On-Chip Photonic Interconnects: A Computer Architect's Perspective

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ABSTRACT

As the number of cores on a chip continues to climb, architects will need to address both bandwidth and power consumption issues related to the interconnection network. Electrical interconnects are not likely to scale well to a large number of processors for energy efficiency reasons, and the problem is compounded by the fact that there is a fixed total power budget for a die, dictated by the amount of heat that can be dissipated without special (and expensive) cooling and packaging techniques. Thus, there is a need to seek alternatives to electrical signaling for on-chip interconnection applications.

Photonics, which has a fundamentally different mechanism of signal propagation, offers the potential to not only overcome the drawbacks of electrical signaling, but also enable the architect to build energy efficient, scalable systems. The purpose of this book is to introduce computer architects to the possibilities and challenges of working with photons and designing on-chip photonic interconnection networks.

KEYWORDS

nanophotonics, on-chip network, interconnect, microring, optical interconnects, network topologies

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ACK	ACKnowledgement	42
ARQ	Automatic Repeat reQuest	42
AWGR	Arrayed Waveguide Grating Router	71
BOX	Buried Oxide	63
CMOS	Complementary Metal–Oxide–Semiconductor	4
CMP	Chip MultiProcessor	50
CRC	Cyclic Redundancy Check	59
DCAF	Directly Connected Arbitration-Free	46
DCOF	Directly Connected Optical Fabric	48
DIMM	Dual In-line Memory Module	69
DMA	Direct Memory Access	50
DWDM	Dense Wavelength Division Multiplexing	9
EDP	Energy Delay Product	45
FBDIMM	Fully Buffered DIMM	69
FEC	Forward Error Correction	59
FSR	Free Spectral Range	10
GBN	Go-Back-N	47
GF	Galois Field	61
HARQ	Hybrid Automatic Repeat reQuest	59
InP	Indium-Phosphide	64
ITRS	International Technology Roadmap for Semiconductor	2
LED	Light Emitting Diode	5
LFSR	Linear Feedback Shift Register	59
LVDS	Low Voltage Differential Signaling	60
MCM	Multi-Chip Module	67
MTBF	Mean Time Between Failure	61

MWSR	Multiple Writer Single Reader	39
MZI	Mach-Zehnder Interferometer	52
NAK	Negative AcKnowledge	36
NcK	N choose K	60
OOK	On-Off Keying	1
PIDRAM	Photonically Interconnected DRAM	70
PMMA	Polymethyl Methacrylate	52
PSE	Photonic Switching Element	48
QoS	Quality of Service	45
RAID	Redundant Array of Independent Disks	60
RSOA	Reflective Semiconductor Optical Amplifier	71
SAW	Stop-And-Wait	42
SECDED	Single Error Correction and Double Error Detection	60
SERDES	SERializer/DESerializer	20
SOI	Silicon-On-Insulator	2
SWMR	Single Writer Multiple Reader	44
TDP	Thermal Design Power	3
TED	Triple Error Detection	60
TIA	Transimpedance Amplifiers	16
TO	Thermo-Optic	52
TPA	Two-Photon Absorption	15
TSV	Through Silicon Via	4
UV	Ultraviolet	51
VCSEL	Vertical-Cavity Surface-Emitting Laser	5
VLSI	Very-Large-Scale Integration	2
WDM	Wavelength Division Multiplexing	4

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