

Creating an infrastructure for e-business: Computing in an e-business world

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Contents

- 3 *The evolution of e-business*
- 7 *The impact of e-business on today's IT environment*
- 9 *Design criteria for an e-business infrastructure*
- 14 *The blueprint for an e-business infrastructure*
- 19 *Pervasive computing*
- 22 *Investment considerations*
- 26 *Conclusion*

Introduction

“The infrastructure of e-business has become a mission-critical component of today’s global enterprise that can not be overlooked. Judging from the impact of recent outages in some of the industry’s leading e-business providers – and from the concerns expressed by leading CIOs and CTOs in e-business – the risk of infrastructure problems continues to grow.”¹

Few technologies have revolutionized business more than the advent of the Internet. Since the mid-nineties, companies all over the world have been quick to realize that the Internet’s true value is not in people’s ability to browse the Web or send e-mail, but rather, in the new opportunities it creates for enhancing business processes, reducing costs and increasing profits. However, e-business is not simply defined as e-commerce transactions; it is about using technology to redefine old business models in order to maximize customer value.

With the relentless evolution of e-business technology, non e-business models and organizational structures will be faced with increasing pressures. Competition will exploit Internet technology as much as possible. New competitors will emerge out of nowhere using new business models and an enhanced customer experience to take away market share and mind share. In order to compete – some might even say survive – in this new economic era, a company must be able to react quickly to challenges – constantly innovating their processes to stay in step with technology and ahead of competition.

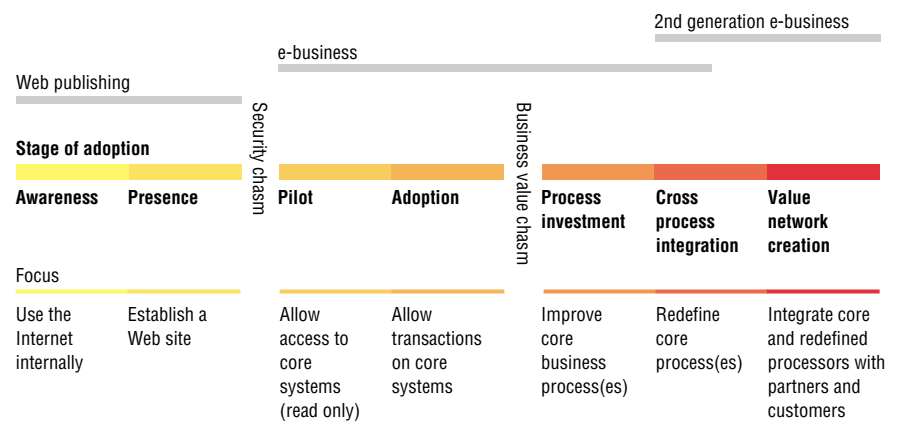
To accomplish this, it is mandatory for a company to build an information technology (IT) infrastructure flexible enough to absorb new technologies quickly and alter the scope and functionality of applications as needed, to support changes in the business model. This white paper will investigate the requirements e-business imposes on IT infrastructures, and provide guidelines for creating an infrastructure that offers the flexibility and reliability necessary to support the constant evolution of business processes in the e-business world.



The evolution of e-business

For most companies, becoming an e-business and making visible progress in the e-business space requires a great deal of planning, and often much trial and error. A research study by The McKenna Group (see Figure 1) shows 4 major phases companies go through as they become more involved with e-business:

Figure 1: e-business adoption process



Source: The McKenna Group Interviews and Analysis

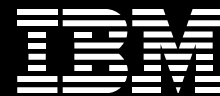
Most traditional companies will begin their transition towards e-business by publishing information about themselves or their products on the Web. They will use the Internet as simply another way of reaching customers with information. Quite often, companies will create a Web-based marketing campaign by utilizing print or broadcast media to drive customers to their Web sites. While it was originally thought that there was minimal risk involved in leveraging the Internet as a marketing channel, companies have begun to realize that their Web presence can have both a positive *and* a negative impact on their brand image. In two highly visible cases, Web sites were unable to handle the increased activity resulting from an expensive TV advertising campaign. This not only resulted in disappointed visitors but also in an onslaught of negative publicity.



Utilizing the Web for marketing purposes certainly has its benefits; however, they may not have a big effect on the company's bottom line. A more direct result in terms of increased revenue or reduced costs can be achieved by moving to the next phase of e-business: allowing customers to access a company's core IT systems to request information about their relationship to the company, i.e., inquiring about the status of a bank account, or actually performing transactions online such as making payments or buying merchandise through an e-commerce application. Since these transactions involve sensitive data such as bank accounts or credit cards, it becomes mandatory that companies build a secure environment in which to run their e-business applications.

In some industries, including the financial sector, providing customers with direct access to core IT systems has resulted in substantial savings. Quite often, portions of these savings have been passed on to the customer, which in turn has enticed more customers to use these services. In many cases, this has produced a very successful e-business initiative. However successful the initiatives are in this phase of e-business adoption, they are the result of taking existing business processes and reconfiguring them to an electronic format.

Some companies are taking e-business to the next level. Not only are they adjusting their business processes to align with new technologies; they are fundamentally changing the entire organization to be completely customer-service and customer-satisfaction focused. Customers can order products or services online, check availability of the products, and follow their orders through the entire production process. A good example is the tracking capabilities built into some major shipping companies' online services. Originally, these companies' Web sites were only able to verify receipt of a package. This has evolved into a complete shipment-tracking capability, which enables a customer to follow a shipment's entire journey and retrieve both the exact



time of delivery and the name of the person who signed for it. These types of e-business applications require more than a Web front-end to existing applications; they necessitate end-to-end integration and complete transparency of all the processes within the organization.

Providing end-to-end process integration is not easy. A major effort is required to develop an integrated back-end application set that allows processes to flow seamlessly. Most companies do not have such an environment. Until the advent of e-business, the resulting inefficiencies, inaccuracies and inflexibilities didn't matter; customers had few options and all competitors were on the same footing. Since customers now have more choices, they will be looking for the company with the most efficient – and integrated – service offering.

This drive for increased integration of services will only become stronger. Already companies are considering forming partnerships to provide a totally integrated experience for their customers. An example is an automotive dot-com enterprise that has created a partnership with multiple car dealers, car manufacturers and a major bank to provide its customers with a one-stop shopping experience. This experience includes online car research and selection, pricing of the selected vehicle, choosing the payment scheme and agreement on a delivery date. These types of partnerships allow companies to be aligned with customers' most important priorities: variety, quality, a competitive price and fast delivery.² Rarely can a single company provide all of these services; a network of companies together increase the value to the customer. Such business models will require a high degree of integration, with the flexibility to quickly enable new partnerships in an automated fashion.



For some companies, the e-business adoption process will move slowly. For others, such as dot coms, certain phases will be omitted, enabling them to go directly to market with new and innovative business models. Whether a company adopts e-business slowly or rapidly, there are three rules of thumb that will always apply:

- *Innovation is key to success in e-business.* Innovation stems from spotting a trend – new business models or new technology – before anybody else does, then implementing the necessary IT systems and applications to support that trend.
- *Integration increases customer value.* Successful e-businesses have the ability to improve the efficiency of business processes and enhance them with innovative business models or technologies.
- *Without a flexible, scalable, reliable and secure IT infrastructure, integration and continuous innovation are impossible to achieve.* Ultimately, success in e-business comes down to the quality of the e-business applications that enable all processes, and the reliability and adaptability of the IT environment that supports them.

The impact of e-business on today's IT environment

While maintaining the traditional role of increasing organizational efficiency and effectiveness, IT departments are often required to lead the business into new industry structures and markets. In fact, a recent study conducted by *The Economist Intelligence Unit* called "Assessing the strategic value of information technology: Planning perspectives for senior executives" (February, 1999) indicates that an increasing number of business executives plan to leverage their IT investments and balance their IT goals toward technology investments aimed at reaching new markets or changing industry and market practices. Because IT systems are an integral part of e-business, the design and construction of a reliable e-business infrastructure is considered no longer solely an IT issue – it is a vital business management issue that is generating a great deal of interest from CEOs and CIOs alike.

The performance – in every sense of the word – of the IT infrastructure has unprecedented visibility and impact on the success of a company's e-business initiatives. If IT fails, the e-business fails, as represented by the following list of IT failure-related consequences:³

- *Poor return on investment: The IT infrastructure fails to meet the business objectives*
- *Forfeited revenue: Customers can't find products*
- *Lost customers: Up to 40 percent of customers don't return after encountering incomplete content or poor service*
- *Eroded brand image: Visitors share poor experiences, which the media exploits.*



To be successful in e-business, companies need to create an IT infrastructure that is optimized to support its e-business requirements; in other words an *e-business infrastructure*. An e-business infrastructure is the set of tools that enable e-business. While the tools required to support a business process can vary from company to company, an e-business infrastructure is generally consistent, and comprises the following components:

- *Network infrastructure*
- *Security infrastructure*
- *Application server environment*
- *Data and content management tools*
- *Application development tools*
- *Hardware and operating systems*
- *Systems management platform*

It is important to note that these components must be complemented by operational procedures and people who install, launch, operate and maintain them in order to help ensure the service levels required to operate a successful e-business.

The following section will describe the key design considerations for an e-business infrastructure, providing a blueprint for companies to help ensure their e-business infrastructure meets the demands of e-business.

Design criteria for an e-business infrastructure

“Companies planning to deploy Internet-based e-business and e-commerce applications face the enormous task of redesigning and integrating their server, network and application infrastructures to support on-demand networked functionality—and most organizations lack the internal expertise to do so.”⁴

Successful e-businesses rely on an e-business infrastructure that meets the following three criteria:

- *Flexibility*—for rapidly evolving e-business models through the addition of new application functionality and the integration of systems and applications with customers, business partners and suppliers.
- *Scalability*—for accommodating unpredictable fluctuations in customer demand and user workload.
- *Reliability*—to help ensure secure, continuous operation and availability of the e-business applications to end-users.

Flexibility

e-business adoption is an evolving process. (Refer to figure 1 – McKenna Group study). Companies typically start with simpler implementations, growing more complex as the business model becomes more integrated with the Internet. To remain successful in this business model evolution, it is mandatory for a company to create a flexible e-business infrastructure. To start, the following list of e-business infrastructure characteristics might be included:

Universal connectivity through the use of open standards. In an e-business environment, companies must allow customers, business partners, suppliers, and influencers to have access to systems and applications with a variety of access devices available. It is key that a company utilize an open standards approach using Internet Standards such as Transmission Control Protocol/Internet Protocol (TCP/IP) and Secure Socket Layers (SSL) for communications and HTML/Java™-enabled thin clients.



A component-based approach to application development. Rapid application development and the ability to reuse parts of existing applications will greatly accelerate the time it takes a company to create new e-business applications with the required functionality. Whether building or buying applications, companies should investigate application development tools that allow applications to be created from smaller building blocks (commonly referred to as “application components”), or at least tailored to the individual requirements of the company’s e-business model.

A component based approach to infrastructure design. The e-business infrastructure may need to evolve with the business model. By adhering to open standards in the selection of infrastructure elements, the elements can be treated as individual components, without jeopardizing interoperability. This approach allows companies to evolve their e-business infrastructure gradually – adding hardware or software components, upgrading existing servers or removing elements of the infrastructure as needed.

Integration with internal and external services. Interoperability – sharing or communicating with mixed technologies across and beyond the enterprise – is an important success factor in e-business. By integrating business applications and data among customers, suppliers, partners and employees, companies can achieve a more effective and efficient e-business model. Enabling integration is accomplished by using open standards-based infrastructure elements in conjunction with an integration, which allows existing application functionality to be integrated with the new application logic.

By following a component-based approach to application development and infrastructure design, providing integration between various systems and applications, and enabling universal access to applications (with open standards as the catalyst to make it all work together) companies can create a flexible e-business infrastructure that can evolve in support of their business requirements.



Scalability

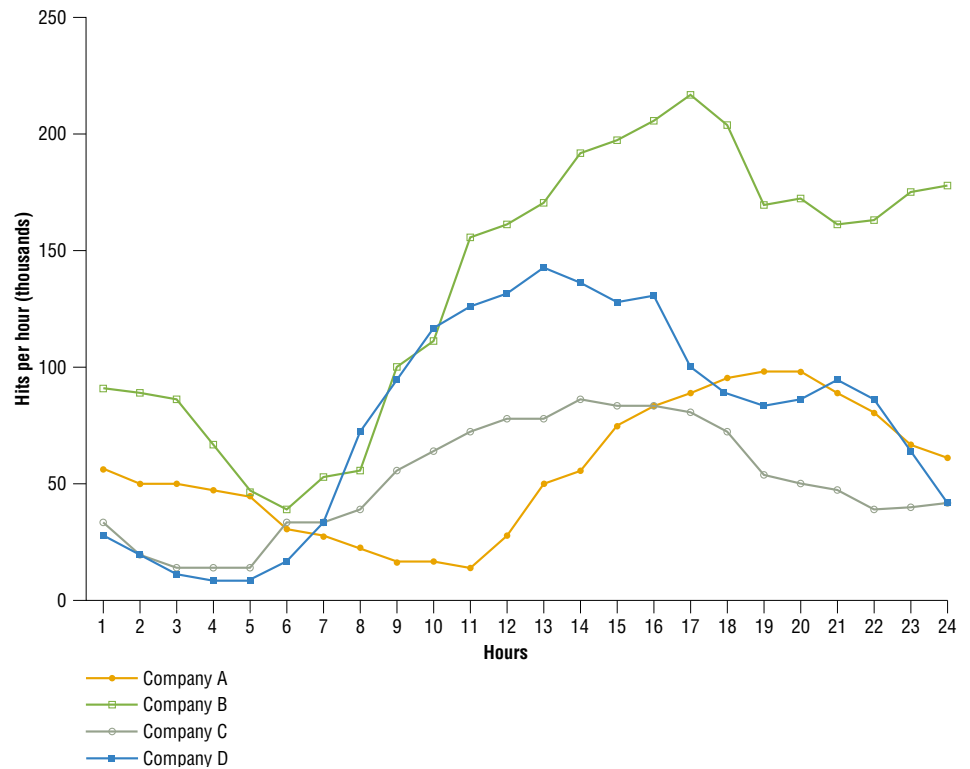
One of the biggest challenges in building a reliable e-business infrastructure is predicting the customer demand that it will need to support. This is especially true for companies that interface directly with the end customer, the number of users that simultaneously access systems, plus the workload they will create can be very hard to predict. If an e-business initiative is successful, the customer base can grow rapidly into hundreds of thousands of users in a relatively short timeframe. Even with a static customer base, and depending on when customers can access the Web applications, demand can fluctuate tremendously during a week – or even a single day – as illustrated by Figure 2.

A scalable e-business infrastructure should be capable of handling increasing workloads while maintaining high availability and good response times – *without* adding significant complexity or corresponding headcount. Scalability is important, because it helps create growth of the IT capability in proportion to business growth, without long periods of excess capacity.

An effective, scalable e-business infrastructure should have easily configurable components and management characteristics that remain true as the infrastructure expands. Some claim their systems are scalable, but all too often they require the other attendant processes and people to grow at the same rate as the technical components – which can be a costly proposition. For example, a common technical approach to increase server capacity is to run multiple Web servers in parallel. While this may be a sound initial approach to meet increased scalability requirements, it may not be as effective in handling very large increases in workload or more complex application types. With this approach, as the need for server processing power continues to grow, companies could be forced to continue adding servers. This can add significant time and expense to maintain the servers and to make all applications consistent across these machines.



Figure 2: Some typical Web site loads over a 24-hour period⁵



Alternative approaches that can enhance scalability are:

- *Developing applications on non-proprietary systems to accommodate added server capacity without dramatically increasing the number of servers and corresponding IT staff. Applications built around a non-proprietary architecture can be moved from one server platform to a more powerful and scalable one without the need to rewrite the applications.*
- *Built in load balancing, which allows companies to treat multiple servers as a single logical system, where the failure, removal or addition of a single machine does not require changes to the existing environment.*

These options, when considered proactively, can help avoid the need to replace components or change processes with each new business advance or requirement.



Reliability

When combined, flexibility and scalability contribute to the third e-business success criteria, reliability/availability. Reliability is the outward-facing feature of e-business – the part that customers see, expect and depend upon. When e-business infrastructures become hindered – unreliable and unavailable due to slowdowns or security breaches – the business case is threatened. It is only through adequate flexibility and scalability planning that reliability and availability can be created.

The blueprint for an e-business infrastructure

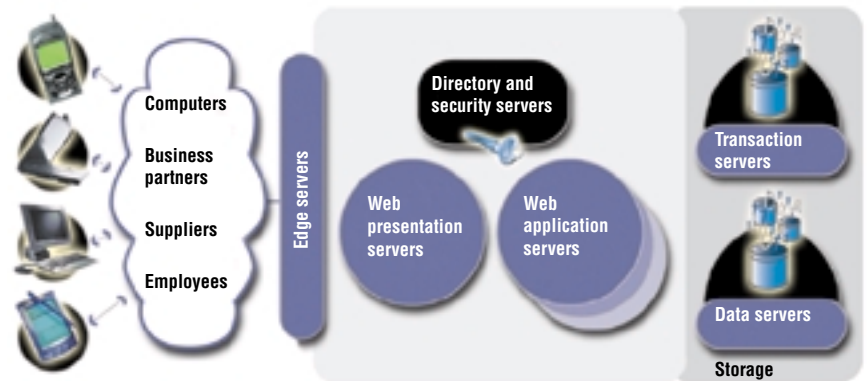
In order for an IT environment to provide the flexibility, scalability and reliability required of e-business, companies need to develop a new kind of IT infrastructure. This infrastructure should consist of open interfaces that allow new applications and services to easily connect. It can also allow individual treatment and management of the elements within the infrastructure, including management of the overall environment. A blueprint of successful e-business infrastructures is shown in Figure 3.

The blueprint consists of five logical functions:

- *Web Application Servers*
- *Directory and Security Services*
- *Edge Servers*
- *Data & Transaction Servers*
- *Storage Management*

Although these five functions could be implemented on either a single server or on multiple servers, separating the functions can present a company to implement infrastructure changes more rapidly – enhancing a single function without losing the interoperability of the other pieces within the e-business infrastructure.

Figure 3: The blueprint for an e-business infrastructure



Web Application Servers

At the heart of e-business infrastructures are the Web application servers. Consisting of server hardware, a server operating system and application server software, the Web application servers “run” a company’s e-business application logic and manage the user interactions. While a single Web application server may be sufficient for most companies, others may choose to implement multiple servers – either optimized for a specific function or to provide for redundancy and scalability.

Increasingly, companies are separating the presentation logic from the application logic on these servers. The server infrastructure can therefore do the processing work in several stages, allowing for the service of static information, or very simple transactions with lightweight dynamic data at the front end. This way, companies don’t have to place load on the more complex applications that run at the back end of the system. In order to enable new e-business processes, the Web application servers should also provide comprehensive integration capability with other systems, connecting with each other and the back-end legacy systems.



Edge servers

Edge-of-the-network servers (edge servers) have emerged as a single-function, cost-effective platform. They perform many of the computing functions that reside between a company's internal e-business infrastructure and the external Internet – router management, basic authentication, firewall protection, and transcoding – with the ability to support new device types and to render outbound data for the Internet in the format of the device itself. Edge servers also improve performance in the areas of caching, load balancing and secured communications. This is important, in that transactions currently handled on a private network are moving to virtual private networking over public lines.

Traditionally, technology has resided primarily on a company's premises. The current trend is to migrate some of the functions to the network itself. Functions such as data security are likely to remain on the enterprise side of the firewall; more transient services, such as caching, are likely candidates for migration. For example, telecom operators and Internet service providers are starting to offer information caching and other services on their infrastructures, while some of the key network infrastructure providers are beginning to build this functionality into the switches that go into the network.

Security

Security requirements are also changing. Although many companies have implemented basic password authorization, complex e-business systems require a more sophisticated environment behind the firewall – beyond basic authorization. This is causing security functions to move from simple passwords to digital security certificates, which not only provide individual user validation but also furnish different levels of validation, depending on the application or data being accessed.



The next step in security is to provide policy-based security management. A policy management server provides single and global sign-on for multiple systems, which can eliminate the need for multiple passwords. It also can manage security independently from each of the individual applications, with authorization administered and managed at a single location. Through the use of a policy-based security system, companies can create a layered approach to security, offering higher degrees of protection against unauthorized access without the system becoming an unnecessary burden on authorized users.

Data and transaction servers

Building a flexible and reliable e-business infrastructure requires seamless integration between the Web application servers and the back-end data and transaction servers. These servers handle processing-intensive and mission-critical workloads. They offer high degrees of security and application integrity, and have the ability to perform complex transactions against large data sets. Scalability on these servers is not achieved by adding additional server hardware; rather, by increasing the capacity of the existing system.

Storage management

All of the four functions described above can be deployed on a single server system. However, the need for scalability will quite often drive a company to implement an e-business infrastructure that relies on multiple systems – and possibly multiple server hardware types – to run the e-business application workload. While such an implementation can increase the scalability and reliability of the overall infrastructure, it also poses a challenge of data currency – making sure that all applications have access to the same set of data.



To meet this challenge, a company can implement a storage management solution. Storage management enables every application within the enterprise to access relevant information – independent of the type of storage the information resides on. Relevant storage mechanisms in an e-business infrastructure include:

- *Direct attached storage – hard disks directly connected to a server system*
- *Network Attached Storage (NAS) – hard disks grouped in a specialized storage server which is attached to the network*
- *Storage Area Network (SAN) – storage capacity residing in a special storage network where administrative tasks – such as backup – are separated from the production environment. In addition to addressing this issue of data currency, Storage Area Networks also improve the performance and administration of the overall storage environment.*



Pervasive computing

Until recently, PCs were the Internet access device of choice. However, preferred substitutes, such as cellular phones and personal digital assistants (PDAs) are currently outselling PCs three to one. By 2003, the number of cellular phones around the world is expected to exceed 1 billion, with about 80 percent of them with some form of access to the Internet. This rapid proliferation of new network access devices is referred to as pervasive computing – migration of the Web beyond PCs to a new generation of devices that can access any service utilizing both wireless and wired connections. The advantages of pervasive devices can generally be grouped in two areas: increased productivity and increased reach.

Pervasive devices with specialized, easy-to-use functions will greatly increase knowledge worker productivity, according to some estimates by a factor of five. Even traditional desktops and notebooks will be used in ways that raise business issues such as manageability, security and mobility. Although the use of multiple devices per user will increase support costs – by a factor of three according to the same estimates – it should be an attractive return on investment by any measurement.

The key to improving user productivity is making computing simple for users by removing more complex workload away from the pervasive device and handling it on a server platform. This in turn will put more stress on the e-business infrastructure – raising questions such as the number of devices it can support, selection of appropriate tools for particular applications and security and continuity among a variety of purpose-optimized devices.



To increase simplicity, devices will be designed for a specific use, each possessing the following four key attributes:

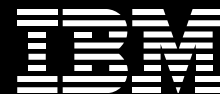
- *End-use optimized*: Devices should deliver pertinent information quickly to the user in the absence of the skill requirements and extraneous functionality required in today's computing.
- *e-business ready*: Devices should help users connect simply and directly to the desired e-business sites. Features such as push-button readiness, content and transaction security and standards-based systems management should be standard.
- *Effortless use*: Devices should offer instant-on and designated path connectivity, intuitive interface and function, self-actuating e-support and services, all within a non-intrusive hardware package.
- *e-lifestyle coordinated*: Devices should work within a personal network, coordinating and integrating the user's work and personal life within a networked world.

In addition to increased productivity, pervasive devices facilitate mobility – allowing users to access applications and data from virtually any location. Mobile phones and wireless Personal Digital Assistants (PDAs) can already access services such as Internet access, consumer and investment banking services, and online information such as entertainment offerings. For a company, this offers a totally new way to reach customers. By adding a wireless channel to existing applications, or building new applications that specifically exploit the capabilities of mobile devices, a company can achieve a significant increase in customer loyalty and competitive advantage.



The improved functionality of pervasive devices will put new demands on infrastructures. Additional services necessary to fully exploit the capabilities of these devices include:

- *Support for subscription services – allows users to “subscribe” to various capabilities available through “services bundles”, which can be automatically downloaded and enabled on the device*
- *Support for location-based services – application and device functionality varies with the location of its user*
- *Dynamically updated functionality – without user intervention, keeps software and functionality current through a transparent contact between devices and the network*
- *Network and device management – manages delivery of content and services to non-PC devices – cellular phones, PDAs, Internet appliances and new technology*

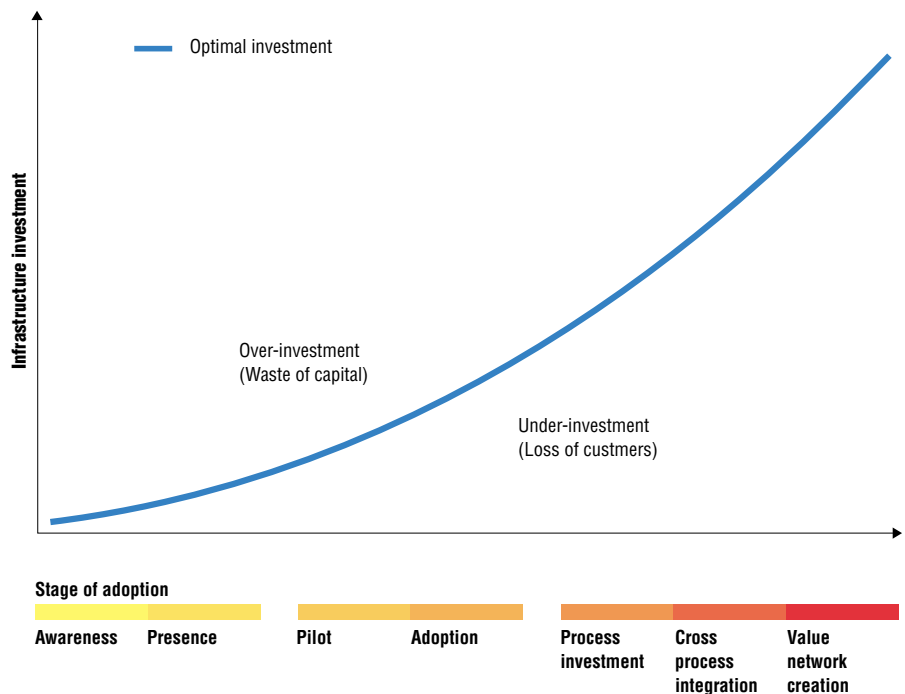


Investment considerations

As companies continue to advance in e-business, they will likely need to continue to invest in their e-business infrastructure. More complicated business models and e-business applications may put higher demands on the infrastructure, resulting in additional costs for network and server hardware, software, people and infrastructure processes. With a successful e-business implementation, these costs should be offset by the growth in revenue generated from the e-business initiative and/or by savings attained in other parts of the business. The objective for many companies in this situation is to find the “optimal investment curve” (see figure 4), which balances infrastructure investments with the evolution of the business model (refer to Figure 1).

Companies that have not found the right balance between investments in e-business infrastructure and the requirements of the e-business implementation are either over-investing and therefore wasting capital, or under-investing and running the risk of an infrastructure unable to keep up with e-business demands – which could result in poor service and potential loss of customers.

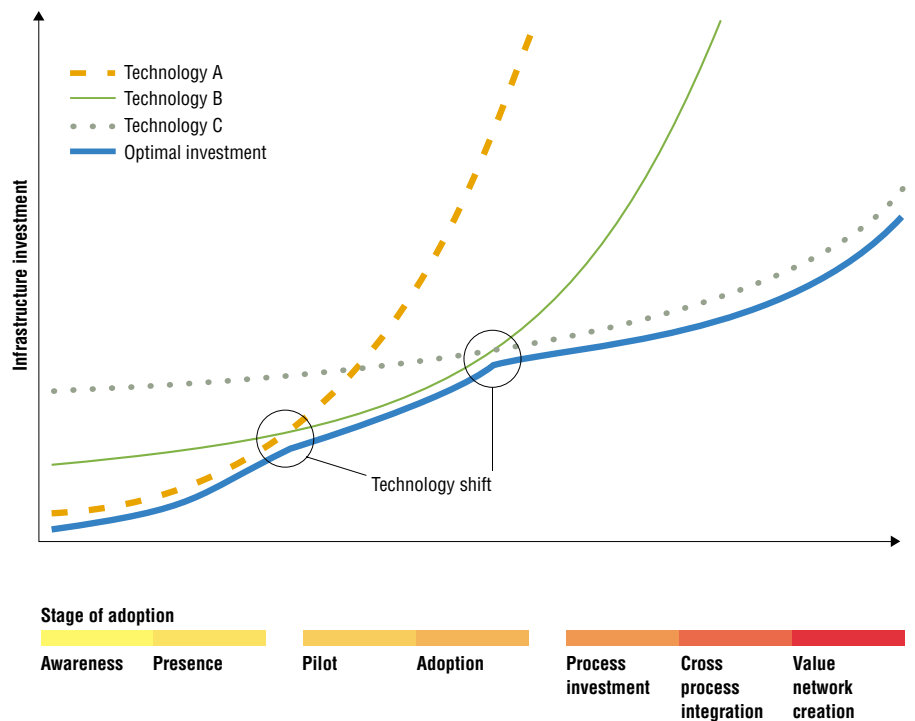
Figure 4: Optimal infrastructure investment



Another view of e-business infrastructure investing is seen in figure 5 – the impact of technology choices. When a company is in the early phases of e-business adoption, it is logical that it would base its e-business infrastructure on the most cost-effective technology base (“Technology A”) for their business model. However, as the business model becomes more complex, the company may need to make substantial investments in their e-business infrastructure to provide the required level of customer service. At a certain point, the chosen technology may be stretched beyond its design point, resulting in either a significant increase in IT costs, or more commonly, degradation of service

levels. Had the company opted for “Technology B” in the early phases of its e-business adoption – even though it was more expensive to use at that point – it might have been able to sustain the evolution of its e-business model much further without facing a rapid increase in infrastructure cost. As new technologies evolve and business models change, companies may be forced to switch from one technology base to another. In fact, this process may repeat itself multiple times. The optimal investment curve in this scenario will link the lowest points of each technology shown.

Figure 5: Impact of technology on the optimal infrastructure investment

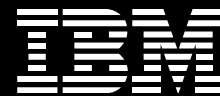




What companies should be looking for is the ability to ride these technology curves and to manage the inflection points in technology. If this is done successfully, organizations can support their business model through the optimal technology and change technologies when it becomes economically justified. This can be accomplished through the following three elements:

- *The use of open standards such as HTML and XML, and multiplatform technologies such as Java™ in application development*
- *The selection of infrastructure components – especially server software – that can run on multiple technology bases*
- *The use of an e-business infrastructure blueprint (as described in this paper) that accounts for additional components, offers new functionality, or increases the scalability and reliability of individual components.*

Companies should look at providers of e-business infrastructure components that meet all of these criteria.

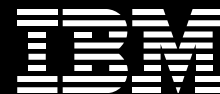


Conclusion

“The future belongs to Web-architected applications that have best-of-breed functionality and access and aggregate resources both inside and outside the corporate firewall. Aberdeen uses the term ‘Internet application architecture’ to describe the framework for these next-generation solutions.”⁶

Managing information technology is a challenge under any circumstances. Creating and managing a successful e-business infrastructure requires careful foresight, adequate time and financial commitments, and qualified resources. Although these requirements may seem difficult to satisfy, contradicting the fast paced, business imperatives of today, the value of a well planned, flexible and reliable e-business infrastructure is paramount, as demonstrated by the many well-publicized disasters in “e-space.” Performance degradation, security exposures and system failures are common and cut right into the unforgiving bottom line of e-business. Less obvious, but equally damaging to an e-business’ revenue stream and a company’s long term survival are the applications and IT infrastructures with insufficient flexibility to keep up with the continuous pace of business innovation required in today’s marketplace. Inadequate e-business infrastructures can cause devastating impacts to businesses.

For this reason, executive decision makers across industries are increasingly prioritizing infrastructure planning and spending in order to fully realize the success of e-business. They understand more and more that the value of an e-business infrastructure is simply the value of the e-business initiative.



However, with the many components involved in today's large e-business systems, companies are having a difficult time identifying which vendor's products best fit their business requirements, and how compatible the products are with each other. With today's time-to-market constraints, companies simply cannot afford to worry about integrating new technologies from multiple vendors. Obviously business executives are not interested in becoming technology experts – they want to focus on sustaining and growing their business.

Taking all of these factors into consideration, along with the growing complexities of e-business systems, makes it advantageous for companies to have a strategic relationship with a vendor that provides a complete e-business infrastructure offering, from development through deployment.² The vendor of choice should be able to build an e-business infrastructure that meets the scalability and flexibility requirements of their customers, without locking them down on a technology base that limits the incorporation of future, more cost effective technologies.



Footnotes

¹Aberdeen Group, October 1999.

²Ravi Kalakota and Marcia Robinson, "e-business: Roadmap for Success," Addison Wesley, 1999.

³Forrester Research, Inc. "Why Web Sites Fail," September 1998.

⁴The Yankee Group, October 1999.

⁵Source: "IBM Analysis of 4 e-business Websites."

⁶Aberdeen Group, October 1999.

⁷The Yankee Group, "Internet Computing Strategies: Creating the one-stop shop for e-business infrastructure," July 1999.

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