

A Guide to High-Speed Interconnects

Fourth Edition

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An In-Depth Look at High-Speed Interconnects

Interconnect technology, the nervous system for any computing, networking, and consumer device, transfers control messages and data within the system and ensures there are no choke points. Increasing bandwidth and the unique requirements of data centers, networking, computing, storage, and HDTV are driving a host of interconnect technologies. With these diverse requirements and competing stakeholders, interconnects are likely to be specialized for the target applications. At the same time, several of these interconnects will lose out or become niche solutions.

The report examines the leading high-speed interconnect technologies—including PCI Express, RapidIO, and HDMI—and provides an unbiased analysis of their strengths, future potential, and projected market position. In addition, within each interconnect, we examine the key vendors offering silicon products as well as the intellectual property to enable silicon. Within each interconnect we analyze market leaders and their products as well as identify technology leaders. We provide market forecast and share our picks for future winners in each interconnect segment.

The report covers transmitter, receiver, and switch products for HDMI, which has become the dominant interconnect on HDTVs. The report also covers products for DisplayPort, as well as bridge and switch products for PCI Express and RapidIO.

We look at the standards for these interconnects as well emerging standard such as USB 3.0 and 100Gbps Ethernet. Some of these changes will introduce a disconnect and could present opportunities for new leaders to emerge in the affected interconnects. These changes include DisplayPort, MR-IOV, PCI Express Gen2 and adoption of blade servers.

Evaluating and Comparing Competing Technologies

Like its predecessor, PCIe is moving beyond PCs into embedded and communications systems. Compared to PCI, PCIe offers greater scalability, robustness, and even broader applicability. RapidIO is championed by Freescale and Texas Instruments, which offer native RapidIO ports on their processor and DSPs, respectively. HyperTransport (HT), another alternative, is riding the success of AMD's PC platform—creating opportunities for native HT peripherals. Each of these interconnects is backed by high-volume platforms—setting the stage for a positioning struggle. We evaluate each of these interconnects and project their relative acceptance.

Video is a driving application for consumer appliances, PCs, and networking. For video panels, HDMI has established a large installed base and can be found on most HDTV. The PC industry determined that its needs are best met with a new video/audio interconnect. Consequently, PC market leaders develop DisplayPort as the Interconnect between computer main-board and the monitor

We look at these competing options for video interconnects and project the evolution of this landscape. The report also examines the leading vendors and their products for each of these interconnects and provides an objective assessment of the vendors that are shipping production-qualified devices as well as projecting the future winners.

Get the Facts Quickly

"A Guide to High-Speed Interconnects" provides an in-depth look at the standards, products and vendors in this market. This new edition, packed with over 150 pages of valuable information, brings you up-to-date on the latest developments in this important market and gives you the analysis you need to help choose a supplier or partner in this field.

The report begins with tutorials on the key technologies implemented by these products, background on the networking market, and a discussion of the latest technology and market trends. Following these introductory chapters, the report delivers thorough coverage of all announced products in this area. For each of these vendors, the report examines the performance, feature set, and architecture of each product, highlighting its strengths and weaknesses in a consistent, easy-to-compare fashion. The report provides our own comparisons of these products and conclusions about which will fare best.

Make Informed Decisions

Senior analysts Jag Bolaria and Bob Wheeler draw on their broad experience in analyzing microprocessor technology to explain the microarchitecture and system interfaces of each device and how it will affect application performance. As the leading vendor of technology analysis for networking silicon, The Linley Group has the expertise to deliver the technical and strategic information you need to make informed business decisions.

Whether you are looking for the most effective solution for your application, a vendor to partner with, or a rising company to invest in, this report will cut your research time and save you money. Get the inside scoop on this market segment. Order "A Guide to High-Speed Interconnects" today.

This report is written for:

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- Marketing and engineering staff at companies that sell networking chips that incorporate or connect to high-speed serial devices.
- Technology professionals who wish an introduction to high-speed interconnect technology.
- Financial analysts who desire a detailed analysis and comparison of serdes companies and their chances of success.
- Press and public relations professionals who need to get up to speed on this technology.

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The following excerpt is from "***A Guide to High-Speed Interconnects.***" This PDF contains the complete table of contents, list of figures, list of tables, author biographies, and information about the publisher. The full report may be purchased from The Linley Group.

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Published May 2008

By Jag Bolaria and Bob Wheeler



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About the Authors

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Jag Bolaria is a senior analyst at The Linley Group. During more than 20 years in the communications and PC semiconductor industries, he defined and launched products that shipped more than 100 million units. Coauthor of *A Guide to Ethernet Switch and PHY Chips*, *A Guide to Broadband Chips*, and *A Guide to High-Speed Interconnects*, he has spoken at many industry events – including Network Systems Design Conference, Northcon, Wescon, and Min/Micro – and has written several application notes as well as articles for *EDN* and other magazines. His extensive industry experience includes senior roles in both marketing and engineering.

Before joining The Linley Group, Jag was the director of network systems and validation for Intel's Ethernet components. He joined this group as the director of marketing, responsible for strategic, product, and technical marketing. In this role, he worked directly with major customers, including Cisco, Lucent, Nortel, D-Link, and Hewlett-Packard.

Prior to that, Jag was in Intel's PC division. As director of marketing for chip sets, he led the development of product plans, design wins, and customer support for Pentium and P6 chip sets, working with all major PC suppliers worldwide.

Before these positions, Jag worked in Intel's communications group in technical marketing, product marketing, strategic marketing, and marketing management roles. He had worldwide product management responsibility for codecs/filters, modems, ISDN components, and LAN devices. During that time, he worked with engineers at AT&T, Fujitsu, IBM, NEC, Nortel/BNR, Rolm, and Siemens, among others.

Jag started his career as an R&D engineer with Standard Telecom Labs (STL), then the research arm of ITT in the U.K. During his three-year tenure with STL, he developed hardware and software for the prototype ISDN switches and LAN ring architectures over optical fiber. Jag earned a bachelor of science degree in electronics, with honors, from the University of Salford in the U.K.

Bob Wheeler



Bob Wheeler is The Linley Group's senior analyst for networking silicon. He has more than 20 years of experience in the PC, networking, and semiconductor industries. An industry analyst and consultant since 1997, he has served clients such as 3Com, AMD, ESS Technology, and Merrill Lynch. Coauthor of *A Guide to Network Processors*, *A Guide to Security Processors*, and *A Guide to 10G Ethernet Adapters and Controller Chips*, he has spoken at industry conferences that include WinHEC, Embedded Processor Forum, and Network System Design Conference.

Before 1997, Bob was division marketing manager for the Network Products Division of AMD. He was responsible for marketing local-area network (LAN) products, including Ethernet and wireless LAN controllers and transceivers. Strategic customers included Cisco, Compaq, HP, 3Com, and many other PC and networking OEMs. During his four-year tenure at AMD, Bob's roles included strategic marketing, product marketing, and technical marketing positions.

Before joining AMD, Bob was head of operations for Way To Go, a technology startup. The company launched an appliance and service for wireless traffic information in the San Francisco Bay Area. Bob was responsible for taking the product from proof-of-concept prototypes to production, including field-testing, contract manufacturing, and establishing the traffic-operations center. This challenging role built on his experience as engineering manager at Sysgen, a manufacturer of PC peripheral products. At Sysgen, Bob was responsible for developing one of the first client/server tape-backup systems for local-area networks.

Bob spent the early part of his career as a software engineer, including seven years at microcomputer pioneer North Star Computers. While working for North Star in the mid-1980s, he was responsible for one of the first ports of Novell NetWare to an OEM platform. In the early 1980s, he worked as an independent consultant at the U.C. Berkeley School of Business, serving as a microcomputer programmer.

About the Publisher

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Our reports are written by our own expert analysts. Technical accuracy is very high, as each vendor provides information about its products and reviews our presentation of those products. We add our analysis and insight, comparing and contrasting the various offerings and indicating the applications for which they are best suited. To ensure that our opinions are objective and unbiased, The Linley Group does not accept stock or retainers from the companies we cover. Our reports are used by more than 200 companies, including leading equipment makers, chip makers, software vendors, and investment firms.

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- Helping an established semiconductor vendor with messaging and positioning for an upcoming product launch
- Assisting an equipment vendor to select key components that are most appropriate for its application
- Providing valuable insights and technical due diligence to an investment group evaluating whether to invest in a semiconductor company

Our analysts start with a deep understanding of the key technologies in these markets, ignoring the hype and finding the features that make a difference. But we also understand that market success is based on business strategy as much as on technical excellence, and our recommendations are always steeped in the realities of the marketplace. We understand the dynamics of startups and established corporations alike and can shape our message to apply to the client's situation.

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Preface

What This Report Covers

This report covers high-speed interconnects used in computing, networking, storage, embedded, and display applications. The report covers standard chip products, FPGA devices, and intellectual property (IP) for interconnects. We focus on products for which serdes and interconnects are the primary function. Furthermore, we focus on interconnects that transfer data at 2.5Gbps or greater.

For PCI Express, the report focuses on bridge and switch chips. For RapidIO, it covers switching products, and for display interfaces, it covers receivers, transmitters, and switch chips. For the display interface, the report covers HDMI and DisplayPort.

Who Should Read This Report

This report is designed to meet the needs of a variety of readers:

- Engineers who are designing networking equipment and need to select a high-speed serial device
- Marketing and engineering staff at companies that sell networking chips that incorporate or connect to high-speed serial devices
- Technology professionals who wish an introduction to high-speed interconnect technology
- Financial analysts who desire a detailed analysis and comparison of serdes companies and their chances of success
- Press and public-relations professionals who need to get up to speed on this technology

As described below, the report is structured to allow different readers to skip certain sections, as needed. For example, experienced networking engineers may wish to focus on the vendor and comparison chapters; financial analysts may instead focus on the tutorial, introduction, comparisons, and conclusions chapters.

Organization of the Report

Chapter 1 provides background information on system-level design for high-speed interconnects. It also provides a tutorial on the terminology used in the design of high-speed silicon. In this limited space, we cannot provide an in-depth tutorial; please refer to the appendix for additional sources of tutorial information.

Chapter 2 provides an overview of the standards for PCI Express, RapidIO, HyperTransport, HDMI, and DisplayPort. Chapter 3 and 4 provide background on high-speed interconnect applications and the interconnect products, respectively. Readers who are familiar with networking-equipment and high-speed design may wish to skim or skip these chapters. They can also be used as a handy reference should an unfamiliar term or concept arise in later reading.

Chapter 5 provides a look at current technology and market trends as well as market size and vendor share for PCI Express and RapidIO products.

Chapters 6–10 cover the leading vendors offering high-speed interconnect products. These products include PCI Express bridges and switches, RapidIO switches, DisplayPort receivers, and HDMI receivers and switches. Each chapter provides background on the company, a description of the various products that they offer, and an analysis of the products and the company's prospects. Vendors covered in this depth are IDT, Pericom, PLX, Texas Instruments, and Tundra.

Chapter 11 covers additional chip vendors in these areas that have fewer products or a smaller market share than the leaders. Chapters 12 and 13 cover the leading vendors of IP and FPGAs for interconnect technology, respectively. The FPGA coverage is limited to devices that integrate serdes cores.

Chapter 14 compares bridge and switch products from selected vendors. It then compares display interface products from the leading suppliers. These include HDMI and DisplayPort receivers.

Chapter 15 concludes the report with a summary analysis of the high-speed interconnect market, looking at the various opportunities for interconnects and our outlook for the leading vendors.

Acknowledgments

The authors wish to thank the numerous people at the many vendors covered in this report who supplied information on their products and reviewed sections of the report. These reviewers helped ensure the highest possible technical accuracy.

Thanks go to our ever-vigilant copy editor, Ellen Clements, for keeping our grammar straight, and to Eileen Schmidt, who assisted with production.

Executive Summary

This report covers some of the leading interconnects in the industry, including PCI Express (PCIe), RapidIO, HyperTransport, HDMI, and DisplayPort. With the exception of PCIe, each of these interconnects is optimized for a specific set of applications. HyperTransport offers performance and low latency for high-performance computing (HPC) applications. HyperTransport is used as the front-side bus in AMD's processors. RapidIO enables peer-to-peer communications and can provide a fabric for distributed computing. RapidIO is integrated in PowerPC processors from Freescale, AMCC, and RMI as well as DSPs from TI and Freescale. HDMI and DisplayPort interconnects are targeted specifically for display interfaces.

PCI Express is used in PC platforms from Intel and AMD. It is also used as a general-purpose I/O interface for HyperTransport platforms, for RapidIO platforms, and with the display interfaces. Consequently, PCIe ships in more platforms and in greater volume than any of the other interconnects covered in this report. For PCIe, we focus on bridge chips and switch chips. We forecast the size of this market and market share for each supplier. PLX, the leading vendor, was one of the first vendors to offer PCIe bridges and switches. In 2008, the company has a broad portfolio of PCIe switch chips, targeting data path and control plane applications. The company also offers several unique features in its product line.

Other vendors for PCIe switch chips include IDT and Pericom. Like PLX, IDT offers a broad product line and has won many designs. It was the first company to offer a PCIe v2.0 switch. Pericom uses its signal-conditioning heritage to offer robust bridges and switches in addition to signal-conditioning devices for PCIe. Tundra also plays in this market with PCIe bridge chips.

Tundra is the leading vendor of general-purpose RapidIO switch chips. In 2007, Tundra focused on integration that would enable RapidIO system designers to reduce system cost. With its interoperability lab and IP cores, Tundra has taken a leading role in advancing RapidIO. IDT also targets RapidIO applications but offers value-added switch chips. These chips offload processing functions to help reduce system cost. In addition to these switch chips, IDT provides bridge chips for RapidIO in wireless applications.

This report also covers HDMI and DisplayPort interconnects, which are used with display panels. With more than 200 million devices shipped in 2007, HDMI is the dominant display interface. It is deployed on a wide range of consumer equipment, including HDTVs, DVD players, game consoles, camcorders, desktop PCs, and notebook computers. DisplayPort is positioned to replace VGA and DVI as the external display interface and replace FPD-Link as the motherboard-to-display interface in notebooks. Future versions of DisplayPort promise to enable networked panels and greater scalability. Although we expect HDMI to remain the leading display interface, DisplayPort will carve out a position in computing platforms, particularly for internal connections.

This report covers receivers, transmitters, and switches for HDMI and DisplayPort. An HDMI founder, Silicon Image was the first vendor to offer HDMI receivers and has the leading market share. Other HDMI receiver and switch competitors include Analogix, Analog Devices, NXP, Parade Technology, Pericom, Redmere, ST Microelectronics, and Texas Instruments. Out of this group, ST and Redmere are the first vendors to offer 1080p resolution with 16 bits per color – the leading color depth.

For DisplayPort, ST (formerly Genesis) was the first vendor to offer receivers and transmitters. The company continues to have a leading set of products. In 2008, it faces greater competition as IDT enters the market along with Analogix and Parade. With Intel and AMD offering system-logic chip sets that support DisplayPort, systems that use this interface should ship before the end of 2008.

In addition to direct competition, interconnect suppliers face indirect competition from ASICs and FPGA. Each interconnect has several vendors that provide IP for OEMs to develop in-house ASICs, for FPGA customers, and for merchant silicon vendors. The leading IP vendors for interconnect technology include ARM, Gennum, MIPS, PLDA, Synopsys, and TranSwitch. TranSwitch plans to offer IP for the highest-performance HDMI receivers.

The leading FPGA vendors offer either hard cores or soft IP for the interconnects covered in this report. Xilinx is the first vendor to offer serdes faster than 6Gbps on 65nm process technology. Lattice offers more cores in hard IP and integrates more 3.125Gbops serdes than any of its competitors. Altera is working on leading-edge serdes and density for its Stratix family of FPGAs. Between these three FPGA vendors, OEMs should be able to find an FPGA solution to meet their system interconnect needs.