Preface

INTRODUCTION

The shift from the industrial economy to the information economy that has happened over the years has led to an enormous increase in competitiveness among companies. This in turn has led to the development of information technology to highly advanced levels. It is now able to support modern enterprise operation in extremely intricate environments where the changing needs of the business community forces firms to be more agile and responsive. The development of technologies that can efficiently handle complex information such as software agents, combined with the development of Internet technologies for business process integration and automation such as Web services, is causing considerable impact on the way economic actors and their roles are implemented in the worldwide market place. This technological evolution has lead to the development of a new value-creating economic paradigm, where the concepts of extended enterprise, the agile enterprise, the smart organization, and the virtual enterprise are starting to hold an important position.

The network based information economy and the virtual-yet-real enterprises are a promising reality. Research on new technologies for the virtual enterprise has released new roads to the design principles and operation approaches, done in order to maximize benefits and overcome any limitations encountered so far, in the real life of the virtual enterprise. New theories and technologies such as agent and Web service supported formation and operation, collaboration requirement planning, active middleware for virtual enterprise operation support and operational parallelism—some of them covered by chapters in this book—present a concrete design framework for virtual enterprise successful operation. At the same time, serious challenges to the future effectiveness of virtual enterprises are also sensed and discussed throughout this book.

In a virtual enterprise, sets of economic actors combine their strengths to provide a specific service traditionally provided by a single enterprise. Such possibilities can greatly influence the economy and enterprise development strategies, and in the long term this will help small and medium enterprises capitalize on the information economy. Historically speaking, small and medium enterprises (SMEs) have founded their competitiveness on static established co-operations, which were based on personal relationships and on the proximity of the involved companies' locations. Groups of SMEs have demonstrated in several regions of Europe and the USA, the ability to successfully exploit a business opportunity that none of its members had the financial and technological ability to realize individually. This approach, although effective in the past, is showing its limitations regarding its capability to face the requirements of the global market, where the search for competitiveness cannot be limited by geographical and personal constraints.

Yet, if we could find a way to exploit the tremendous advancement of ICT and the promises of the border-less electronic market, in order to harvest the cultural attitude toward cooperation of SMEs, and transpose it from its local environment to the worldwide market, we would unleash a tremendous com-

petitive potential in the world global market. Moreover, within both the overall Industrial Policy and the Enterprise Policy, there is a clear imperative to support initiatives that will facilitate and enhance the current operation of SMEs "daily" and "routine" working activities. Particularly, the European Commission White Paper on Growth, Competitiveness and Employment proposed a synergetic strategy to ensure the mobilization of economic operators to support the development of 17 million European SMEs (the number of European SMEs equalizes the number of the unemployed).

Virtual enterprises allow businesses to concentrate on their best skills and be flexible within their environments. Their strategic guideline is the electronic commerce model and more specifically the cooperative business or B2B scenario, where the virtual enterprise offered a new and major step. It defied the conventional organization operation scenario by accomplishing tasks traditionally meant for an organization much bigger with lots of financial, human and technical resources. This is made possible due to there being a collaborative effort. A company having the right know-how, another with the technical capability, the other with the right human skill set, can come together across the Internet to aggregate it all. The Information Economy gifts a virtual enterprise composition for entrepreneurs who want to achieve their dreams (Wikipedia).

Virtual enterprises are a major trend in cooperative business. Specialization and flexibility are some of the key aspects of an every day more dynamic and global market. The concept of virtual enterprise has been applied to many forms of cooperative business relations, like supply chains, construction industry, outsourcing or temporary consortiums.

As with all types of enterprises, virtual enterprises present both benefits and challenges. Organizations can benefit from virtual enterprises through more business opportunities, lower cost connections with suppliers, more chances to create revenue, more efficient operations, and a reduction in administrative costs. The challenges facing virtual enterprises are integration difficulties, security, expense control, inexperienced users and the level of incorporation required to create a successful virtual enterprise (Sun Microsystems, Inc., 2004).

One of the ideas driving virtual enterprise creation is that of processes dynamically constructed out of available Internet-based services, as needed at runtime. In the late 1980's, Marty Tenenbaum talked about a "sea of services" on the Internet that would facilitate virtual enterprise formation. Now that we have Web Services, this idea of finding services at runtime has great potential. Agent technology can help to locate and apply Web Services in virtual enterprises, and also to dynamically construct and operate them.

The most ambitious technologies however, intend to automate the process of formation and operation of virtual enterprises, mainly through multi-agent technology approaches, where each partner enterprises of the virtual enterprise can be represented by an agent. Research on multi-agent technology addresses issues that fit the virtual enterprise scenario. Agents are autonomous, interact with other agents, and enable approaching inherently distributed problems with negotiation and coordination capabilities (Cardoso & Oliveira, 2005).

A lot of academic work has been done so far in applying software agents to virtual enterprises. Due to this work many interesting results have been achieved concerning the virtual enterprise life cycle. However, some of these results mean more confusion rather than clarification. Recent research, for example, proposes abandoning specific implementations of software agents, in favor of building on emerging Web service standards—called service agents—while others propose that we just use MAS technology.

 "Agent and Web Service Technologies in Virtual Enterprises" addresses the different dimensions of the above mentioned technologies when applied to virtual enterprises. The book intends to provide an integrated view of the most recent contributions to the agent and Web service technologies in virtual enterprises. Several dimensions can be identified in this mission:

- **The Web service dimension:** This technology is very popular for virtual enterprise integration and operation where the academic approach has not solved the fundamental problems of service discovery as yet. How do interested parties find the capability they're looking for? How do they advertise? How can software do this on behalf (but without the intervention) of a person? Many proposals along these lines exist, ranging from content-based routing in the early 1990's to the use of DAML-S for agents in recent years but none of them has led to deployed, practical systems so far.
- **The software agent dimension:** This includes multi-agent systems (MAS) technology, mobile agents, intelligent agents and other combinations of traditional agent technologies.

The mission of the proposed book is to discuss the main issues, trends and opportunities related to the application of agent and Web service technologies to virtual enterprises, from the above-mentioned dimensions. The book will take a comprehensive approach, and disseminate practical solutions to promote virtual enterprise and interorganizational integration. The overall objectives are:

- To introduce and discuss the business integration requirements in the virtual enterprise and other emerging interorganizational models
- To discuss Web service and software agent technologies and applications
- To discuss Web service and software agent technologies in virtual enterprise formation, integration and operation
- To introduce relevant and recent developments and solutions (academic and industrial) addressing the several dimensions and issues of the book

This book is both for an academic audience (teachers, researchers and students, mainly of post-graduate studies) and professional audience (managers, organizational and system developers and IT specialists) in terms of explaining the requirements and frameworks for IT solutions.

This book is expected to act as a guide for technology solution developers from academia, research institutions and industry, providing them with a broader perspective of Agent and Web Services.

This book contains 14 excellent chapters authored by a group of internationally renowned and experienced professionals and researchers in the field of IT and virtual enterprise (VE) science. Contributors also include younger authors, creating a value-added constellation of dynamic authors. Concerning the environments from which the contributions are presented, the chapters came from academia, research institutions and industry.

ORGANIZATION OF THE BOOK

The 19 chapters in this book are organized into four sections. These sections address the state of the art software agents and Web services areas along with the main phases of the virtual enterprise life cycle, being in a simplified view formation, integration and operation.

The book's organization scheme, in respect to the previously mentioned three phases of the virtual enterprise's life cycle and the technology addressed, is given in Table 1.

- **Section I,** "Agents and Web Services Overview," consists of two chapters that give an overview of the current advances in the software agent and Web service technologies.
- Chapter I, "Software Agent Technology: An Overview," surveys some key research issues in the software agents' area. It annotates several researchers' opinions on many areas concerning software

Table 1. Book organization

Virtual Enterprise phase	Technology	Sections	Chapters
	Overview	1	1, 2
Formation		2	3
Operation	Integration	3	4-9
	Collaboration		
	Applications	4	10-14

agents aiming to give a more documentary point of view on each argued subject. Its main goal is to provide an overview of the rapidly evolving area of software agents, serving as a reference point to a large body of literature and outlining the key aspects of software agent technology.

• Chapter II, "Web Services Technology: An Overview," examines the concept of service-oriented architecture (SOA) in conjunction with Web services technology, as an implementation of the former's design principles. Following a brief introduction of SOA and its advantages, a high-level overview of the structure and composition of the Web services platform is provided. This overview covers the core Web services specifications as well as features of the extended architecture stack, which together forms a powerful and robust foundation for building distributed systems.

• **Section II**, "Virtual Enterprise Formation," consists of one chapter that discusses the application of software agents and Web service technologies in the formation of virtual enterprises.

• Chapter III, "Virtual Enterprise Formation Supported by Agents and Web Services," describes the use of software agents and Web services to support the formation of virtual enterprises. The partners of a virtual enterprise are represented as software agents. The AGORA multi-agent architecture is used. The focus of this chapter is on the description of the services provided by each partner and the partner selection process. The concept of agent interaction protocols is used to manage the interactions during the formation of the virtual enterprise. An implementation of the ideas and examples from industrial case studies are used for the validation of the approach and discussions. The use of Semantic Web technology and Web services with multi-agent systems is discussed as the future direction for this work.

• **Section III**, "Virtual Enterprise Integration," consists of nine chapters that discuss the problems of virtual enterprise integration. Agents and Web services are examined through various aspects of the integration problem such as information and knowledge sharing, distributed project scheduling and views and cross-enterprise culture sharing.

• Chapter IV, "Adaptive Service Choreography Support in Virtual Enterprises," discusses Web service choreography application in virtual enterprises. The contribution of the paper is two-fold: it explores reusability of the applicable business protocols in different business scenarios and suggests ways to adapt the implementations of the partners' services (end-points) to the changes in the business protocols.

• Chapter V, "Technologies to Support the Market of Resources as an Infrastructure for Agile/Virtual Enterprise Integration," describes the functionalities of the market of resources and explains how it

supports A/V E integration. It also addresses some technologies that could support A/V E integration based on the market of resources, namely XML/ebXML and Web services, in the integration and automation of processes and services. The chapter proposes an architecture to support the operation of the market of resources, representing a fusion of the peer-to-peer (P2P) architecture with the client-server architecture, as a variant of P2P architecture.

- Chapter VI, "The Utilization of Semantic Web for Integrating Enterprise Systems" presents the utilization of ontologies for the formation of an ONAR framework and its application for service oriented application integration (SOAI). Ontologies based enterprise application integration (ONAR) framework utilizes Semantic Web technologies to define shared information among heterogeneous systems.

- Chapter VII, "A Recommender Agent to Support Knowledge Sharing in Virtual Enterprises," presents KARe, a multi-agent recommender system that supports users sharing knowledge in a peer-to-peer environment. In this way, KARe reflects the intrinsically distributed nature of virtual enterprises. Supporting social interaction, the system allows users to share knowledge through questions and answers. This chapter focuses on KARe's recommendation algorithm, presenting its description and evaluation

- Chapter VIII, "Framework of Agent-Based Intelligent System for Distributed Virtual Enterprise Project Control," the authors propose the multiagent systems with negotiation strategies for project schedule control—a collaborative system framework wherein a distributed project can be scheduled dynamically by agents in the virtual enterprise environment. A prototype of the multiagent systems, with the negotiation strategies, is implemented in Java, JADE, FIPA-ACL, and the negotiation strategies are experimentally validated. The prototype successfully demonstrates the online coordination and resolution in dynamic scheduling, while handling unexpected events to meet each project participant's requirements.

- Chapter IX, "Sharing Views, Information, and Cross-Enterprise Culture in the Corporate Situation Room," presents a methodology for modeling corporate interactions using the concept of the situation room (SR) as a supporting paradigm. Such an approach facilitates a way to model interactions of a virtual enterprise nature, by means of an information and knowledge auction market that is concerned with the communications and interactions within a virtual enterprise.

- Chapter X, "Multi-Agent Systems Integration in Enterprise Environments Using Web Services," presents a decoupled architectural approach that allows software agents to interoperate with enterprise systems using Web services. The solution leverages existing technologies and standards in order to reduce the time-to-market and increase the adoption of agent-based applications. The chapter also presents case studies of applications that have been enhanced by this architecture.

- Chapter XI, "Web Service Discovery and Composition for Virtual Enterprises," presents a methodology and a software framework to support short-term collaborations between business partners within a virtual enterprise, based on process-oriented design and communication by Web services. Their framework developed in the frame of the Austrian project MOVE, supports the graphical design and verification of business processes, the execution and supervision of processes in transaction-oriented environment, and the dynamic composition and optimization of processes.

- Chapter XII, "Achieving Agile Enterprise Through Integrated Process Management: From Planning to Work Execution," describes an integrated process management system that will integrate project management, business process modelling, simulation, and workflow technologies to support scheduled workflow execution. The target will be achieved by utilizing a tool for modelling work processes that can semi-automatically generate workflow processes based on a scheduling tool and then export it to a workflow engine via Web services using XML process definition language (XPDL). In addition, the simulation capability allows testing workflows before deployment.

- **Section IV**, "Virtual Enterprise Operation," consists of six chapters that discuss virtual enterprise operation. Agents and Web Services are examined through various aspects of the virtual enterprise operation such as supply chain management, business process modelling and applications of virtual enterprises in various sectors such as environmental and health care.
- Chapter XIII, "Agents and Multi-Agent Systems in Supply Chain Management: An Overview," discusses the current state-of-the-art agents and multi-agent systems (MAS) in supply chain management (SCM). Following a general description of SCM and the challenges it is currently faced with, we present MAS as a possible solution. The authors argue that an application involving multiple autonomous actors, such as SCM, can best be served by a software paradigm that relies on multiple independent software entities, like agents. The most significant current trends in this area are discussed and potential areas for further research are outlined.
- Chapter XIV, "A Conceptual Framework for Business Process Modeling in Virtual Organizations," suggests a conceptual framework for modelling business processes in virtual Organizations, by introducing Web services technology. Web services can be the business enabler for the new organizational form, which is particularly well suited to meeting the demands arising from today's turbulent changes in the firms' environment. The proposed framework consists of several steps in a bottom-up approach, aiming to support the modelling and coordination of the complex and shared business processes in the examined environments.
- Chapter XV, "Towards a Virtual Enterprise Architecture for the Environmental Sector," explores the potential of formulating virtual enterprises for the environmental sector. In particular, Section II lays the foundations by introducing concepts related to environmental management information systems (EMIS) and the major challenges for environmental information processing and dissemination. In Section III, a virtual enterprise architecture for environmental information management is introduced and Section IV specifies the operational fashion of such a virtual enterprise. Section V summarizes latest developments in the field, and discusses the potential for wide-range adoption of virtual enterprises in the environmental sector.
- Chapter XVI, "Using VO Concept for Managing Dynamic Security Associations," discusses how the virtual organization concept can be used for managing dynamic security associations in collaborative applications and for complex resource provisioning as possible components of the Agent based virtual enterprises. This chapter provides an overview of the current practice in virtual organization management at the organizational level and its support at the security middleware level. It identifies open issues and basic requirements of the virtual organization security functionality and services and suggests possible directions for further research and development. The research presented here is based on experience gained from the major grid-based and grid-oriented projects in collaborative applications and complex resource provisioning.
- Chapter XVII, "Interoperability Middleware for Federated Business Services in Web-Pilarcos," presents the Web-Pilarcos architecture that addresses the needs of managed collaboration and interoperability of autonomous business services in an inter-organisational context. The Web-Pilarcos B2B middleware is designed for lowering the cost of collaboration establishment and to facilitate management and maintenance of electronic business networks. The approach is a federated one: all business services are developed independently and the B2B middleware services are used to ensure that technical, semantic and pragmatic interoperability is maintained in the business network.
- Chapter XVIII, "Web-Based Template-Driven Communication Support Systems: Using Shadow netWorkspace to Support Trust Development in Virtual Teams," describes the development and some initial experiences with a Web-based, template driven, asynchronous communication support tool and how this system can be used to support trust development in virtual teams and performance

goals of virtual teams. This chapter presents the capabilities and features of the communication support system.

- Chapter IXX, "Web Service Design Concepts and Structures for Support of Highly Interconnected E-Health Infrastructures: A Bottom-Up Approach," the authors present organizational issues that are revealed when considering the case of interconnecting and integrating different compartments of a modern hospital. They present a technology-based approach for solving interoperability problems at the service level, and they deliberately adopt a problem-solving approach that is successfully adopted in the European IST Project ARTEMIS.

EXPECTATIONS

This book is expected to be read by academics (i.e., teachers, researchers and students), technology solutions developers and enterprise managers (including top level managers). It is expected to be a guide for technology solution developers, from academia, research institutions and industry, providing them with a broader perspective of virtual enterprise technologies. It aims to increase their awareness on how agent and Web stechnologies can best serve the needs of an ever expanding and increasingly competitive organizational model. This book also widens horizons for researchers interested in this emerging field and presents the background and state-of-the-art developments.

As a book it is expected to raise the awareness of the potential of the virtual enterprises model so that managers, who should employ proactive behavior towards new approaches to business, are able to exploit it. In other words, the book provides guidance and helps raise awareness, pro-activeness and agility of enterprise managers. This should include top level and IT managers, for strategic and dynamic alignment with business opportunities, on the problems of virtual enterprise development, implementations and operation as well as on the evolution of their actual enterprises towards virtual enterprise.

This work will support teachers of several graduate and postgraduate courses, from an information technology perspective. In particular, it will support the emerging courses on virtual enterprise technologies and provide a basis for understanding content, and an area for further study, research and solutions development.

The editor is also expecting that the book will contribute to the diffusion of the virtual enterprises technological concept in other parts of the world, not only in the most developed countries.

Finally, the editor is grateful to the readers for any constructive criticism and indication of errors—conceptual, omissions or in typing.

The Editor,
Nicolaos Protogeros

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