Achieving Service-Oriented Architecture

Applying an Enterprise Architecture Approach

Rick Sweeney
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RICK SWEENEY
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Acknowledgments

I would like to thank Shelley Therrien for grammatically reviewing this book and helping me put it together. I would also like to thank my wife, Linda, for putting up with me for months while I focused on writing.
Introduction

This book is not about the technical capabilities and technologies required to build a service-oriented architecture (SOA) application. There have been many books written on this subject. Some are very good. I highly recommend Michael Rosen, Boris Lublinsky, Kevin T. Smith, and Marc J. Balcer’s *Applied SOA: Service Oriented Architecture and Design Strategies* (Hoboken, NJ: John Wiley & Sons, 2008) for anyone wanting to build technically sound and highly flexible SOA applications.

This book is about an architectural approach to the *cultural, organizational,* and *operational* changes that must be made across the corporate landscape to successfully achieve SOA. Thus this is an enterprise architecture business organization and management practice book. Both the technical knowledge provided in books like *Applied SOA* and the business organization and management practices defined in this book are critical to realizing the full value of SOA. Adopting one without the other will limit your SOA success.

I wrote this book because SOA has changed the entire landscape for planning, designing, implementing, and supporting business “applications.” The success of SOA requires a major paradigm shift in the fundamental core of how information technology (IT) organizations and the business in general operate. Adopting SOA as an architectural strategy will force you to challenge every aspect of your corporate culture and current practices, which will effect a transformation that impacts every aspect of your company.

This book will show you how to set up your IT and business organizations and practices to successfully implement and run your SOA “application” development life cycle under an architecturally driven SOA paradigm. Its content is based on years of experience of promoting architecture under a “service-based” philosophy well before the concept of SOA became popular. SOA has simply validated this philosophy and brought focus to its virtues to the entire audience of vendors, consultants, IT departments, and business in general.

I hope that you will find value in the contents of this book. At a minimum, it will provoke many discussions that will challenge the traditional approaches that many of you have been using. For those of you who agree with all or most of what is stated in this book, it will be a useful tool for you to accelerate SOA’s adoption in your company. The more people within your IT organization, business units, and vendors/partners who read the book, the more consistent and accelerated that adoption will be.
Introduction

Who Should Read This Book?

Clearly this book targets the chief information officers, chief technology officers, and chief architects of corporations. These individuals and the positions they hold have the best possibility of effecting a transformation and paradigm shift in their company. Rarely does a corporate transformation occur without a top-down commitment of the executive leadership.

This book also targets the architecture practice within IT. The architects will have to invest the biggest commitment and do most of the work to implement what is presented in this book.

Everyone else in IT should read this book as well. They need to understand how this paradigm shift will affect them and their departments and be committed to the transformation as well. Having everyone in IT on the same page will certainly accelerate SOA’s adoption.

This does not mean that business leaders should not read it as well. The business leaders from the executive level down may not understand (or care to understand) some of the technical examples described in this book. Nevertheless, the multitude of value propositions presented will certainly ring true and be readily recognized by these leaders.

There is also value to guiding business leaders to specific sections of the book. For those businesspeople participating in governance activities, the governance chapter (Chapter 8) presents an excellent tool for teaching and educating them as to the critical role they must play and the new responsibilities they must embrace. For those involved in specifying or documenting business requirements for IT projects, Chapter 9, “SOA System Development Life Cycle,” and Chapter 11, “People Involved in the SOA Process,” are critical. There is value in this book for every leader in the company. The more these leaders read and understand, the higher the probability of their acceptance and support.

Finally, any IT partners and vendors you have (such as outsource developers) or business partners with which your IT people interact (such as an outsource call center partner that integrates or uses your systems to service your customers) should read the book as well. An effective and comprehensive internal SOA practice has tremendous value. Having a synergistic extension of that practice embedded in your external partner and vendor environments provides even more value.

SOA Adoption Has Been Slow

The concept of SOA has been around for several years now. Technologies that provide SOA capabilities are also maturing. Yet SOA has not reached the level of penetration that was expected. The reason its adoption has been slow is not because of technology restrictions but because of architectural restrictions. These architectural restrictions in the context of people, policies, and practices have not adapted and transformed to support the SOA architectural paradigm.

Achieving a successful SOA vision will depend more on how effective you are with people skills and at establishing these new SOA policies and practices than on the successful implementation of the technologies themselves. The establishment of these new SOA policies and procedures will, in effect, create a major paradigm shift in the culture of the corporation. Don’t get me wrong: A strong technical architecture...
is key to successfully realizing the value of SOA, but attempting to do so solely from a technical perspective, without focusing on the policies, procedures, and practices, will almost certainly fail to achieve all that SOA has to offer.

The absence of this transformation of the practices used in the corporation is why SOA’s adoption has been slow. It is because successfully implementing SOA is not simply the implementation of a vendor product or technology. Nor is it the use of Web services. Successful implementation requires a major paradigm shift in how the company thinks about, manages, and uses its IT assets.

This adoption failure has been further exasperated by the relatively short-term focus of corporations. The mentality of corporate culture has evolved to such a point that anything that cannot be completed, or at least have a major milestone, within six months is almost impossible to even start. All SOA vendors will “sell” you on one relatively simple short-term project to begin your SOA process. They sell this approach not because they necessarily believe it is the best way to be successful at SOA but because it is the best way to sell their product.

Perhaps a more accurate description of what is described in this book is service-oriented enterprise architecture. This book applies enterprise architecture practices and principles to SOA. The goal of enterprise architecture is to maximize utilization and efficiency of the IT assets and to identify synergistic opportunities and values for the business. Interestingly, the goal of SOA is to maximize utilization and efficiency of IT investments through services and to create synergistic opportunities and values for the business using those services.

The barriers to maximizing the goals of enterprise architecture have traditionally been the size and age of the legacy application portfolio and the lack of a more effective model to architect and build business applications. The barriers to maximizing SOA’s goals have been the lack of people, processes, and practices defined from an enterprise architecture perspective to support the SOA model. This book brings enterprise architecture practices and principles to the SOA model. It defines all the things architects usually define (governance, system development life cycle [SDLC], frameworks, models, etc.) but defines them to specifically support and maximize SOA.

Throughout my years of developing and evolving a service-based architecture approach to business systems, I had to rely on a lot of experience-based intuition and trial and error to set up the practice. There was nothing out there that documented how to do it. Even today there is still very little, which is why I wrote this book. I am providing you with my insight and knowledge as it relates to over 25 years of IT leadership experience and over 15 years of driving a service-based philosophy for business application design. This book was written to help others learn from my experience and avoid having to figure it out on their own. Even if you do not embrace the contents of this book 100 percent, I am confident that you will get significant value out of the experiences and examples I provide.

The Business Is Already Involved in Architecture; It Just Does Not Know It

The two largest reasons for adopting and “institutionalizing” an architecture practice are the rapid expansions of technologies in terms of viable technical alternatives
Introduction

and the business’s perceived rights for involvement in technical decisions. These are realities that the architects must manage and control. New technologies and capabilities will continue to be introduced, and nontechnical businesspeople will continue to be exposed to them through avenues like the Web and vendor contacts. This presentation will be heavily weighted toward the positive, or “sizzle,” business values of the technology and very little toward the support, integration, and architectural synergy with the rest of the enterprise.

All these events have contributed to create a world where architecture can no longer be perceived as an IT function. Architecture needs to be perceived as a business function at the tactical and strategic levels. This requires that the business take ownership of the architecture. There is a difference between selling the value of an architecture practice to the business and having that business drive the architectural value through co-ownership.

To this end, the architecture practice must facilitate this transformation from IT ownership to business ownership. Doing so will require an entirely new perspective of the IT process throughout the organization, a major paradigm shift in corporate culture, processes, and accountabilities. It also requires a whole new set of policies, procedures, and standards within the architecture practice arsenal to help the organization achieve this paradigm shift.

The architecture practice must learn to proactively live and exist in this new world to be successful. The architects must spend a significant amount of their effort on communicating and educating both the business community and the business application vendors that reach out to that business community. The old days of waiting for the business to bring a project to IT before assessing the architecture implications are long gone. Recognizing that the business will become aware of technical solutions to meet some of its business needs and institutionalizing a process and culture where the business understands enough about the value and need of the architecture practice to involve it up front will help tremendously in achieving a long-term SOA vision.

Pragmatism Is Also Important

Architects must be pragmatic. New technologies and business application solutions are hitting the market and businesses are being exposed to them at light speed. Any bureaucratic process that slows or derails this process in the eyes of the business will fail. In this new world, the architects are incapable of stopping purchased business applications and often the noncompliant technologies and platforms they use from being introduced into the environment. By getting up front in the acquisition process (especially before a purchase commitment has been made to the vendor), the architects have the opportunity to influence these decisions and to minimize the impact by proactively establishing vendor compliance commitments in future releases. If the business is prepositioned to view and validate these solutions in the context of an architecture that it has taken ownership of, the probability of a more positive (architecture-compliant) outcome rises significantly.

Since more and more companies buy business applications rather than build them or alternatively partner with someone else to use or “lease” their business applications (e.g., application service providers), the traditional architectural approach
around development does not apply. The advent of vendors providing software as a service (SaaS) further extends this model. The new approach cannot just focus on data and integration concerns but must also focus on maximizing the architectural compliance and SOA interoperability of these purchased or leased solutions. Conducting architectural discussions with these vendors and reaching an architectural vision and compliance agreement with them prior to signing a contract to purchase their business applications helps to move all business applications used by the company toward the SOA vision, not just the ones custom built in-house.

**SOA Is the Way**

No other architectural approach to business applications provides the capability to achieve the maximization of efficiency and flexibility that SOA can offer. If you think of SOA as a way to transform all the physical aspects of business applications into standardized, logical, and consumable “views” of the underlying application code, you have taken the first step down the right path. If you now understand that these logical views or services can be structured to support their delivery to a consumer over any number of delivery channels without replicating their underlying functionality, you have taken the next step in the right direction. Finally, if you recognize that an architecture practice is required to ensure that the business applications delivered are designed to provide the flexibility, adaptability, and reusability promised, you have taken the final step toward a belief in and commitment to SOA. If you can get vendors who promote business solutions to your business to understand these beliefs as well, and get them to agree to support the architecture in future releases of their products, you will remove a large barrier in your quest to achieve the end state SOA vision.

**Not an Introduction to Enterprise Architecture or Service-Oriented Architecture**

This book is not an introduction to enterprise architecture or SOA. It assumes anyone implementing the model and the practices it defines has a strong base of experience and knowledge in architecture principles, processes, and practices. Its intent is to show how to transform your enterprise architecture practice so that SOA is the predominant strategic approach for applications utilized in the company and how the enterprise architecture organization can facilitate this rise of SOA to prominence.

**SOA Is Here to Stay**

SOA is here to stay. Its prominence will become more and more evident to more people as time goes on. I think back to when relational database technology came to the market. The biggest knock was that it was too inefficient to support transaction processing. Most of its early adopters used it to replicate data for reporting purposes. Advances in database efficiencies coupled with increased computing power and disk input/output performance have led us to today where very few online transaction
processing (OLTP) systems applications do not have a relational database engine. It can be argued that some technical people saw the virtue of relational databases for OLTP and together with the hardware and software vendors evolved multiple technologies (CPU, memory, storage, database performance tools, etc.) to make the technology not only pragmatic but also desirable. It took many instances of proven adaptations of the relational database technology and the publication of these successes as repeatable processes before the tipping point for relational databases was reached.

The (relatively) slow adoption of SOA has been the result of similar factors. Proven, repeatable experiences with SOA that can be readily understood and adopted by others are lacking. They are lacking because the repeatable experiences that are out there are technical implementation experiences, not architectural experiences. This has hindered the ability of architects to show and promote SOA’s value as a core, prominent strategy for the company to adopt. What is lacking is a repeatable SOA SDLC, a repeatable SOA governance process, and a repeatable SOA enterprise architecture framework.

This is what this book hopes to provide. It lets the reader “see” the entire architectural approach to SOA and how all the pieces of the approach fit together and complement each other. It provides all the definitions and documentation needed to implement the approach. It provides comprehensive, repeatable architectural processes that can be adopted and implemented in your company.

The enterprise SOA architects still need to investigate and learn more about your environment and transform your company to the SOA model defined in this book based on your unique corporation. The final chapter in this book (Chapter 14) shows you how to do this.

Architects Need to Be Proactive

It is important that architects recognize that they need to be proactive, not reactive. If architecture waits for a new technology or a new approach like SOA to be introduced at a project level, it is already too late to architect the solution from an enterprise perspective. It becomes a tactical implementation exercise, not a strategic one. The architects need to be proactively ahead of the business from a technology perspective in addition to the practice perspective. What role will business process management systems play? Wireless access protocol? Security assertion markup language (SAML)? Web Services 2.0? Describing their role in the context of the as-is and to-be architecture instead of as a single business application project has a profound impact on many decisions that will be made, not the least of which is vendor contracting, pricing, and infrastructure capacity.

What You Will Learn in This Book

Reading this book will provide you with a complete and comprehensive methodology and framework for adopting and managing an SOA environment including:

- Direct linkage and management of all SOA activities to the corporate strategy and business plans.
Introduction

Direct mapping of the business (conceptual) view of the SOA assets to the design (logical) view of those SOA assets and their implemented (physical) representations.

The book also shows you how to set up and run your SOA enterprise architecture practice using this methodology and framework and how to leverage existing architecture artifacts into this new framework. An overview of the methodology is presented in Exhibit I.1.

This SOA Enterprise Architecture Framework (SOA∼EAF™) Methodology diagram and the associated architecture framework that supports it are defined in detail in Chapter 5.

This book provides everything you need to set up and manage the methodology and framework. It will show you how to set up and run the SOA SDLC to develop architecture-driven SOA applications. It will define the governance processes to effectively and efficiently manage this SOA SDLC. The book also defines all the resources needed to implement all the processes in terms of their roles, responsibilities, and capabilities. It tells you how to leverage the SOA model to evolve and migrate your legacy application environment to modernize and maximize these investments going forward. It shows you how to address different business and IT organization models and how to deal with them. Finally, the book shows you how to assess your current business and IT SOA enterprise architecture maturity. You will be able to identify gaps between your current people, processes, platforms, and practice capabilities and the ones defined in this book. You will be able to build your own SOA business strategy and roadmap for bridging this gap.

How This Book Is Organized

This book is organized into four parts.

**Part I** discusses the value of SOA and architecture in general. It discusses how a new architectural approach is required to achieve all the value that SOA has to offer.
Part II defines the SOA-EAF and the methodology that uses this framework. This part also discusses how to integrate and leverage your existing enterprise architecture assets into this new framework.

Part III defines the SOA processes and practices within the methodology that need to be implemented to effect the paradigm shift throughout the corporation and realize SOA’s advantages. It defines the different types of resources and skills needed within the company to transform the organization and effectively manage the transformation. It also redefines the roles and responsibilities of the business participants in the SOA application development process.

Part IV provides information on how to assess your company’s SOA maturity and how to use that assessment to develop your SOA business strategy and roadmap to implement the SOA model and practice defined in this book.

Three appendixes are provided as references. Appendix A contains templates of documents and forms described in the book that you can modify and use in your own practice. Appendix B defines the different types of SOA services discussed throughout the book and describes their applicability. Appendix C provides an example of the architectural principles and considerations that must be addressed when defining an enterprise architecture approach for SOA. It uses the enterprise SOA security development framework as an example. These appendices are provided so they can be pulled out and referenced by business architects, solution architects, and project architects. In addition, there is a glossary of acronyms used in this book.

Closing Remarks

This book provides a repeatable process and shows a pragmatic way to achieve all that SOA has to offer. It also provides insight into how an architecture practice can play an even larger strategic role within the organization. Throughout this book I have provided many examples based on my experiences. While the exact situations you encounter may be different, the architectural process and management techniques I used to resolve them are the points I want to make with those examples. I hope they will help you when you encounter similar processes and management issues in your unique environment.

I am interested in your feedback and comments. You can leave them on my blog, www.soaistheway.wordpress.com. I will gladly respond and use your input to improve the next edition of this book.

Good luck, and let the journey begin!
About the Web Site

My blog (www.soaintheway.wordpress.com) is dedicated to the promotion and advancement of the service-oriented architecture approach to business systems design. The purpose of the site is to provide a forum where people like myself, who believe that SOA is the next baseline of the business application evolution, can share and express ideas and help advance the institutionalization of SOA throughout the business domain. You will also find electronic versions of the template documents and forms provided in Appendix A to help facilitate their use and adaptation. Feel free to use them within your company as is or modify them to suit your own business needs. If you are using the templates or variations of the templates for commercial reasons or include them in documents distributed to entities outside your company, I ask that you honor the copyright laws and include the following copyright disclosure at the bottom of each template page:

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Achieving Service-Oriented Architecture
PART I

Value of Enterprise Architecture and SOA
CHAPTER 1

What Is an Architecture Practice, and Why Do You Need One?

I have been studying and practicing architecture from an information technology and business strategy perspective for more than 20 years. While the concept of architecture was not well defined, well understood, or well communicated in those early years, the advancements in computing technologies were forcing the concept to the surface due to unmanaged complexities in information technology (IT) that were impacting efficiencies and costs. IT organizations were being further impacted by a rapidly accelerating trend of computer literacy by the nontechnical business community. Systems were no longer being perceived as magical “black boxes,” and the business involvement was not limited to business requirements. In some cases today the business jumps right over the pragmatic assessment of requirements into the selection of a prebuilt vendor solution for IT to “install.”

Since the beginning of multiplatform computing, much has been written about the value of an enterprise architecture practice. Most revolves around the “selling” of architecture to the business leaders. This material is essential for obtaining buy-in and commitment. As architects, however, we recognize there is a more fundamental underlying reason why architecture is important. That reason is simply that computing technology and systems have become increasingly more complex. The number of technologies, the ways those technologies are being adapted and utilized, and the multitude of alternatives available as solutions to any given business need seem to grow exponentially each year. The result is that there are literally thousands of ways that technology can solve any one business need. While this is good in terms of competitiveness and pricing, it is bad in terms of complexity and overhead. In other words, the good news is we have many alternatives and options for solving a problem technically. The bad news is we have many alternatives and options for solving a problem technically, and without an architecture you end up implementing many different ways to solve different instances of the same problem.

Business Organizations and Departments Do Not Operate as Isolated Islands

The obstacles begin to emerge when it is realized that individual business needs are not self-contained or isolated islands. All or a portion of any one business's
Value of Enterprise Architecture and SOA

needs may, and often do, have value to other business units and other business processes. While the ability to enter and validate an order from a customer was originally perceived as an internally bounded business activity, today many customers are provided the capability to directly enter the order through the Web or through a partner web site supporting your business. These add-on systems are directly influenced and impacted by the way the order system works. Adding the capability to identify high-value customers for premier services or to cross-sell customers through any of these add-on mechanisms will depend largely on how the underlying application operates and how the add-on solutions are implemented.

The point is, adapting to any of these evolutionary changes without consideration of an architecture has a high probability of incurring excessive costs for duplicity and support and may not even be attainable for technical or financial reasons.

Thus, in addition to providing guidance and traceable links to the business strategy and business unit plans, an architecture provides fundamental, basic analytical, and management capabilities to ensure that everything aligns properly and works efficiently.

If you think about building a home, the architect shows you, the customer, floor plans and layouts, even perhaps a scale model. He may even show the plans or model in the context of a high-level architecture (i.e., where it sits on the lot or how far it is set back from the street). What he does not show you is how all the plumbing and wiring is laid into the building and interconnected or where the heat ducts are. He may not show where the utilities are brought in from the street. Rest assured, however, that all of these specifications are documented and will be part of the delivery. They are specified not only based on your input in terms of the size of the building and its layout, but also on the zoning and building codes of the community. There is an expectation that the customer does not have to worry about these code and zoning requirements. The architect takes care of them. Do you as the customer take the blame and responsibility if the building inspector finds a violation?

Now let us think back to when the Pilgrims first settled in America. Certainly they applied basic building principles, but there were no building or zoning rules. As our country grew and became more crowded and complex, the need for these regulations became more apparent. Similarly, as the size and complexity of our technology infrastructure grew, we recognized the need for these basic standards and principles as well.

An enterprise architecture practice is an organization within the company that manages the complexities of the IT environment and applies principles and techniques to reduce the complexities, improve efficiencies, and reduce capital and operational expenditures. This alone should be enough to justify an architecture practice. Architecture, however, can provide an even more critical service. Architecture can help the business take advantage of the IT infrastructure to gain competitive advantages over the competition. An architecture-compliant environment and strategic architecture principles can provide opportunities and advantages not possible without these capabilities.

As a way to illustrate how technology complexity has evolved, I would like to present a brief history of computing. I will focus on some key technological milestones that have played a major role in this evolution. Understanding the past helps us deal with the future. We need to use what history has taught us to help us
What Is an Architecture Practice, and Why Do You Need One?

avoid similar mistakes in the future. We also need to realize that taking advantage of new technologies and approaches can be accelerated if we understand how the adoption of previous technologies evolved.

Looking at the Past to Understand the Future

Technology advancements are for the most part an evolution. Each new technology concept is based on improving what already exists. Companies that can recognize these improvements early on and adopt them are usually the ones that gain the greatest competitive advantage from them. Understanding how computing has evolved historically and the roles that technologies played in that evolution can help us assess where technologies of today might lead us in the future.

In the beginning, business use of computers was simple and straightforward (although it may not have seemed so to those adopting it). It consisted of punch cards in, green bar printouts, and assembler language in the middle. There were not many options involved for how to do things.

Three key technology advancements resulted in the next major leap in business computing. First was the development of a new program language called common business-oriented language (COBOL) designed for writing business applications. The second advancement was the introduction of magnetic disks allowing data and programs to be readily accessible in real time. The third advancement was the introduction of the real-time terminal device based on the customer information control system (CICS) from IBM. These technologies brought us out of the world of batch processing into real-time processing, at least at a rudimentary level. As a result of these advancements, the type and volume of business applications exploded. In addition to performing traditional financial batch processes, such as general ledger and payroll, computers were now being used to price and process orders, generate invoices, and manage inventories and purchases.

The next major milestone was the introduction of the mini- and superminicomputers that exploded the competitiveness of the computer hardware market and started the continuous advancements in the price performance of computer hardware that continues to this day. People walk around today with devices in their pocket that have more processing power and storage capacity than a computer with a footprint the size of a football field in the 1960s!

There was, however, a downside to this era of the computer evolution. The downside was the proliferation of redundant data and duplicity of business logic through the explosion of silo business applications.

Businesses began extracting data from the mainframe to their minis, tweaking duplicated business logic to support a slightly different set of processes, and providing a custom user interface to support them. And thus the era of multiple “stovepipe” applications with significant redundancy of data and logic began.

The next two technology advances did not create a new era of computing, they simply extended the boundaries of the existing proliferation era and slapped a new label on it. These two advances were:

1. Significant advancements in networking and network interoperability
2. The introduction of the macrocomputer known as the personal computer (PC)
For the first time there was availability of computing power at the desktop and connectivity to tap into it. The new label attached to applications developed in this phase was client-server. Now business data (especially reference and edit/validation supporting data) and business logic were not being duplicated on a few minicomputer platforms. They were being proliferated to hundreds, if not thousands, of desktop PCs throughout the company.

At this point most businesses had reached the epitome of what I call the resource-consumption model. Every new application:

- Was more costly and time consuming to develop and deploy.
- Added to the total year-over-year fixed cost expenses of operations.

More important, but seldom recognized, this proliferation did not improve, but instead eroded, the flexibility and adaptability to business changes.

In fact, many companies were backed into a corner where their only option was to build or buy another silo stovepipe solution even though they recognized the long-term impact of these decisions. Some companies were lucky enough to recognize the value of middleware and adopted an enterprise application integration (EAI) framework. This helped to minimize the number of point-to-point connections among the systems and reduced the need for some redundant business data and logic. Those that did adopt a middleware EAI strategy were better positioned to move to the next layer of sophistication.

The next major technology advancements were unique in that they came from an entirely different direction. They were not focused on helping businesses improve their internal systems, but they ended up revolutionizing the way we conduct business. I am talking, of course, about the Web browser and World Wide Web technologies.

While many companies were successfully extending their systems externally to their customers and suppliers, they did so without the availability of a globally accepted ubiquitous channel to do so. Customer and vendor penetration was limited in that it often required that they also make a significant investment to participate in this electronic relationship. (Bulletin Boards were the exception.)

The World Wide Web changed all this. What started out as a mechanism to help find information more easily on the Internet and more intuitively through a graphical user interface ended up providing a globally accessible ubiquitous user interface for processing business transactions. Business transactions were now capable of traversing multiple companies and multiple industries through partnerships that heretofore were unheard of. We only have to look at the online travel web sites like Orbitz® or Priceline® to see the synergistic market value of partnerships across multiple industries with a common goal (selling travel services).

The World Wide Web explosion was fueled by the introduction of another technology: fiber optic networks. Fiber optics not only geometrically expanded the bandwidth globally, but its proliferation did to the cost of wide area networks what chip advancements did to the cost of computers. Not only was bandwidth cheap and plentiful, but a standard ubiquitous interface called the Web browser was made available to take advantage of it! Wireless technologies are now taking away the physical restrictions of this new world. It truly is now anytime, anyplace.