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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.

New York, May 2013

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Contents

1	Introduction	1
1.1	Transistors to Photonics	1
1.2	Photonics for Memory	4
1.3	Remainder of this Book	8
	References	9
2	Photonic Interconnects	11
2.1	Photonic Technology	11
2.1.1	Wavelength-Division Multiplexing	12
2.1.2	Waveguides	13
2.1.3	Ring Resonators	14
2.2	Photonic Metrics	16
2.3	Generation	17
2.3.1	Encoding	18
2.3.2	Serialization	19
2.3.3	Driver Circuit	20
2.3.4	Modulator	20
2.4	Routing	20
2.4.1	Optical Link	21
2.4.2	Wavelength Routing	21
2.4.3	Spatial Routing	21
2.4.4	TDM Routing	22
2.4.5	Wavelength-Selective Spatial Routing	22
2.5	Reception	22
2.5.1	Wavelength-Division Demultiplexing	23
2.5.2	Detector	23
2.5.3	Amplifier	24
2.5.4	Deserialization	24
2.5.5	Decoder	24
	References	24

3	Silicon Photonics	27
3.1	Materials	27
3.1.1	Crystalline Silicon	27
3.1.2	Polycrystalline Silicon	28
3.1.3	Silicon Nitride	29
3.1.4	Amorphous Silicon	29
3.1.5	Germanium	29
3.1.6	Silicon Dioxide	30
3.1.7	Material Stacks	30
3.2	Waveguides	31
3.2.1	Crystalline Silicon Waveguides	32
3.2.2	Silicon Nitride Waveguides and Waveguide Crossings	33
3.2.3	Inter-Channel Crosstalk in Crystalline Silicon and Silicon Nitride Waveguides	34
3.3	Microring Resonators	34
3.4	Modulators	35
3.4.1	Crystalline Silicon Modulators	35
3.4.2	Crystalline Silicon Microring Resonator Electro-Optic Modulator Arrays	41
3.5	Switches	47
3.5.1	Universal Microring Resonator Switches	47
3.5.2	Microring Resonator Broadband Switches	48
3.5.3	Microring Resonator 4×4 Broadband Switches	59
3.6	Photodetectors	64
3.6.1	Germanium Photodetectors	64
3.6.2	Silicon Photodetectors	64
3.6.3	Photodetector Arrays	65
3.7	Lasers	65
3.7.1	On-Chip Silicon Lasers	65
3.7.2	Off-Chip Compound Semiconductor Lasers	66
3.8	Couplers	66
3.8.1	Lateral Couplers	67
3.8.2	Vertical Couplers	68
3.9	Links	68
3.10	Fabrication	69
3.11	Integration	70
	References	72
4	Photonic Simulation and Design Space	79
4.1	Performance Simulation	79
4.1.1	Motivation for Photonic Simulation	80
4.1.2	Methodology and Design Flow Overview	80
4.1.3	Photonic Device Library	82

4.1.4	Physical-Layer Performance Analysis Tools	91
4.1.5	Integration with Other Simulators	96
4.2	Related Work	96
	References	98
5	Photonic Network Architectures I: Circuit Switching	101
5.1	Photonic Network Architecture Overview	101
5.1.1	Packet-Switching Networks	103
5.2	Circuit-Switching Basics	105
5.2.1	Path-Setup Protocol	107
5.2.2	Photonic Spatial Switch Design	109
5.2.3	Modulator and Detector Banks	112
5.2.4	Mesh Topology	117
5.3	Physical Layer Analysis of Photonic Circuit Switching	117
5.3.1	Insertion Loss Analysis of 4×4 Switch Designs	118
5.3.2	Scalability Study Using Physical-Layer Analysis	122
5.3.3	Effect of Modulation Rate	137
5.4	System Design Considerations	139
5.4.1	Gateway Concentration	140
5.4.2	Selective Transmission	142
5.5	Evaluating Photonic Circuit Switching with Scientific Applications	143
5.5.1	Application Description	144
5.5.2	Studied Network Architectures	145
5.5.3	Evaluation	146
5.6	Off-chip Memory Access	150
5.7	Evaluating Photonic Memory Access Using Embedded Applications	154
5.7.1	Embedded Applications	154
5.7.2	Network Architectures	156
5.7.3	Simulation Results	158
5.8	Architectures Using Deposited Multi-layer Devices	159
5.8.1	Multi-Layer Mesh	160
5.8.2	Matrix-Crossbar	160
	References	162
6	Photonic Network Architectures II: Wavelength Arbitration and Routing	165
6.1	Wavelength Bus Structures	165
6.1.1	Source-Routed Bus	166
6.1.2	Destination-Routed Bus	167
6.1.3	Multi-Write Single-Read	168
6.1.4	Single-Write Multi-Read	169

6.1.5	Wavelength Crossbar	170
6.1.6	Token Arbitration Ring	171
	Reference	172
7	Photonic Network Architectures III:	
	Advanced Photonic Architectures	173
7.1	Time Division Multiplexed Arbitration	173
7.1.1	Fully-Connected TDM Arbitration	174
7.1.2	Enhanced TDM Arbitration	178
7.2	Wavelength-Selective Spatial Routing	188
7.2.1	Concept	188
7.2.2	Analysis	195
7.2.3	Simulation Results and Analysis	198
	References	201
8	Conclusions	203
8.1	Major Technology Challenges Ahead	203
8.2	Integration and Scalability: The Role of Design Automation	205
	Index	207