the various computing devices, communication devices, and network transmission mechanisms used in the enterprise.

1.2.5 Information Systems Strategic Planning – Aligning IT with Business

The information systems planning process mainly defines the application systems which satisfy the information services strategy and then develops an IS architectural view for the enterprise. The two main steps of this activity (application identification and IS architecture) are described below.

1.2.5.1 Application Identification and Selection

This step attempts to translate the information services strategy into specific application systems. It consists of identifying the application systems at the enterprise level which can satisfy the information services strategy of an enterprise. For example, this stage would identify the ERP applications, customer relationship management systems, and online-purchasing systems, and office applications (e.g., voice mail, e-mail, intelligent documentation retrieval and storage systems, electronic form processing, multimedia systems) to satisfy the vision of an electronic enterprise. In manufacturing

enterprises, the applications in business, engineering, and manufacturing are identified to support a computer integrated manufacturing vision.

The identified application systems are defined in terms of the processes, the required flow of information between the processes and various response time and application/corporate security restrictions. The application systems identified in this stage are specified in detail later in the application requirement specification phase of the application. This stage essentially identifies the applications which, if approved, are carried through a system life cycle project. Several methodologies have been developed for this stage. Examples are the traditional information systems planning methodologies such as IBM's Business Systems Planning (BSP), Rockart's Critical Success Factors (CSF), Nolan's Stage Model, and Porter's Models. These planning methodologies are briefly reviewed for general information (a more detailed review can be found in [McNurlin 2001]).

IBM's Business Systems Planning (BSP) has been the most widely known and used information system planning methodology for many years. BSP was used by IBM internally and was introduced to customers in the mid 1970s. The main steps in BSP are as follows:

- Define the organization's business needs and processes.
- Identify the data classes and applications needed to support the business processes.
- Chart and analyze how the current applications can meet these needs.
- Identify and evaluate the new applications that need to be developed.

BSP involves a lengthy procedure in which data is tracked as it flows through various activities (e.g., order processing, inventory control, etc.). The output of one activity is treated as input to the next so that all data flow between all organizational units is studied. BSP generates a large amount of information which can be stored in databases. More information about BSP can be found in IBM manuals and other sources (see, for example, the Zachman web site www.zachman.com).

Critical Success Factors (CSF) was introduced by John Rockart at MIT [Rockart 1982]. CSF has been used by many consulting firms. The main steps of CSF are as follows:

- Identify the most critical ingredients of an enterprise which will make the enterprise successful.
- Define the application systems which will support the critical business functions.
- Analyze, evaluate and justify the proposed application systems.

The main difference between CSF and BSP is that CSF points the enterprise toward long-range critical factors without having to analyze all the data and processes.

The Nolan Stage Model was introduced by Richard Nolan in 1973 at Harvard and later expanded by the consulting firm of Nolan, Norton and Company [Nolan 1973]. This approach was initially developed to map the growth of the IS (information system) budget over time in relation to the services provided by the information systems. At present, the stage model analyzes the ways in which IS growth affects the information services. This approach compares the stage of each firm with the stages of growth in other similar companies.

The following steps generically represent the essence of the aforementioned planning methodologies:

- Understand the short range and long range critical business needs of the enterprise as stated in the information services strategy. Porter's Competitive Force Model, for example, can be used to see how the business strategy addresses the five competitive forces (threat of new entrants, bargaining powers of customers and buyers, etc.).
- Identify the applications needed to support the critical business needs. These applications can be analyzed, evaluated and justified by using, say, the Buisness Value Matrix approach.

- Categorize the needed applications in terms of integrations and links with other applications, organizational level to be used, volume and origin of work, security requirements, transaction processing, and realtime requirements.
- Evaluate current applications to determine how many new applications will need to be developed and how many existing applications will need to be re-engineered by using new technologies (i.e., provide wireless and multimedia interfaces to existing applications). It may be desirable to determine the applications that may need to be decentralized for better support. This may involve organization politics to assess the effort needed for application conversion ("downsizing").

1.2.6 IT Infrastructure Planning

IT infrastructure planning is concerned with determining the most appropriate computer and communication technologies needed to develop and deploy the applications identified in the IS planning. This step also translates the technology independent model developed previously into a technology specific model. IT infrastructure planning is a crucial activity because computers and communication systems are the basic delivery mechanisms for not only the application systems but also the manufacturing, healthcare, and financial services of digital corporations. Examples of the important IT infrastructure components are the Intranets which provide Web services in corporate private networks; web servers and proxies that reside in the middle tier; application servers to support sophisticated applications; factory networks which connect many manufacturing devices to cell and area controllers, and "Extranets" which connect many business (e.g., healthcare industry participants).

Specifically, the main infrastructure capabilities (middleware, network services, local computing services) needed to support applications must be carefully examined in the planning iteration. Figure 1-7 and Figure 1-8 show different views of an online purchasing system where a Web browser accesses a purchasing system that in turn accesses a catalog. The IT infrastructure becomes increasingly important as you iterate through the system life cycle (i.e., planning iteration only concentrates on high level issues that could be "show stoppers" while the first release must go through detailed considerations such as the exact version of middleware needed). The details depend on the type of applications being engineered/reengineered. For example, legacy data access requires a different type of infrastructure than a Web-based distributed object application.

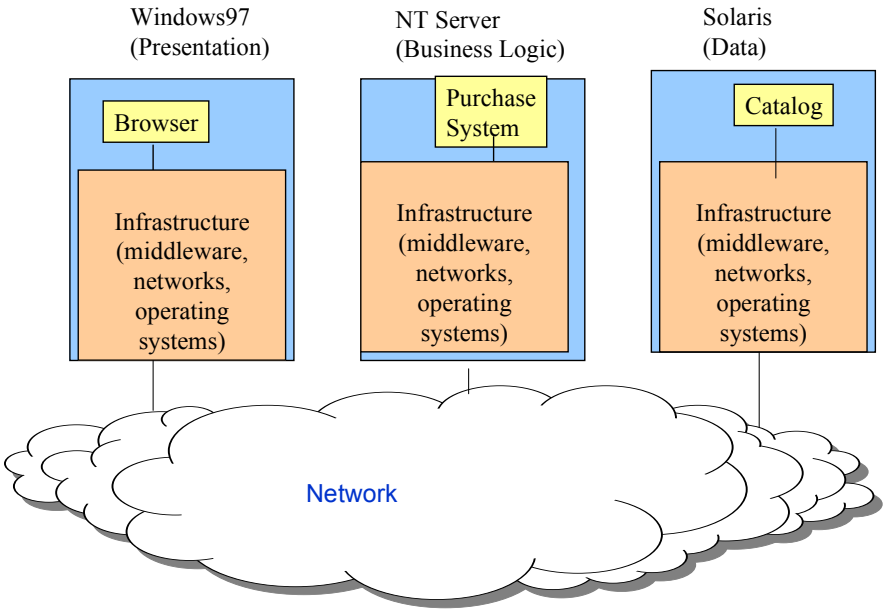

Figure 1-7: Simplified View of Infrastructure for an Online Purchasing System

The real IT infrastructure is a complex combination of middleware and network services that reside on different computers that are interconnected through a network. Figure 1-8 shows a more realistic view of an actual online purchasing system that is a refinement of the view presented in Figure 1-7. This view shows the actual infrastructure components that need to be planned and managed in a business environment.

- Middleware Planning. Basically, the middleware should make the entire IT infrastructure appear as a tightly integrated environment which provides a range of networking, database, transaction management, remote messaging, naming, directory, security, and other services needed by the applications. Some of these middleware services are being packaged into "Middleware Platforms" (also known as Application Servers). For example, IBM's WebSphere is such a platform. The key challenge is: how can we put all these pieces together into a functioning IT infrastructure that can support the variety of services and applications needed by the modern enterprises?
- Computing Platforms and Network Planning. The hardware devices (computers, terminals, I/O devices) and the system software (operating systems and database managers) are chosen and the network architectures for interconnecting various hardware and software components need to be selected. In addition, the subnets in the enterprise and the interconnections between the subnets are chosen to support the application interconnection determined in the IS architecture step. Network planning addresses the layers 1 to 4 issues of the OSI Model and is concerned with network interoperability throughout an enterprise. The prevailing network architectures use IP (Internet Protocol) to tie several physical network technologies such as fiber optic links, broadband networks and wireless networks.

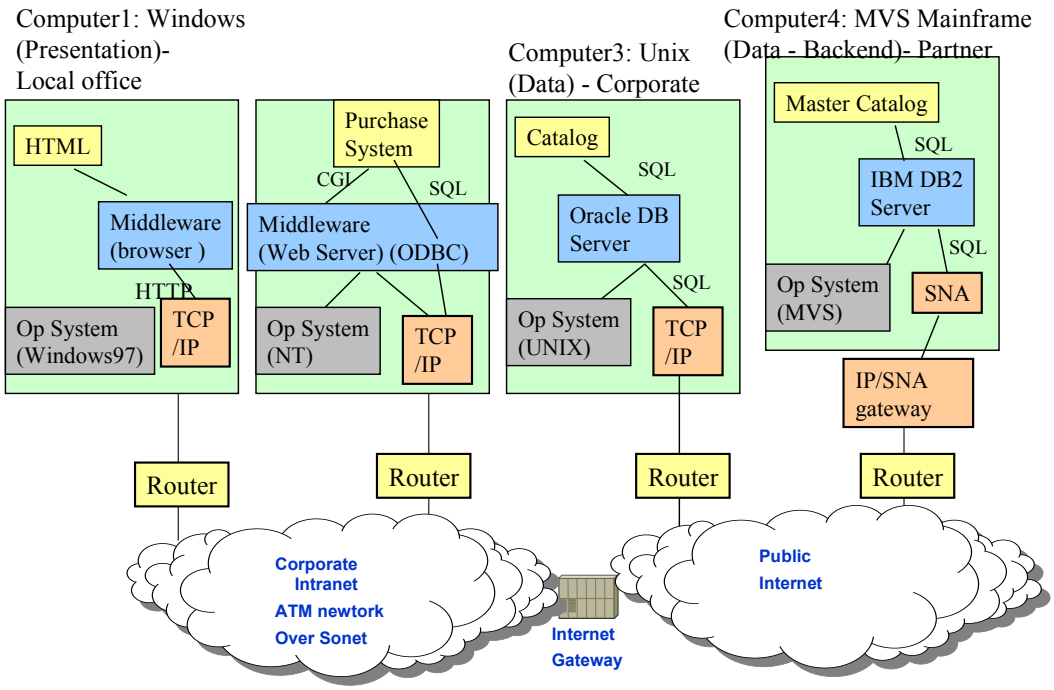

Figure 1-8: Example of IT Infrastructure

1.2.7 IS Architecture Planning

An IS architecture consists of the IS components (e.g., applications, databases, computers, networks), a specification of what they do and a configuration that shows how these components interface and interact with each other. IS architecture planning thus involves the following major decisions: 1) what are the needed IS components and what will they do, 2) interconnections and flows between the applications and databases, 3) allocation of applications to the sites of the enterprise, and 4) assignment of organizational responsibilities to oversee the actual implementation of application systems identified. The output produced by this stage shows the various organizational sites where the end users will submit requests, the sites where the programs and data will reside and how the information between the various sites will be exchanged. Approaches such as service oriented architectures (SOA) are being used at present to develop IS architectures (we will review SOA later). Independent of the approach, the following questions are good places to start in establishing an IS architecture:

- Outsource: Should I outsource part or all the applications I need?
- Buy: Should off-the-shelf packages be used to satisfy the requirements?
- Build: Should the needed applications be developed from scratch (i.e., new user interfaces, new application code, new databases)?
- Reuse: Should existing applications/databases be reused

After these decisions, what does an enterprise-wide IS architecture look like? Initial results could resemble the technology independent model shown in Figure 1-9. This model shows the key business applications (existing and the new) and how they interact with each other. In addition, odel, the ASPs have been identified. Additional information such as the applications that will be bought, developed and/or re-used can also be embedded in this diagram through color codes, etc.

Reengineering (i.e., redesign, migration, interfacing) of existing, in many cases legacy, applications is an important aspect of IS architectures at present. For example, it may be possible to satisfy the

business requirements by reengineering (i.e., interfacing and migrating) the existing databases. Access to enterprise data, especially legacy data, from a diverse array of tools and applications, residing on a variety of platforms and interconnected through different network technologies, is of key importance in most enterprises. In particular, many Web-based tools need to access enterprise data. In several cases, the requirements can only be satisfied by re-architecting and migrating the existing legacy applications that are old, unstructured, and monolithic. Choice of an appropriate approach depends on several factors such as business value of the legacy system and its technical value (see Figure 1-10).

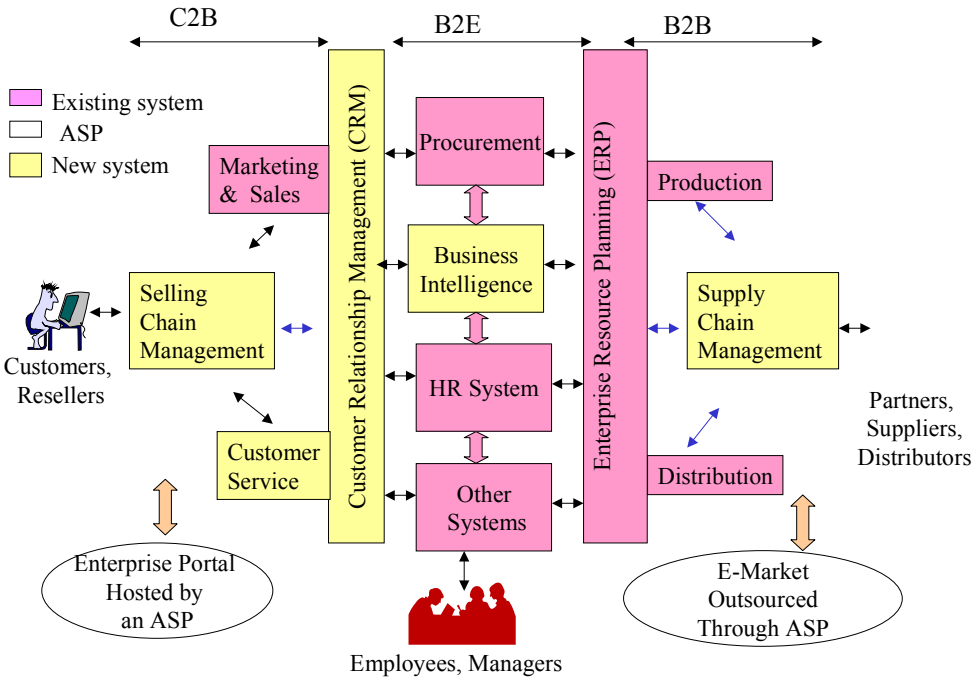

Figure 1-9: Technology Independent IS Architecture

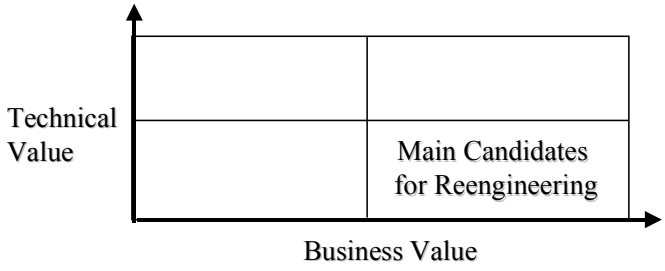

Figure 1-10: Legacy Application Analysis

The final IS architecture that combines applications (old plus new) and also includes a high level view of the enabling IT infrastructure may look something like a configuration shown in Figure 1-11. In this configuration, the new applications reside in the middle tier that is accessed directly from the users. The existing back-end and external applications are accessed through some type of back-end integrator, in effect an "enterprise service bus" (ESB). We will discuss this configuration later.

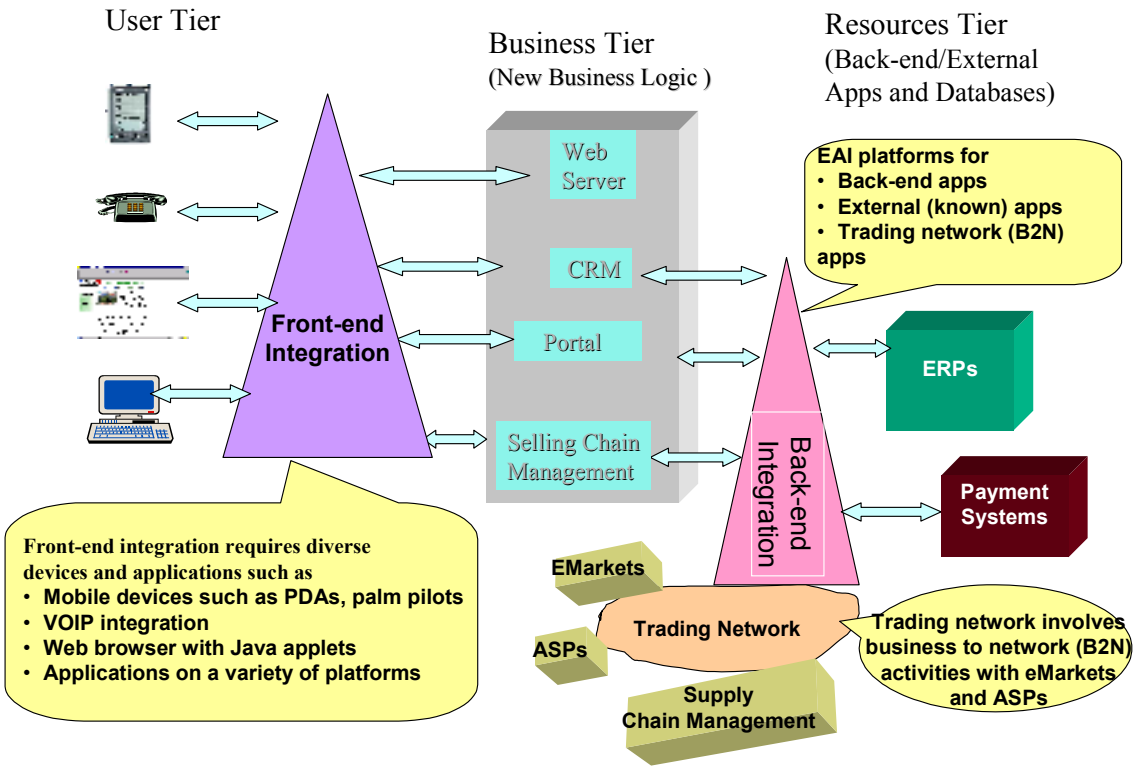

Figure 1-11: Solution Architecture that Combines New, Old, ASPs, etc.

1.2.8 Resource and Cost Estimation/Evaluation

The time, money, computing and human resources needed for conversion from the existing platforms to the future platforms are estimated and evaluated in this stage. The major activity is to decide if the transition between the existing IT infrastructure and the future infrastructure is cost beneficial. If it appears that the decisions made in the earlier stages are cost beneficial, then the plan is finalized; otherwise one or more of the planning stages are iterated until a satisfactory network configuration is finalized. In each iteration, the stages may be repeated with more details.

Better cost estimation is of key importance in this stage. Over the last 20 years, many cost estimation techniques for information systems have been suggested. More attention is being paid at present to component-based software cost estimation [Lim 2003]. Despite a great deal of work, most cost estimates in information systems are based on heuristics and guidelines. Here are some guidelines:

- Assign the initial estimating task to the final developers.
- Delay finalizing the initial estimate until the end of a thorough study.
- Anticipate and control user changes.
- Monitor the progress of the proposed project.
- Evaluate proposed project progress by using independent auditors.
- Use the estimate to evaluate project personnel.
- Computing management should carefully study and approve the cost estimate.
- Rely on documented facts, standards, and simple arithmetic formulas rather than guessing, intuition, personal memory, and complex formulas.
- Do not rely on cost estimating software for an accurate estimate.

A wide range of cost/benefit approaches have been proposed in the literature. Lets briefly review a well known cost/benefit model (known as the Mcfarland model) to quickly evaluate a particular strategy based on broad estimates. This model, shown in the following figure:

- Categorizes each service in terms of costs (low, high) and benefits (low, high)
- Focuses on low cost/high benefit first ("must do" region)
- Explores high cost, high benefits services ("investigate")
- Avoids high cost and low benefit services ("avoid)"

This simple model can be used to quickly analyze a large number of projects and identify the ones that need to be pursued and the ones that need to be avoided. For a project with high potential benefits but high cost, an attempt should be made to reduce the cost (say by outsourcing) to move it to the "must-do" zone. On the other hand, a project with low cost but low benefit should be examined for adding some benefits. In other words, important projects that fall in the "Don't Care" and "Investigate" zones should be further examined and studied to move them to the "Must Do" zone.

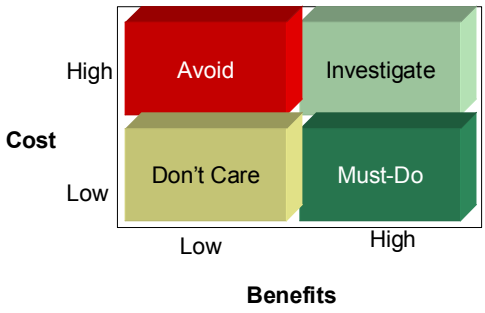

Figure 1-12: Simple Cost-Benefit Analysis Model

1.3 Enterprise Architectures and Integration Through SOA

Enterprise Architecture (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 1-13 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.

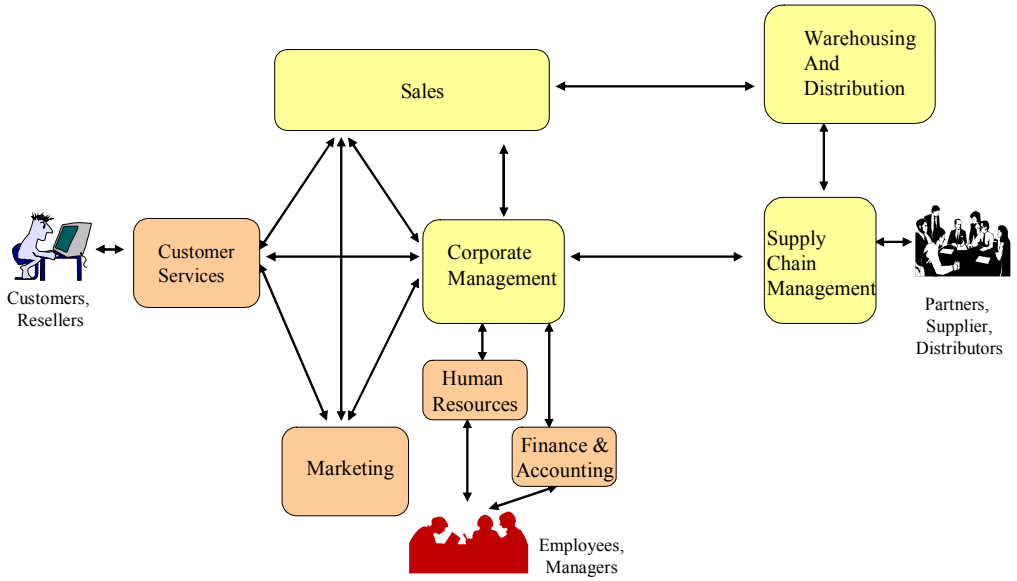

Figure 1-13: Service Oriented View of a Retail Store (Darker Blocks mean Outsourced/Rented Services)

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

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. 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.

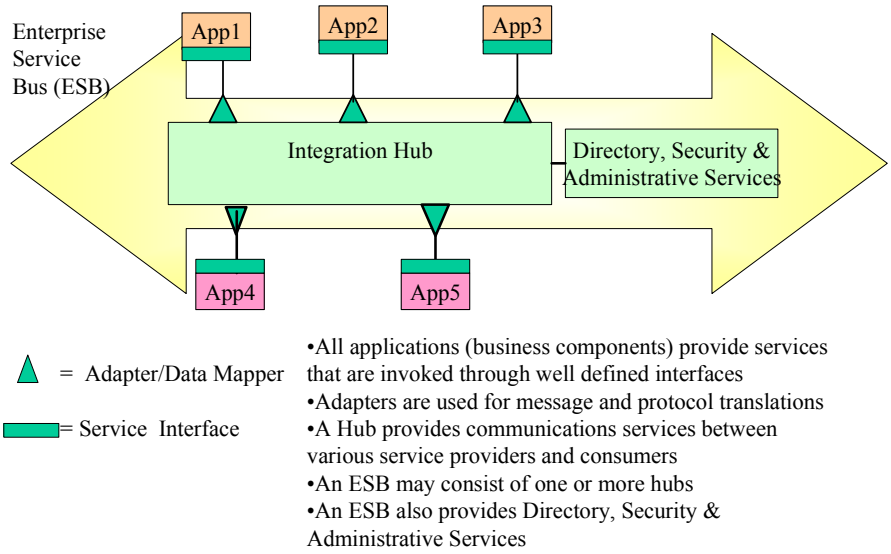

Figure 1-14: Conceptual View of SOA and an Enterprise Service Bus (ESB)

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 1-14 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 1-13
- 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 1-15 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.

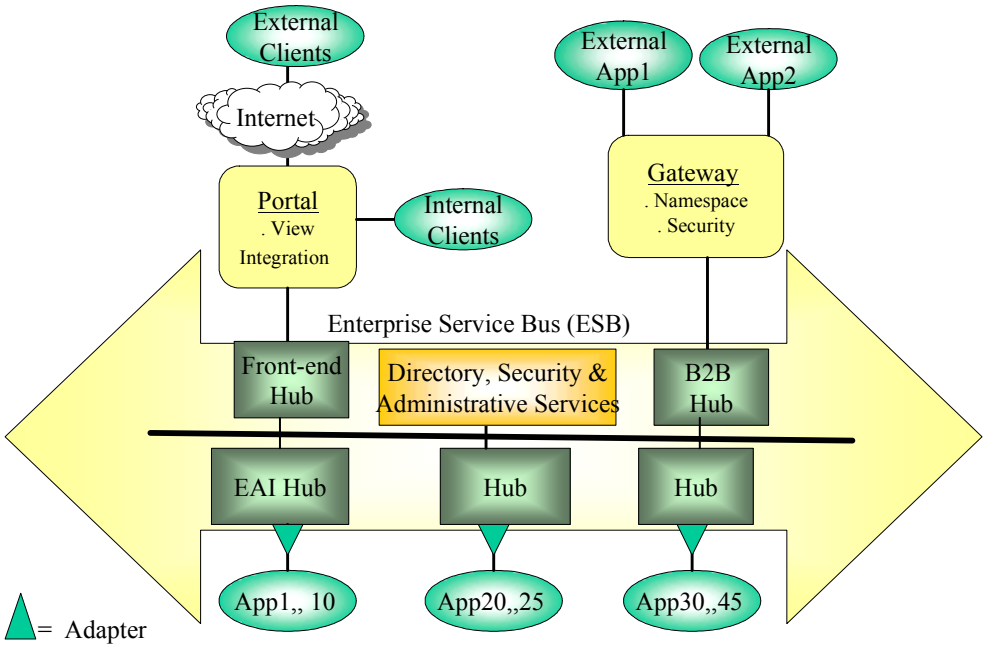

Figure 1-15: SOA Oriented View of EA

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 1-16 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.

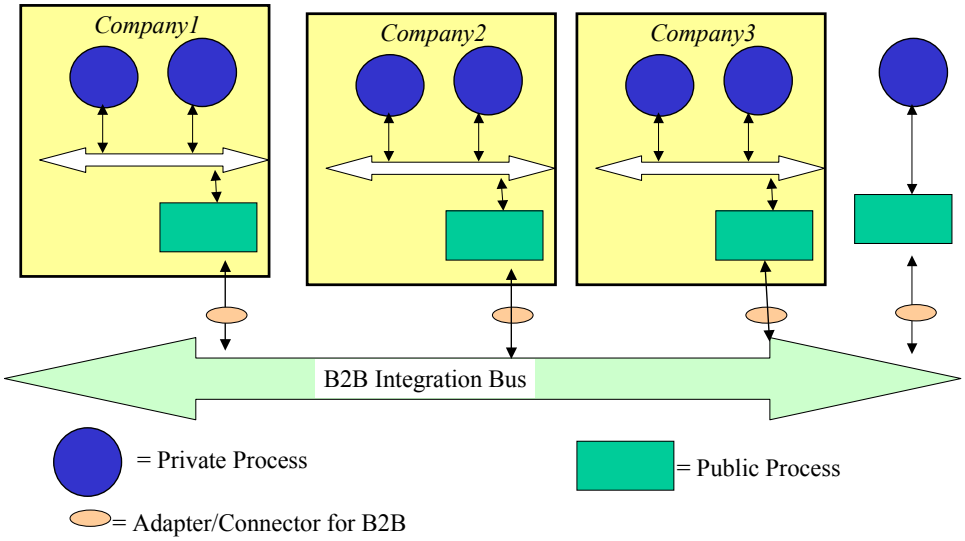

Figure 1-16: B2B Integration Architectures

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

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