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Photonic Network-on-Chip Design

Springer

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Preface

This book is a product of an emerging interdisciplinary field that is using photonic communications to address many of the challenges associated with scaling computing system performance. With the emergence of multicore architectures and the ever-growing quest for parallelism, system performance is increasingly bound by its communication rather than computation capabilities. Data movement in the optical domain offers many unique advantages and the possibility of new interconnection network architectures that can enable future computing performance gains. The underlying photonic technologies also present many unique design challenges. It is our goal in this book to bridge the gap among these interdisciplinary fields and create a common reference for evolving the design and development of chip-scale photonic networks.

Optical communication, which already has major roles in large-scale computing systems, will be completely transformed by the silicon photonic chip-scale integration. In turn, silicon photonics could potentially become the most important technology to sustain the continued performance scaling of integrated circuits over the next decades.

The distinctive properties of photonic interconnects are explained in the first half of the book. This part also contains a comprehensive overview of the rich family of photonic devices that have been developed over the past few years, thanks to some fundamental engineering breakthroughs. In the second half of the book, three main classes of photonic network architectures are presented to illustrate the variety of design solutions that are made possible by the combination of photonic and electronic devices.

The two halves of the book are connected by the presentation of a design and simulation environment as a common toolset that fosters research collaboration in this emerging interdisciplinary field. On one hand, it enables computer system engineers to explore the use of new devices to design photonic network architectures. On the other hand, it enables photonic researchers to understand the impact of different device designs on system performance.

In the presentation of the various topics, it was our intention to balance theoretical models and simulation domains with empirical results. This way the reader can develop a working knowledge of what is theoretically possible and what has already been successfully demonstrated. We hope that researchers, designers, and architects across disciplines find the material in this book relevant and gain an understanding and appreciation of this exciting field.

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