Preface

Forrester recently introduced the term "business technology" pointing out that this represents one of the major shifts in the way people think about computers in IT history. Forrester's business technology is based on two key ideas: IT risks are business risks, and IT opportunities are now business opportunities.

Modern business owes a lot to information technology (IT). IT helps businesses in achieving business goals and, in general, in becoming more efficient, effective and competitive on a highly competitive market. On the other hand, however, the implementation of information technologies may bring some business risks as well. It is well known that some businesses had experienced "IT-based horror stories" due to wrong implementations of enterprise information systems or because of some sort of data loss and/or disruption. As contemporary business is becoming more and more bound to IT, this dependence may become critical for business itself in case of data lost, data unavailability, wrong IT-implementation, and so on.

Information technologies, particularly during the last decade, after introducing Internet and Web, have opened new opportunities for businesses in their efforts to cope with increasing competititon, reduce the costs of doing business, increase the profits, improve the quality of products and services, improve relations with customers, and ease data access. In general, information technologies are used to enhance both efficiency and effectivenness of a business. IT plays crucial role in both "Doing the Things Right" and "Doing the Right Things" as Peter Drucker defined the terms of "efficiency" and "effectiveness.

However, at the same time, organizations may face several situations in which their business may suffer due to some IT-related problems, such as: unavailable

data, lost data, data exposed to competition and unauthorized usage, stolen or lost computers, stolen backup tapes, hardware error on any computer component that causes system downtime, broken LAN/WAN connection, destroyed computers or computer center due to any type of disaster, hackers' activities over Internet, and so forth. Organizational management can not be effective if it does not integrate organization-wide information management as well. This is in particular important for contemporary businesses which require continuous computing platform as a main prerequisite for business continuance. Therefore, modern business needs an efficient integration of business continuity management into organizational management, the process which is done by integrating the continuous computing technologies into enterprise information system.

In today's information age, information management comprises numerous activities with data processing/data management being the core component. In addition to core data management implemented in one or more databases, information management includes the following components as well: system management, network management, security management, and so forth. Recently, with advances in Internet technologies and e-business, the need for achieving "a near 100%" level of business computing availability was brought up yet again. Consequently, the term of "business continuity management" was coined up and became a significant part of organizational information management. Business continuity management (BCM) has become an integral part of organizational management. It involves several measures (activities) that have to be implemented in order to achieve higher levels of the system/application availability ratios.

Business continuity has been treated as both IT and managerial issue during the last ten years particularly after the e-business boom and the "9/11" event. In that sense, an enterprise information system should be managed from business continuity perspective in a way that this process includes managerial and system administration activities related to managing the integration of business continuity drivers.

The main objective of this book is to assist managers and IT managers in becoming aware and more knowledgable on the economics of downtime and continuous computing technologies that help in achieving business continuity and managing efficiently information resources.

The book has three main goals. The first and foremost goal is to provide clear and precise understanding of several information technologies that can be used in order to enhance business continuity. The second goal is to help managers and IT managers in understanding how important are information technologies in modern business. The third goal is to explore in more details the role of enterprise servers, server operating systems and serverware solutions within the form of integrated server operating environment in improving availability ratios, continuous computing dimensions and business continuity in general. Other continuous computing

technologies are explained as well, however, an emphasis was given on server operating platforms and this is the main distinctive point of this book.

This manuscript is intended to provide the reader with a foundation of concepts relevant to using and managing information technologies in order to enhance the availability ratios of business computing platforms. However, it is not intended to provide a comprehensive description of all aspects of numerous continuous computing technologies that are listed in the book. This is because of the fact that each continuous computing technology described in the book is itself a topic for one or many books. That is the reason why the book is not intended to provide the reader with enough specific and detailed technological knowledge on each continuous computing technology to make them continuous computing and business continuity experts on that particular technology.

What makes this book different when compared to other books is in the following aspects: a) systemic approach that considers a set of continuous computing technologies for enhancing business continuity and b) in exploring the role of enterprise servers, server operating systems and serverware solutions for enhancing business continuity. The methodological approach used in the book is also distinctive. It is based on one of the main system's definitions provided by C.W. Churchman, one of the founders of the systems approach, operations research and systems science. His five-dimensions systemic view has been used as a framework for identifying the role of today's enterprise information systems and business computing in general in modern business.

The book consists of three parts and includes fourteen chapters. Each chapter includes a list of discusssion questions, and one or more case studies related to that chapter.

The first part of the book (Chapters I–IV) builds a foundation for understanding modern business, business computing, economics of downtime and business continuity. The second part (subsequent eight chapters, V–XII) describe the major continuous computing technologies that can be implemented for enhancing business continuity. The third part of the book contains two chapters: one dealing with business continuity management (Chapter XIII), and Chapter XIV that provides some relations between business continuity and business agility.

Chapter I introduces the main framework of business computing in Internet era. It has been evident that businesses today, more than ever, are faced with tremendous competition in a rapidly changing environment. Companies are operating on highly competitive markets that have become global, more dynamic and customer-oriented. Customers are more powerful and ask for customized products and services, while governments issue more and more compliance regulations. In today's e-business and e-economy world, in many cases the whole business is IT-dependent and data-driven. Therefore, such businesses need to be able to continuously run their mission criti-

cal applications. This implies that data operations activities and operations such as backup, update, upgrade, and hardware maintenance have be done without bringing the system down. Businesses employ information technologies in order to provide responses to business pressures and business risks, by enhancing productivity levels, reducing costs and improving the quality of products and services. In this chapter, the following concepts are introduced: business pressures and IT-based responses, business technology, business risks.

Chapter II introduces the terms "downtime" and "uptime" and their importance in modern business. The concept of the "economics of downtime" is explained as well, having in mind the fact that in modern business, even a few minutes of system downtime may cause thousands or even millions in lost revenues. In addition, such situations may result in bad decisions, unsatisfied customers, broken image of the company. Simply put, when mission-critical applications are considered, system downtime (both planned and unplanned) should be avoided or minimized. This fact emphasizes the need for system's reliability, availability and scalability.

The implications of downtime can be expressed in financial terms and easily bound to a company's economic results. Therefore, the terms such as "economics of availability," "economics of uptime/downtime" have become topics of interests in the field of the economics of enterprise information systems. Different types of businesses, different business functions and accompanying applications, require different levels of availability. Today, it is possible to measure or estimate losses in financial terms of each hour, even minute of downtime. These losses vary depending on the type of business (e.g., online banking systems, call centers, airline reservation systems, point-of-sale systems, dispatching systems, online shops, e-mail servers, etc.).

Chapter III defines the main framework for the book. The systems approach defined by C. W. Churchman (1968), one of the founders of operations research and systems approach, is used as a main methodological framework. Several dimensions of business continuity, continuous computing are defined by using Churchman's systemic model that contains five dimensions: objectives, environment, resources, components, and management. An attempt was made to apply Churchman's concept of systems approach to developing a framework for implementation of continuous computing technologies for enhancing business continuity.

By following Churchman's systemic model, the objective of a continuous computing platform in an organization are identified as achieving the business continuity or business resilience. In other words, this means the following: continuous data processing, continuous data access and delivery, multi-platform data access, on-time IT-services and better decisions through better data access. The system's measures of performances are defined in the form of several continuous computing attributes such as scalability, reliability, availability, fault-tolerance, disaster tolerance, auto-

matic failover. The model is re-shaped into "the onion model" of high availability information architecture.

Business continuity relies on several continuous computing technologies that provide an efficient operating environment for continuous computing. Implementation of continuous computing technologies provides a platform for "keeping business in business" since business-critical applications are installed on enterprise servers, run by server operating systems that include serverware components, backed-up by data storage systems and supported by several fault-tolerant and disaster-tolerant technologies.

The term "high availability" is associated with high system/application uptime which is measured in terms of "nines." The more nines in a number that represents availability ratio of a specific platform, the higher level of availability is provided by that operating platfom. In addition to the term "availability," two additional dimensions of server operating platform are used as well: reliability and scalability.

Chapter IV identifies the main information architectures that are used in designing and implementing of enterprise information systems and business computing in general.

These systems are designed, developed and implemented by using several approaches and methodologies. No matter which information system development methodology is used, business information system comprises several information technologies such as servers, desktop computers, portable/mobile computing devices, systems software, application software, data communication technologies, computer networks, and so forth. Information systems employ several profiles of IT specialists including those who are dealing with business continuity.

Contemporary business computing is mainly based on a client/server architecture or one of its several modifications such as "Thin" or "Thick" c/s, two-tier c/s, three-tier, "n-tier client-server," while several types of old-style mainframe-based architectures still exist. Client-server architectures consist of servers and clients (desktop and portable computers) with applications being installed and running on server computers. There are also specific types of servers still named mainframe computers (e.g., IBM's mainframes, Hitachi's mainframes, Amdal's mainframes), but they are installed, implemented and used within client-server architecture and without dumb terminals.

Recently introduced new computing paradigms and models such as Web-enabled legacy systems, utility or on-demand computing, software-as-a-service (SaaS), Web-based software agents and services, subscription computing, grid computing, clustering, and ubiquitous or pervasive computing use the combination of the previous configurations and newly developed technologies.

Chapter V describes server configurations or enterprise servers that play crucial role in modern computing environments especially from business continuity and

business agility perspectives. Servers are identified as integrated operating environments consisting of server hardware, server operating system (SOS), server applications, and server-based utilities called serverware. Servers are expected to provide such an operating environment that must meet much more rigorous requirements than a standard desktop operating system can provide. Such platforms are of special interest for businesses that require "always-on" or "online-all-the-time" computing environments. Therefore, server operating systems that provide zero-downtime or 100% uptime or some solution which is "near it" are of extreme importance for such businesses.

Purchasing a server is not a simple task, even when it is done for small business and even in a case when a high availability is not critical requirement. It happens to be a strategic decision having in mind all kinds of the factors including: processor type and vendor, operating system, commercial versus open-source dilema, and so forth. The selection of a server or server configuration is explained in more details having in mind the server's business continuity perspective consisting of the measures of performances such as availability, reliability, and scalability. A framework consisting of several questions and suggested options has been defined.

In **Chapter VI**, server operating systems are explained from the business continuity perspective. Modern server operating systems are expected to provide a set of features and functions that are critical in achieving business continuance. These features and functions usually come bundled (pre-installed) together with core operating system. A "built-in support" includes a number of features, functions or business continuity drivers that aim at enhancing the performances of continuous computing. In addition to standardcore operating system features that come within the core server operating system, a new approach in developing server operating environments for running business critical applications brings several enhancements called "serverware." Some of these applications come in the form of pre-installed or pre-integrated software "bundles" while some others are operating system—independent but very close to that specific SOS platform. As a result, both IT-vendors and IT-specialists have introduced newbroader term called "server operating environment" or "server operating platform."

A conceptual model to illustrate the role of server operating system and server operating platforms in the design of an information system for continuous computing infrastructure is presented in this chapter.

Chapter VII explores advanced server technologies for business continuity such as: fault tolerance and disaster tolerance technologies, fault-tolerant servers, server virtualization technology, server management software, and so forth. Server configurations may include several types of additional hardware and software features that may enhance availability ratios. These technologies include: SMP/Clustering, support for 64-bit computing, support for storage scalability, online reconfiguration, bundled servers, reloadable kernel and online upgrade features, crash-handling technologies, workload management.

Fault-tolerant servers are such servers that are able to continue to operate properly even when one or more faults within their hardware components occur. This feature helps in achieving higher levels of application availability. Such configurations called fault-tolerant servers differ from traditional clustering systems in which a specific failure (hardware failure, communication failure, system software failure, application software failure) on one server causes moving (transferring) the partial or the whole application processing to a second server within a cluster configuration.

Standard server configurations usually include redundant components such as: hot-swappable power supplies, ECC (error-correcting code) memory units, hot-swappable disk units, redundant processor components that perform the processing instructions in lockstep, while self-checking technology can detect and isolate errors at the component level. Server virtualization technology is explained in Chapter VII.

Chapter VIII deals with the selection of the server operating platform for business continuity. It identifies first the main attributes of server operating systems that are of interests from business continuity perspective. As many as 22 attributes or selection criteria are identified and short explanation was given for each of them. This list include criteria such as: TCO, multiplatform support, multiprocessing support, support for 64-bit processing, support for VLM (very large memory) and VLDB (very large data base) concepts and technologies, support for fault-tolerance and disaster tolerance, support for virtualization, integrated system management features, patch management, applications availability and integratibility, application development tools (integrated suites) availability for a specific server operating system platform, DBMS support, availability of enterprise resource planning (ERP) suites, availability of system integration tools (middleware support), support for file/print services, support for Internet, communication, networking, security protocols, support for application-programming protocols, availability of serverware products (messaging servers, Web servers, etc.), PC-client and mobile/portable support (PC-X, CIFS, PC-NFS support, and WAP support), availability of specialists (system administrators) for a specific platform, GUI and Web-based interface, and Viability of OS vendor.

In addition, this chapter presents some empirical studies on the performances of most widely used server operating systems such as several UNIX versions, several Linux flavors, Windows Server versions, some proprietary server operating systems such as OpenVMS, OS/390, and so forth.

Chapter IX explains the roles of system administration and system administrator in enhancing availability ratios of server operating platforms. Core system administration techniques on HP-UX operating systems are explained as well as advanced system administration tools, routines and features that are important in enhancing server's availability ratios.

This issue is very important in business continuity because super-user account is one of the most exploited vulnerabilities on IT platforms. This so-called "root" account or "super-user" (su) on UNIX/Linux servers and System Administrator on Windows servers posses all permissions and unrestricted access to all the files. Should the root account fall into the wrong hands, the security of the whole server configuration becomes compromised.

In addition to most commonly used system administration utilities, some additional and more advanced technologies, tools, routines and utilities that can be used in order to ensure higher levels of availability are explained on HP-UX as an example of server operating system.

As continuous computing and business continuity become more and more important in modern business, a number of new IT-professions have been introduced. It has become evident that employing only traditional system and network administrators is not enough for ensuring a comprehensive business continuity solution on enterprise-wide platform. Therefore, businesses that tend to implement a comprehensive business continuity solution seek for specialists such as Business Continuity Manager, Enterprise Business Continuity Manager, Director of Business Continuity Program, Business Resilience Architect, Business Continuity Analyst, Business Analyst for Business Continuity Program, Business Continuity Specialist, Business Continuity Administrator, Disaster Recovery Specialist, Emergency Preparedness Specialist, and so forth.

Chapter X describes major backup and recovery technologies that are used in enhancing business continuity. Several information technologies are used in order to store data in data centers in an efficient and effective way and protect it such that business does not suffer if data is lost. Primarily, this set comprises the following three main groups: data storage, data backup and data recovery technologies. Efficient and effective organizational data management represents one of the main prerequisites for assuring continuous computing and business continuity. Information technology provides a number of data storage and backup solutions for achieving continuous computing as a basis for business continuity. Technologies used for storing data (data storage), data backup and data recovery are of highest importance for business continuance.

Backup concept is presented and traditional tape-based and disk-based backup technologies are first explored. However, traditional backup is just the first stage toward an integrated storage solution that can enhance availability ratios and business continuity. Continuous computing requires even more comprehensive solutions than traditional tape-based backup. Having mission critical data on a tape in the form of traditional backup is much better than loosing data completely, however, recovering from hardware/software glitch or any kind of failure that caused interrupting data processing in the form of restoring data from a tape usually take a significant time,

depending on the amount of data. Therefore, businesses are seeking higher levels of application availability and continuous computing need more sophisticated and, with regard to data backup and data recovery speed, much faster solutions.

In **Chapter XI** advanced data protection technologies such as RAID technology, direct access storage, storage area network (SAN), network attached storage (NAS), off-site data storage, data vaulting, data mirroring and data replication, snapshoot technology, clustering, continuous data protection are shortly explained.

From business continuity perspective, SAN technology provides several advantages such as: enhancing application and data availability, increasing storage capacity, allowing booting and rebooting servers from the SAN environment, enabling duplication features such as "business continuity Volumes," "data-volume cloning," and other real-time duplication technologies, reducing hardware costs. One of the most important characteristics of the NAS infrastructure from business continuity perspective is that data stored within NAS filers remains available even if server is down.

Mirroring and data replication are new technologies that emerged some 5–6 years ago. They are most frequently used as additional, second-level backup technologies, in addition to standard tape-based backups.

Data vaulting is an advanced data archiving technology that permits an automated backup of data to a remote location, archiving and recovery. Data transfer is made via high-speed communication lines that connect business' data centers with "data vaults" as purpose built vaults.

Cluster configurations have the abilitiy of adding computers and other devices and resources in order to increase the overall performances of the system. This is especially important from scalability perspective: the system can be scaled up by adding more hardware resources (processors, RAM), or by adding new computers. A most common use of clustering today is to load balance traffic on Web sites organized and managed by Internet service providers.

Chapter XII discusses computer network technologies within the context of business continuity as an integrated networking infrastructure is a prerequisite for any kind of e-business in a networked economy. It consists of several data communications and computer network technologies that are implemented in order to come up with appropriate data communications—computer network platform.

Network technologies make the third layer of an information system that enables continuous computing. They include technologies such as communication devices, communication media, communication protocols, network operating systems, networking protocols, data protection, and security standards. Network cards, modems, cable modems, DSL modems, routers, bridges, switches, hubs, firewalls, and so forth, are used to connect computers within local area networks, wide area networks, virtual private networks, campus networks, metropolitan networks.

Several communication media, guided and non-guided, such as leased lines, ISDN, ATM, frame-relay, wireless communications devices and protocols, satellite communications, and so forth, are used in order to establish several types of computer networks. These networks are in turn basis for networked enterprises, e-business, e-government and e-economy.

In modern Internet era, in what is called "networked business," the network security in an organization that operates in such a kind of environment represents a business continuity problem. The famous saying, "A chain is only as strong as its weakest link" applies as a rule in modern e-business. Network downtime caused by security attacks is costing large enterprises more than $30 million a year, according to a recent study by Infonetics Research. According to the study, "The Costs of Network Security Attacks: North America 2007," large organizations are losing an average of 2.2% of their annual revenue because of security attacks.

Chapter XIII describes business continuity management (BCM) that involves several measures (activities) that have to be planed in order to achieve higher levels of the system/application availability ratios.

Business continuity management consists of strategies, policies, activities and measures that business undertakes in order to survive when some sort of catastrophic event occurs. Even though it represents a managerial activity, at the end, business continuity in information age relies on high-ratios of application/data availability, reliability and scalability that should be provided by server operating environment. Therefore, business continuity management, being a part of the fifth dimension of Churchman's definition of the system, as defined in introduction, should be based on continuous efforts of integrating business continuity drivers into contemporary enterprise information systems.

Chapter XIV provides some insights on the relations between continuous computing, business continuity and business agility. Business agility is an enterprise-wide response to an increasingly competitive and changing business environment, based on: customer orientation and satisfaction, enriching the customer, reducing time-to-market, increasing profitability, mastering the uncertainty, improving efficiency and effectiveness by continuous process improvement, enterprise-wide collaboration, and improving information access. Continuous computing technologies are employed in order to achieve business continuity from the business operations perspective. In the same time, these technologies are the main prerequisite for business agility as agility relies on available information and "always-on" information system that generates it. Several IT-based agility drivers and their features that are critical for enhancing the enterprise-wide agility are identified.

At the end, the reader should keep in mind that, when continuous computing technologies and information technologies in general are considered, no text is current, be it a book, chapter in the book, or paper published in a scientific journal.

The dynamics of changes in IT industry makes the writing of IT-related texts some sort of "risky business" due to the fact that some sections become obsolete and/or out-of-date sometimes even prior to publication.

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