Foreword

"Despite the dotcom boom and bust, the computer and telecommunications revolution has barely begun. Over the next few decades, the Internet and related technologies really will profoundly transform society."[1]

By 2050 the Internet will have impacted our business, culture, and society as a whole as much if not more than did Gutenberg's printing press 600 years ago in 1450. Sheer economics will force the majority of business and government interactions to be automated. Although the rate and extent of automation will vary by domain, most interactions will not only take place over the Web, they will be almost entirely free of human interaction. As with previous industrial revolutions, the profound impacts are unpredictable, especially the social, political, and religious impacts. However, the automation of everyday personal, commercial, and governmental activities is more easily predicted due to the potential economic benefits and the extrapolation of existing automation. The Third Industrial Revolution, the Information/Biotech Revolution, is well underway.

Typically, there are multiple alternative technologies on which next-generation technologies might be built. Currently there are only two widely accepted enabling technologies that are both new, and hence are in their infancy, and mission critical. They are Web Services and the Web, or the next-generation Web, called the Semantic Web. To achieve even some of the promises for these technologies, we must develop vastly improved solutions for addressing the Grand Challenge of Information Technology, namely dealing better with semantics or real-world "meaning". More precisely, we must enhance automated actions and data to more closely correspond to the real-world actions and facts that they represent, with minimal human involvement. This Grand Challenge is the core challenge not just of Information Technology but also of all next-generation automated applications. This challenge has been calling out for a Silver Bullet since the beginning of modern programming.

So what is a Silver Bullet? The ancient Greeks believed in the mystical power of silver as an infallible defense, means of attack, or solution to an otherwise insoluble problem. Germanic folklore of the Middle Ages held that only silver could slay man-eating werewolves. In a popular late-nineteenth-century English novel a silver bullet was the only means of killing the werewolf that plagued London. In a myth from my youth, the Lone Ranger TV series, based on 1930–40s novels, starred the Lone Ranger, a masked, clean, and heroic vigilante who came to the defense of many a prairie town by using a single silver bullet to slay the villain. The term Silver Bullet entered into the computing vernacular in 1987[2] when "Silver Bullet" was used pejoratively to dismiss the potential of a simple or single solution to longstanding and otherwise invincible software engineering challenges.

"Ontologies: A Silver Bullet for Knowledge Management and Electronic Commerce" provides a comprehensive introduction to the only known potential Silver Bullet for the Grand Challenge. That Silver Bullet is ontologies. An ontology, in the sense used in this book, is a community-mediated and accepted description of the kinds of entities that are in a domain of discourse and how they are related. They provide meaning, organization, taxonomy, agreement, common understanding, vocabulary, and a connection to the "real world". For a given community, dealing with an agreed-upon domain (e.g., selling software over the Web), the ontological solution provides a definition of all required concepts and their relationships so that every program, Web service, or database that solves a problem in that domain can automatically communicate with other like entities based on the common definitions. Such solutions require concepts, languages, and tools, many still in their infancy. This volume gives a comprehensive introduction to ontologies in the context of the Semantic Web and Web Services challenges that lie at the heart of the Next Generation of computing. It describes and illustrates the basic concepts, languages, and tools currently available and in development. It illustrates these with knowledge management and electronic-commerce applications. One application, selling software over the Web, is based on UN/SPSC, an ontology that is accepted and used worldwide. Hence, the applications in this volume are not just speculative. They solve real problems. What is speculative is the adoption and development of ontological concepts, languages, and tools to extend such solutions to all domains. Unlike most technological solutions, ontologies start with human, community agreement on an ontology. Hence, ontologies are not solely a technical challenge. This is what you should expect of a technical solution that connects to the real world as ontologies do, by definition.

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[2] Frederick P. Brooks: "No Silver Bullet – Essence and Accidents of Software Engineering", *IEEE Computer,* 20(4):10–19, April 1987.

It remains to be seen whether ontologies will be the Silver Bullet for Knowledge Management and Electronic Commerce as this volume suggests or whether ontologies will be just another failed claim for a next-generation technology. To become versed in this, the Grand Challenge of Information Technology, and to understand the challenges and potential solutions that ontologies, and currently only ontologies, offer, you must understand the material offered comprehensively in this volume. The Third Industrial Revolution has begun and ontologies offer the hope of a Silver Bullet to overcome the Grand Challenge that stands in the way of its realization.

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1 Introduction

Recently, ontologies have moved from a topic in philosophy to a topic in applied artificial intelligence that is at the center of modern computer science. Tim Berners-Lee, Director of the World Wide Web Consortium, referred to the future of the current WWW as the *Semantic Web* − an extended Web of machine-readable information and automated services that extend far beyond current capabilities. The explicit representation of the semantics underlying data, programs, pages, and other Web resources will enable a knowledge-based Web that provides a qualitatively new level of service. Automated services will improve in their capacity to assist humans in achieving their goals by "understanding" more of the content on the Web, and thus providing more accurate filtering, categorization, and searches of information sources. This process will ultimately lead to an extremely knowledgeable system that features various specialized reasoning services. These services will support us in nearly all aspects of our daily life − making access to information as pervasive, and necessary, as access to electricity is today.

The backbone technology for this Semantic Web is *ontologies*. Ontologies provide a shared understanding of certain domains that can be communicated between people and application systems. Ontologies are formal structures supporting knowledge sharing and reuse. They can be used to represent explicitly the semantics of structured and semistructured information enabling sophisticated automatic support for acquiring, maintaining, and accessing information. As this is at the center of recent problems in knowledge management, enterprise application integration, and e-commerce, increasing interest in ontologies is not surprising. Therefore, a number of books have recently been published to cover this area. Examples are [Davies et al., 2003], [Fensel et al., 2002(a)], [Fensel et al., 2003], [Gomez Perez & Benjamins, 2002], and [Maedche, 2002]. However, these other publications are either collections of papers written by a diverse group of authors or they focus on a specific aspect of ontologies, for example, ontology learning. The book *Ontologies: A Silver Bullet for Knowledge Management and Electronic Commerce* is one of the few single-authored books that provide comprehensive and concise introductions to the field. The first edition had the merit of being the first book that introduced this area to a broader audience. Compared to the first edition, three major improvements have been made for the second edition:

- Many recent trends in languages, tools, and applications have been integrated and the material has been updated quite substantially, reflecting the dynamics of our area of interest.

- The book is clearly structured into four sections: the concepts underlying ontologies; the languages used to define ontologies; the tool to work with ontologies; and the application areas of ontologies.

- Many small mistakes have been eliminated from the text.

Chapter 2 provides a definition of ontologies and illustrates various aspects of ontologies. Chapter 3 provides a survey of ontology languages, especially in the context of the Web and the Semantic Web. Chapter 4 provides examples of all relevant aspects that arise when working with ontologies. Even commercial tool sets have become available and are described in this chapter. Finally, no technology without its applications. Chapter 5 discusses the application of ontologies in areas such as knowledge management, enterprise application integration, and e-commerce.

All that remains is for me to wish the reader enjoyment and entertainment while reading about one of the most exciting areas of computer science today.