

## ***A Guide to Ethernet Switch and PHY Chips***

***Sixth Edition***

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### **Evaluating and Comparing the Latest Ethernet Switches and PHY Chips**

The Ethernet market is marked by rapid technology transitions, which often result in large shifts in vendor share. In Ethernet switches, 10 Gigabit Ethernet (10GbE) shipments are growing quickly, with Broadcom, Marvell, Dune, and Fulcrum competing to establish a leadership position. These vendors are working to increase port counts and reduce costs. Broadcom and Marvell are also the leaders for Gigabit Ethernet switch chips. The market for 10GbE PHY chips is even more competitive, with several vendors vying to establish an early leadership position. In some cases, large vendors have acquired startups to fill holes, while at the same time, PHY vendors continue to raise new funding.

With the adoption of 10GbE in servers within the data center, it is necessary to have aggregation switches that support higher data rates. IEEE working groups are busy developing specifications for 40GbE and 100GbE. We expect these specifications to be adopted in the data center as well as in telecommunication applications. Although FPGAs are the first devices that can implement 40GbE and 100GbE MACs and switches, several vendors are developing ASSPs for these applications.

Ethernet is riding its success from LAN to access and metro markets with service providers migrating from circuit switched networks to Carrier Ethernet. Instead of competing directly with the established vendors, new players such as Xelerated and Tpack are entering with Carrier Ethernet products. The combination of new investment and increasing number of entrants is serving to make the Ethernet switch and PHY market increasingly competitive. A Guide to Ethernet Switch and PHY Chips breaks this market into five key segments:

- GbE switch chips
- 10GbE switch chips
- Carrier-Ethernet switches
- 10GbE PHYs for copper and optical media
- 10GbE (KR) backplane transceivers

Unlike typical market research, this report provides technology analysis and head-to-head product comparisons. Which chips will win designs and why? How will these vendors be positioned as GbE and 10GbE continue to grow? Only The Linley Group's unique technology analysis can provide this forward-looking view.

### **We Sort Out the Technology and the Key Vendors**

"A Guide to Ethernet Switch and PHY Chips" begins with an extensive overview of this growing market. The report provides tutorials that help you decipher the myriad of acronyms and Ethernet standards. We explore the target markets and applications for GbE silicon, followed by an explanation of the common attributes of these products.

Following these introductory chapters, the report delivers a complete chapter on six major vendors that offer products in multiple segments: Broadcom, Marvell, Realtek, Vitesse, and Xelerated. Each major-vendor chapter includes company background information, full details of announced products, a discussion of the vendor's roadmap where available, and our conclusions about the vendor and its products. Then, for each product segment, we include a chapter covering other vendors and a chapter comparing the products in the segment.

Product segment chapters include coverage of switch chips and PHY chips. We cover switch chips from Centec, Dune, Ethernity, Fujitsu, Fulcrum, and Tpack. For PHY products, we cover optical transceivers from NetLogic, AppliedMicro, ClariPhy, Phyworks, and Inphi, as well as Ethernet backplane transceivers from these vendors. We also provide coverage of 10Gbps Ethernet-over-copper chips from Aquantia, Plato Networks, Solarflare, and Teranetics, and provide the landscape of vendors that have yet to announce products. Finally, we offer our outlook for the leading vendors in each segment and for the overall market.

### **Make Informed Decisions**

As the leading vendor of technology analysis for networking silicon, The Linley Group has the expertise to deliver a comprehensive look at the full range of chips designed for GbE/10GbE applications. Senior analysts Jag Bolaria and Bob Wheeler use their broad experience to deliver the deep technical analysis and strategic information you need to make informed business decisions.

Whether you are looking for the right Ethernet chip for your application or seeking to partner with or invest in a chip vendor, this report will cut your research time and save you money. Make the intelligent decision, order "A Guide to Ethernet Switch and PHY Chips" today.

### **This report is written for:**

- Engineers designing Ethernet switch products or systems that embed an Ethernet controller or switch
- Marketing and engineering staff at companies that sell related chips who need more information on Ethernet chips
- Technology professionals who wish an introduction to Ethernet chips
- Financial analysts who desire a detailed analysis and comparison of GbE, 10GbE, and switch-fabric semiconductor 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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# Table of Contents

|   |           |
|---|-----------|
| List of Figures .....                       | ix        |
| List of Tables.....                         | xi        |
| About the Authors .....                     | xiii      |
| About the Publisher.....                    | xv        |
| Preface .....                               | xvii      |
| Executive Summary.....                      | xix       |
| <b>1 Networks and Equipment .....</b>       | <b>1</b>  |
| What Is a LAN?.....                         | 1         |
| Evolution of Ethernet LANs .....            | 2         |
| Cable Plants.....                           | 3         |
| Ethernet Clients .....                      | 4         |
| Data Centers .....                          | 4         |
| Carrier Networks.....                       | 6         |
| Ethernet Equipment .....                    | 8         |
| SMB Switches .....                          | 8         |
| Desktop Switches .....                      | 9         |
| Top-of-Rack Switches .....                  | 9         |
| Modular LAN Switches .....                  | 10        |
| Carrier Ethernet Switch/Routers .....       | 10        |
| Wireline-Access Equipment.....              | 10        |
| <b>2 Ethernet Technology.....</b>           | <b>12</b> |
| Network Layers and IEEE 802 Standards ..... | 12        |
| Link Layers .....                           | 14        |
| Spanning Tree and VLANs .....               | 16        |
| Data Center Bridging .....                  | 17        |

|   |           |
|---|-----------|
| Link Aggregation .....                        | 18        |
| Authentication and Security .....             | 18        |
| <b>Carrier Ethernet .....</b>                 | <b>18</b> |
| Provider Bridging .....                       | 19        |
| MPLS .....                                    | 19        |
| Carrier Ethernet Services .....               | 20        |
| OAM and Protection Switching .....            | 21        |
| Timing Synchronization .....                  | 22        |
| Hierarchical Traffic Management.....          | 23        |
| <b>Ethernet Physical Layers .....</b>         | <b>24</b> |
| Fast Ethernet .....                           | 25        |
| Gigabit Ethernet.....                         | 26        |
| 10GbE Optical.....                            | 26        |
| 10GBase-LRM .....                             | 27        |
| 10GBase-CX4.....                              | 27        |
| 10GBase-T .....                               | 27        |
| 40GbE and 100GbE .....                        | 28        |
| Backplane Ethernet Standards .....            | 29        |
| <b>Physical-Layer Interfaces .....</b>        | <b>30</b> |
| <b>Optical Modules .....</b>                  | <b>31</b> |
| <b>Related Protocols .....</b>                | <b>32</b> |
| QoS and DiffServ .....                        | 33        |
| IP Routing and Multicast .....                | 33        |
| Network Management .....                      | 34        |
| Power Over Ethernet.....                      | 35        |
| <b>System Interfaces.....</b>                 | <b>35</b> |
| PCI.....                                      | 35        |
| PCI Express .....                             | 36        |
| <b>3 High-Speed Design Issues .....</b>       | <b>37</b> |
| <b>Signal Integrity .....</b>                 | <b>37</b> |
| Crosstalk and EMI .....                       | 37        |
| Channel Effects: ISI and Reflections.....     | 38        |
| Impairments on Fiber .....                    | 39        |
| Jitter .....                                  | 40        |
| <b>PCB and Connectors .....</b>               | <b>40</b> |
| <b>Signal Conditioning.....</b>               | <b>41</b> |
| Coding .....                                  | 41        |
| Equalization.....                             | 42        |
| <b>Clock and Data Recovery.....</b>           | <b>43</b> |
| <b>Semiconductor Technologies .....</b>       | <b>45</b> |
| <b>4 Gigabit and 10G Ethernet Chips .....</b> | <b>47</b> |
| <b>Switch Chips.....</b>                      | <b>47</b> |
| Common Characteristics .....                  | 47        |
| Performance.....                              | 50        |

|   |           |
|---|-----------|
| System Design .....                                       | 51        |
| Software Considerations .....                             | 52        |
| <b>GbE-Over-Copper PHYs .....</b>                         | <b>52</b> |
| Common Characteristics .....                              | 52        |
| <b>10Gbps Ethernet PHYs .....</b>                         | <b>53</b> |
| Optical-Module Architecture .....                         | 54        |
| Optical-PHY Architecture and Common Characteristics ..... | 55        |
| Copper-PHY Architecture and Common Characteristics .....  | 56        |
| Interoperability and Compliance .....                     | 57        |
| Performance .....   | 58        |
| <b>5 Trends and Market Outlook .....</b>                  | <b>61</b> |
| <b>Technology Trends .....</b>                            | <b>62</b> |
| Switch Chips .....  | 62        |
| 10GBase-T PHY Chips .....                                 | 64        |
| 10Gbps Optical-PHY Chips .....                            | 65        |
| <b>Emerging Technologies .....</b>                        | <b>66</b> |
| Data-Center Technologies .....                            | 66        |
| Carrier Ethernet .....                                    | 68        |
| Physical-Layer Developments .....                         | 68        |
| <b>Market Trends .....</b>                                | <b>69</b> |
| Data Center .....   | 69        |
| Blade Servers .....                                       | 70        |
| Ethernet Backplanes for Embedded Applications .....       | 71        |
| GbE Adoption .....  | 71        |
| 10GbE Adoption .....                                      | 72        |
| Copper vs. Fiber .....                                    | 73        |
| Merchant Switch Chips .....                               | 75        |
| <b>Market Size and Outlook .....</b>                      | <b>76</b> |
| <b>Market Share .....</b>                                 | <b>77</b> |
| <b>6 Broadcom .....</b>                                   | <b>79</b> |
| <b>Company Background .....</b>                           | <b>79</b> |
| <b>Enterprise Switch Chips .....</b>                      | <b>80</b> |
| LAN Switch Chips .....                                    | 80        |
| Data-Center Switch Chips .....                            | 82        |
| System Design .....                                       | 83        |
| <b>SMB Switch Chips .....</b>                             | <b>85</b> |
| <b>Core Switch Chips .....</b>                            | <b>87</b> |
| <b>10Gbps PHYs .....</b>                                  | <b>89</b> |
| Optical Transceivers .....                                | 89        |
| Backplane KR Transceivers .....                           | 91        |
| Copper Transceivers .....                                 | 91        |
| <b>Conclusions .....</b>                                  | <b>92</b> |

|           |                                       |            |
|-----------|---------------------------------------|------------|
| <b>7</b>  | <b>Marvell</b> .....                  | <b>95</b>  |
|           | <b>Company Background</b> .....       | <b>95</b>  |
|           | <b>Switch Chips</b> .....             | <b>96</b>  |
|           | Enterprise Switch Chips .....         | 96         |
|           | Data-Center Switch Chips.....         | 98         |
|           | SOHO Switch Chips .....               | 99         |
|           | System Design.....                    | 100        |
|           | <b>Product Roadmap</b> .....          | <b>102</b> |
|           | <b>Conclusions</b> .....              | <b>102</b> |
| <b>8</b>  | <b>Realtek</b> .....                  | <b>103</b> |
|           | <b>Company Background</b> .....       | <b>103</b> |
|           | <b>Switch Chips</b> .....             | <b>103</b> |
|           | <b>Conclusions</b> .....              | <b>105</b> |
| <b>9</b>  | <b>Vitesse</b> .....                  | <b>107</b> |
|           | <b>Company Background</b> .....       | <b>107</b> |
|           | <b>Switch Chips</b> .....             | <b>108</b> |
|           | Key Features and Performance.....     | 108        |
|           | Design Details.....                   | 110        |
|           | <b>10Gbps PHYs</b> .....              | <b>111</b> |
|           | <b>Product Roadmap</b> .....          | <b>113</b> |
|           | <b>Conclusions</b> .....              | <b>113</b> |
| <b>10</b> | <b>Other Switch Vendors</b> .....     | <b>115</b> |
|           | <b>Centec</b> .....                   | <b>115</b> |
|           | Company Background.....               | 115        |
|           | Key Features and Performance.....     | 116        |
|           | Conclusions.....                      | 118        |
|           | <b>Dune Networks</b> .....            | <b>118</b> |
|           | Company Background.....               | 118        |
|           | Key Features and Performance.....     | 119        |
|           | Conclusions.....                      | 121        |
|           | <b>Ethernity</b> .....                | <b>122</b> |
|           | Company Background.....               | 122        |
|           | Key Features and Performance.....     | 123        |
|           | Design Details .....                  | 125        |
|           | Conclusions.....                      | 127        |
|           | <b>Fujitsu Microelectronics</b> ..... | <b>127</b> |
|           | Company Background.....               | 127        |
|           | Key Features and Performance.....     | 128        |
|           | Conclusions.....                      | 129        |

|                                   |            |
|-----------------------------------|------------|
| <b>Fulcrum .....</b>              | <b>129</b> |
| Company Background.....           | 129        |
| Key Features and Performance..... | 130        |
| Design Details.....               | 132        |
| Product Roadmap.....              | 134        |
| Conclusions.....                  | 134        |
| <b>Tpack .....</b>                | <b>135</b> |
| Company Background.....           | 135        |
| Key Features and Performance..... | 135        |
| Product Roadmap.....              | 137        |
| Conclusions.....                  | 138        |
| <b>Xelerated .....</b>            | <b>139</b> |
| Company Background.....           | 139        |
| Key Features and Performance..... | 139        |
| Internal Architecture .....       | 141        |
| System Design.....                | 142        |
| Conclusions.....                  | 143        |
| <b>11 10Gbps PHY Vendors.....</b> | <b>145</b> |
| <b>AppliedMicro .....</b>         | <b>145</b> |
| Company Background.....           | 145        |
| Key Features and Performance..... | 146        |
| Conclusions.....                  | 148        |
| <b>Aquantia .....</b>             | <b>149</b> |
| Company Background.....           | 149        |
| Key Features and Performance..... | 150        |
| Conclusions.....                  | 151        |
| <b>ClariPhy .....</b>             | <b>152</b> |
| <b>Cortina .....</b>              | <b>153</b> |
| Company Background.....           | 153        |
| Key Features and Performance..... | 154        |
| Conclusions.....                  | 155        |
| <b>Inphi .....</b>                | <b>155</b> |
| <b>NetLogic .....</b>             | <b>156</b> |
| Company Background.....           | 156        |
| Key Features and Performance..... | 156        |
| Conclusions.....                  | 160        |
| <b>Phyworks .....</b>             | <b>161</b> |
| <b>Plato Networks .....</b>       | <b>162</b> |
| <b>Solarflare .....</b>           | <b>164</b> |
| Company Background.....           | 164        |
| Key Features and Performance..... | 165        |
| Conclusions.....                  | 167        |
| <b>Teranetics .....</b>           | <b>167</b> |
| Company Background.....           | 167        |
| Key Features and Performance..... | 168        |
| Conclusions.....                  | 169        |

|  |            |
|--|------------|
| <b>12 Switch and PHY Comparisons .....</b>           | <b>171</b> |
| <b>Comparing GbE and 10GbE Switch Chips.....</b>     | <b>171</b> |
| 10GbE Switch Chips.....                              | 171        |
| GbE Switch Chips With 10GbE Uplinks .....            | 173        |
| GbE Smart-Switch Chips .....                         | 175        |
| Carrier-Ethernet Switch Chips .....                  | 178        |
| Fabric Chips.....                                    | 182        |
| <b>Comparing 10Gbps PHYs.....</b>                    | <b>183</b> |
| Optical Transceivers.....                            | 183        |
| 10GBase-KR Transceivers .....                        | 185        |
| 10GBase-T Copper PHYs.....                           | 186        |
| <b>Conclusions.....</b>                              | <b>187</b> |
| <b>13 Conclusions.....</b>                           | <b>189</b> |
| <b>Market Directions .....</b>                       | <b>189</b> |
| <b>GbE Vendor Outlook .....</b>                      | <b>191</b> |
| <b>Carrier Ethernet Switch Vendor Outlook .....</b>  | <b>192</b> |
| <b>Emerging 10GbE Switch and Fabric Vendors.....</b> | <b>192</b> |
| <b>10GbE PHY Vendors .....</b>                       | <b>194</b> |
| <b>Closing Thoughts .....</b>                        | <b>195</b> |
| <b>Appendix: Further Reading.....</b>                | <b>197</b> |
| <b>Index.....</b>                                    | <b>199</b> |

# List of Figures

|   |    |
|---|----|
| Figure 1-1. Typical LAN architecture .....  | 2  |
| Figure 1-2. Typical data-center components .....                                  | 5  |
| Figure 1-3. Generic network architecture .....                                    | 7  |
| Figure 2-1. IEEE 802 standards .....  | 13 |
| Figure 2-2. IEEE 802.3 basic frame format .....                                   | 14 |
| Figure 2-3. VPLS switch conceptual model .....                                    | 21 |
| Figure 2-4. Hierarchical traffic management .....                                 | 23 |
| Figure 2-5. Ethernet physical layer .....   | 24 |
| Figure 2-6. 10G Ethernet physical layer .....                                     | 26 |
| Figure 2-7. Layer model for 40G/100G Ethernet.....                                | 28 |
| Figure 2-8. Optical module size, power, and estimated price .....                 | 32 |
| Figure 3-1. Transmitted data eye (left) and received data eye (right) .....       | 39 |
| Figure 3-2. Transmitted eye with pre-emphasis (left) and received eye (right) ... | 42 |
| Figure 3-3. Impulse response and equalization .....                               | 43 |
| Figure 3-4. Conceptual diagram of a phase-locked loop.....                        | 44 |
| Figure 4-1. Block diagram of a typical GbE switch .....                           | 48 |
| Figure 4-2. Single-port GbE PHY simplified block diagram.....                     | 53 |
| Figure 4-3. Architecture of a generic optical module .....                        | 54 |
| Figure 4-4. 10Gbps serdes architecture .....                                      | 55 |
| Figure 4-5. Block diagram of a generic 10GBase-T PHY.....                         | 57 |
| Figure 4-6. Circadiant tester results for 10GBase-LRM .....                       | 59 |
| Figure 5-1. Forecast for Ethernet switch chips, 2008–2013.....                    | 71 |
| Figure 5-2. Forecast for 10G Ethernet switch chips, 2008–2013 .....               | 72 |
| Figure 5-3. Forecast for 10G Ethernet PHY shipments, 2008–2013.....               | 74 |
| Figure 5-4. Merchant Ethernet switch-chip revenue by speed, 2007–2008.....        | 76 |

|   |     |
|---|-----|
| Figure 5-5. Gigabit Ethernet switch-chip and PHY market share, 2007–2008 .... | 77  |
| Figure 6-1. Broadcom 48×GbE+2×10GbE stackable Layer 3 switch .....            | 84  |
| Figure 6-2. Broadcom Core XGS chip set in a data-center switch .....          | 89  |
| Figure 7-1. Block diagram of Marvell 48×GbE+2×10GbE Layer 3 switch .....      | 101 |
| Figure 9-1. Vitesse 24×GbE stackable Layer 2 switch .....                     | 111 |
| Figure 10-1. Centec 48×GbE+4×10GbE Carrier Ethernet switch design .....       | 117 |
| Figure 10-2. Ethernity Carrier Ethernet application.....                      | 126 |
| Figure 10-3. Fulcrum FM4000 in a two-stage fat-tree architecture.....         | 133 |
| Figure 10-4. Block diagram of Xelerated AX340 architecture .....              | 141 |
| Figure 10-5. Xelerated AX340 in 16-port GPON line card.....                   | 142 |
| Figure 11-1. Plato 10GbE PHY architecture with analog signal processing ..... | 163 |

## List of Tables

|   |     |
|---|-----|
| Table 2-1. OSI reference model .....  | 13  |
| Table 2-2. Ethernet PHY standards .....                                       | 25  |
| Table 5-1. Forecast for 10G Ethernet switch chips, 2008–2013.....             | 72  |
| Table 5-2. Forecast for 10G Ethernet PHY shipments, 2008–2013.....            | 74  |
| Table 5-3. Merchant Ethernet switch-chip revenue by speed, 2007–2008 .....    | 76  |
| Table 5-4. Gigabit Ethernet switch-chip and PHY market share, 2007–2008 ..... | 78  |
| Table 6-1. Key parameters for selected Broadcom StrataXGS 4 switch chips....  | 82  |
| Table 6-2. Key parameters for selected Broadcom SMB switch chips .....        | 86  |
| Table 6-3. Key parameters for Broadcom XGS Core fabric.....                   | 88  |
| Table 6-4. Key parameters for Broadcom 10Gbps transceivers.....               | 90  |
| Table 7-1. Key parameters for Marvell Prestera-DX enterprise products .....   | 97  |
| Table 7-2. Key parameters for Marvell Prestera-CX products .....              | 99  |
| Table 7-3. Key parameters for Marvell SOHO switch chips.....                  | 100 |
| Table 8-1. Key parameters for Realtek GbE switch chips.....                   | 104 |
| Table 9-1. Key parameters for selected Vitesse GbE switch chips.....          | 109 |
| Table 9-2. Key parameters for selected Vitesse 10GbE PHYs.....                | 112 |
| Table 10-1. Vendors of GbE and 10GbE switches .....                           | 115 |
| Table 10-2. Key parameters for Dune Petra devices.....                        | 119 |
| Table 10-3. Key parameters for Ethernity ENET devices.....                    | 123 |
| Table 10-4. Key parameters for Fulcrum switch chips .....                     | 131 |
| Table 10-5. Key parameters for Tpack TPX devices.....                         | 136 |
| Table 10-6. Key parameters for selected Xelerated switch chips.....           | 140 |
| Table 11-1. Vendors of 10Gbps Ethernet PHYs .....                             | 145 |
| Table 11-2. Key parameters for AppliedMicro 10Gbps PHY chips.....             | 147 |
| Table 11-3. Key parameters for Aquantia PHY products .....                    | 150 |

|  |     |
|--|-----|
| Table 11-4. Key parameters for NetLogic PHY chips .....                | 157 |
| Table 11-5. Key parameters for NetLogic SFI/XFI retimer devices .....  | 159 |
| Table 11-6. Key parameters for NetLogic backplane transceivers.....    | 159 |
| Table 11-7. Key parameters for Solarflare PHYs.....                    | 166 |
| Table 11-8. Key parameters for Teranetics second-generation PHYs.....  | 169 |
| Table 12-1. Comparison of 10GbE switch chips .....                     | 172 |
| Table 12-2. Comparison of GbE switch chips with 10GbE uplinks.....     | 174 |
| Table 12-3. Comparison of 24×GbE smart-switch chips .....              | 176 |
| Table 12-4. Comparison of single-chip 8×GbE smart-switch devices ..... | 178 |
| Table 12-5. Comparison of Carrier Ethernet switch chips.....           | 180 |
| Table 12-6. Comparison of switch-fabric products.....                  | 182 |
| Table 12-7. Comparison of 10Gbps EDC components .....                  | 184 |
| Table 12-8. Comparison of 10GBase-KR dual PHYs .....                   | 185 |
| Table 12-9. Comparison of 10GBase-T PHY chips .....                    | 186 |

## 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

## ***The Linley Group***

The Linley Group is the leading vendor of technology analysis on networking, communications, mobile and wireless semiconductors, providing a unique combination of technical expertise and market knowledge. We help clients understand the market for these devices, their product requirements, the choices available, and which ones are best for a particular application.

### **Technology Reports**

For clients desiring off-the-shelf assistance, we offer standard reports on specific topics. These in-depth reports provide an overview of a particular market segment, including market size and share, key trends, and expected developments. The reports then analyze all available products, highlighting their strengths and weaknesses. Readers find our reports particularly useful when they are selecting a vendor or partner.

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.

Our reports cover Ethernet chips, network processors, communications processors, embedded processors, security processors, and high-speed interconnect as well as processors and connectivity chips for mobile and wireless devices. Additional titles are in development. We offer our reports in paper and PDF formats. Multiple paper copies and multiuser PDF licenses are available at significant discounts.

### **Consulting Services**

The Linley Group offers customized consulting services for clients that need help with a specific issue. The Linley Group has served a variety of

clients, including Altera, AppliedMicro, AMD, ARC, Bay Microsystems, Brocade, Cavium, Cortina, Cypress, Exar/Hifn, EZchip, Fulcrum, Freescale/Motorola, Gennum, HP, IBM, IDT, Intel, LSI/Agere, Marvell, Mindspeed, MIPS, NetLogic, Raytheon, Sony, Symantec, Transmeta, Wintegra, Xelerated, Xilinx, Crosslink Capital, Piper Jaffray, and Ziff Brothers Investments. Typical consulting projects include the following:

- Helping established semiconductor vendors with competitive analysis, messaging, and positioning for upcoming product launches
- Working with young companies to improve their product definition to best differentiate themselves from potential future competitors
- Assisting equipment vendors to identify the core silicon most appropriate for their application
- Providing valuable insights and technical due diligence to investment firms 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.

## Events

The Linley Group presents focused seminars and conferences that analyze products and design strategies in a particular technology segment, providing information that engineers can immediately use to improve their designs. These one- and two-day events feature in-depth technical presentations from our own analysts as well as leading technologists from the industry. Thousands of people have already attended.

Please check our web site for a list of upcoming dates, topics, and locations. The web site also offers the proceedings (slides) from past events free of charge.

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# Preface

## ***What This Report Covers***

Our coverage includes commercially available chips for high-volume Gigabit Ethernet (GbE) and 10 Gigabit Ethernet (10GbE) designs. This edition extends our coverage from local-area network (LAN) components to Carrier Ethernet devices for use in access, metro-area (MAN), and wide-area (WAN) networks. We consider GbE PHYs to be mature products and have excluded them from this year's coverage. We do not cover custom chips (ASICs) designed by or for a specific OEM, as these devices are not available to other customers as merchant products.

This report covers GbE and 10GbE switch chips but not Fast Ethernet (FE) switch chips with GbE uplinks. For Carrier Ethernet applications, we cover switch chips, most of which run at GbE data rates. For PHY products, we cover 10Gbps serdes devices used in optical modules and on line cards. We also cover 10GBase-LRM PHYs, which are designed to compensate for electrical dispersion (EDC). For 10G Ethernet over copper (10GBase-T), we cover the leading PHYs. This report also covers switch fabrics, which are typically used in highly scalable systems.

## ***Who Should Read This Report***

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

- Engineers designing Ethernet switch products or systems that embed an Ethernet controller or switch
- Marketing and engineering staff at companies that sell related chips who need more information on Ethernet chips
- Technology professionals who wish an introduction to Ethernet chips
- Financial analysts who desire a detailed analysis and comparison of GbE, 10GbE, and switch-fabric semiconductor 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 communications 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**

The first two chapters provide a tutorial and overall introduction to networking and Ethernet technology. Chapter 1 provides background information on LANs, data centers, Carrier Ethernet, and related equipment; Chapter 2 focuses on the details of Ethernet technology. The appendix provides pointers to additional sources of tutorial information. Readers who are familiar with Ethernet may wish to skim or skip these chapters.

Chapter 3 provides background and terminology for high-speed interconnect technology and system design. Chapter 4 defines and describes the major types of GbE and 10GbE silicon, setting the stage for later chapters that study individual products. Chapter 5 provides a look at current technology and market trends as well as market size and vendor share by product segment.

Chapters 6 through 9 cover the four vendors—Broadcom, Marvell, Realtek, and Vitesse—that have a major presence in multiple GbE and 10GbE segments. For each vendor, the report provides a company overview, strategic analysis, detailed product descriptions, design examples, a roadmap of future products where available, and overall conclusions.

Chapter 10 covers GbE and 10GbE switch chips from Centec, Dune, Ethernity, Fulcrum, Tpack, and Xelerated. Chapter 11 covers 10GbE PHY products from Aquantia, AppliedMicro, ClariPhy, Cortina, NetLogic, Plato Networks, Phyworks, Inphi, Solarflare, and Teranetics.

Chapter 13 compares Ethernet switch products in selected segments, including 10GbE switches, switch fabrics, and multiple GbE-switch types. It also compares Ethernet PHY products in selected segments, including 10GBase-SR serdes, 10GBase-LRM products, and 10GBase-T PHYs. Chapter 14 concludes the report with our high-level analysis of the market and presents our outlook for the leading vendors.

## **Acknowledgments**

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# Executive Summary

The Ethernet component market in 2008 had annual revenue greater than \$2 billion. With the global recession of 2009, however, we project the market will shrink to less than \$2 billion. We expect the Ethernet market to recover in 2011 and continue to grow to \$3 billion by 2013. In this report, we break down this growth for switches and PHYs for different data rates. We also break down the market share for each of the major vendors of switches and PHYs.

Beneath this overall growth, there are significant trends and key players. The major trends include gradual conversion of low-cost SMB/SOHO switches from Fast Ethernet (FE) to Gigabit Ethernet (GbE), deployment of 10G Ethernet (10GbE) in data centers, and growth in Carrier Ethernet switches. The SMB/SOHO transition is creating products that have high integration and low power dissipation. The leading chip vendors for SMB/SOHO products are Broadcom, Marvell, Realtek, and Vitesse. We examine the strategies, current products, and future plans for each of these vendors.

Data centers are consolidating both servers and storage resources. Virtualization allows these resources to be shared and increases server utilization. This increase requires greater I/O bandwidth and thus drives the need for 10GbE server and switch ports. 10G Ethernet is also the long-term solution for converging the storage and data networks. To better support data-center applications, the IEEE is enhancing Ethernet for lossless operation and improved QoS. In addition, the recently finalized Fibre Channel over Ethernet (FCoE) standard defines the transmission of storage traffic over an Ethernet channel.

The merchant market for 10GbE, however, has been slow to develop, resulting in several casualties. In the switch market, Fujitsu has discontinued product development and is not pursuing new designs. In 2009, Marvell joined Broadcom and Fulcrum as a 10GbE switch silicon vendor. We analyze the products from these vendors on the merits of each product for different applications.

In addition to switches, this report covers 10GbE PHYs designed for optical media, copper media, and backplanes. Most OEMs are adopting SFP+ optical modules, which enable multiport 10GbE line cards. SFP+ also defines a direct-attach option that provides a low-cost solution for connecting racks in a data center. OEMs are also looking at 10GBase-LRM to

reduce the cost of optical modules, but deployments of this technology continue to be small.

The leading players for optical PHYs include AppliedMicro, Broadcom, ClariPhy, Cortina, NetLogic, Phyworks, and Vitesse. Several of these vendors modify their optical PHYs for 10GbE backplanes, which are already being adopted by major OEMs such as HP. Clearly, there are too many vendors chasing this market; consolidation is inevitable.

Owing to high power dissipation and cost, the volume for 10GbE-over-copper (10GBase-T) PHYs has been small, but most OEMs expect these PHYs to eventually ship in greater volumes than their optical counterparts. Among the several vendors targeting 10GBase-T PHYs, Teranetics was the first to deliver a production-ready device that consumes less than 6W. For 2010, the race is on to produce a sub-4W 10GBase-T PHY and integrate Energy Efficient Ethernet (EEE) features. Other vendors in this category include Aquantia, Broadcom, Plato Networks, Solarflare, and a couple of vendors yet to announce products.

Beyond 10Gbps, the IEEE 802.3ba working group is defining physical-layer standards for Ethernet at 40Gbps and 100Gbps. These standards have progressed sufficiently to enable sampling of silicon products by the end of 2009. The initial products include FPGAs from Xilinx and Altera as well as PHYs from NetLogic.

Carrier Ethernet (CE) represents another growth area for vendors of Ethernet switches and PHYs. The requirements of Ethernet switches for carrier systems differ from those of enterprise switches. Even among CE applications, products for access systems have different requirements than those for edge systems. Some vendors are enhancing their existing enterprise-focused switch chips to meet CE requirements. Additionally, several vendors are either sampling or developing switch chips optimized for CE applications. These vendors include Centec, Ethernity, Tpack, Vitesse, and Xelerated in addition to market leaders Marvell and Broadcom.

Within the data center, large enterprise, and metro/wide-area networks, switch fabrics are needed to meet high-end scalability, availability, and performance requirements. Dune Networks is the leading supplier of switch-fabric chips, outlasting the early group of startups. In 2009, Broadcom significantly updated its switch-fabric chips, which now offer several unique features. With two choices of excellent switch fabrics, more OEMs may be enticed to move from ASICs to merchant silicon. To help with this transition, we offer an independent comparison of these fabrics.

For each of these markets—SMB/SOHO, enterprise, data center, and Carrier Ethernet—this report provides technical background, typical systems, and market trends. The report analyzes the vendors and their products for these markets. Finally, we compare products in each category and provide guidance on the best product for different applications.