New Markets for Telecom and Datacom Lasers: 2009 to 2013

Chapter One

Expected Release in August 2009

Chapter One: Introduction

1.1 Background to this Report

These are not happy times for the communications laser business, most of the laser firms have been hit by the worldwide recession and the recent financial data coming out of the publicly traded laser, transceiver and (more generally) optical components firms has not been especially encouraging. Nonetheless, from what CIR has been told by firms in this space, however, they do not seem to be having things as bad as they did during the optical networking meltdown of the early 2000s.

Much of 2009 and 2010 will see the communications laser business digging itself out of the mess created by the worldwide economic slump. After that the medium-to-long term prospects for these devices now look quite good, but in volume terms only. While there is little doubt that most of the laser firms currently active will survive through the current downturn, they appear to face growing challenges when it comes to pricing. As we discuss in this chapter and throughout this report, this pricing challenging is likely to come from improved designs and manufacturing approaches (especially integration) that promise significant cost declines.

The new volume opportunities are being created by profound changes that (at last) are beginning to occur in public networks, data centers and enterprise networks. These changes are in many ways the ones that were predicted for optical networking a decade ago before the telecom business imploded at the beginning of this decade. These didn't happen then, but they are beginning to happen now.

1.1.1 Long-Haul and Lasers: 100 Gbps and Tunable

In the long-haul segment of the public network, the scene now seems set for a major upgrade of carrier backbones. This will lead to enhanced demand for high-performance DFB and FP lasers and this new demand will itself be driven and shaped by two interrelated trends. The upgrade of major carrier backbones to data rates considerably higher than at present is one of these trends. The other is the transition from a SONET to a WDM infrastructure.

Need for 20/25 Gbps and 100 Gbps lasers: Although a year or two back most of the carriers were talking about 40 Gbps upgrades, many are now talking about 100 Gbps core upgrades instead. There is nothing new about an order of magnitude leap in core data rates; the last big change in this area was 1 Gbps to 10 Gbps. However, the move to incorporate 100 GigE into carrier networks will be much more challenging from the laser maker's perspective than the upgrades to long-haul SONET/SDH OC-768 that were being proposed a couple of years back. There are no lasers capable of supplying serial 100 Gbps solutions at the present time and even 100 Gbps solutions based on 4 x 25 Gbps parallel solutions are a technological challenge.

 © 2009 Communications Industry Researchers, Inc.

Ethernet replaces SONET and impact laser markets: The replacement of OC-768 by 100 GigE in the core networking strategy of major carriers appears to signal that the longstanding battle between SONET and Ethernet is over and that Ethernet won. Actually, things are not quite that simple. For a start, the long prophesized "death of SONET/SDH" is not near in the sense that telephone companies are not going to stop installing SONET/SDH ports; these will be useful for many years to come. Indeed, Chinese carriers are currently actively building OC-48 networks at the moment, for example, and one laser firm that we spoke to for this study told us that it had actually seen an increase in its SONET/SDH business. So lasers for SONET/SDH boxes will still sell in big numbers for some time to come.

SONET/SDH is not really an "opportunity" any more in the sense that it would hardly be worth the while of a firm to get into the SONET space for the first time, except in circumstances where its fixed marketing costs were minimal; for example if a firm could get into the SONET space with existing products and for customers that were easy/inexpensive to reach. But SONET transceivers/transponders will become increasingly commoditized and so will the lasers in them.

WDM replaces SONET for core networking/transport and impacts laser markets: The decline of SONET/SDH marks not only a big shift towards Ethernet, but also a shift from TDM to WDM. WDM has been in use for many years in the public network, of course, but mostly in the long-haul segment. It has been slow to come to the metro segment, but the consensus is that WDM deployment in the metro space will begin to accelerate now.

The impetus behind WDM use is – as it has always been – to grow capacity dramatically. However, the thinking around this is now a little different than before. Until very recently there was a tacit assumption that as the network needed more bandwidth, part of the response would be that the SONET/SDH core transport network would simply grow its capacity. It seems now that there will be no more SONET/SDH standards beyond OC-768 and higher bandwidths will be achieved by optically muxing together SONET/SDH (and Ethernet) data.

SONET/SDH is no longer central to the story; it is melting away as a core networking technology. In its place WDM will become much more widely and strategically used throughout the public network as an infrastructure technology. This shift will be marked by the gradual adoption of the ITU's "Optical Transport Network" (OTN) standards, which does for WDM what the SONET/SDH hierarchy did for TDM a couple of decades ago. CIR believes that this shift to WDM will mean the arrival of a much higher volume market for tunable lasers than at present, along with a substantial new market opening up for lasers in ROADMs. The re-architecting of the core network in WDM form also raises the question of whether new roles will open up for pump lasers as optical amplifiers assume a new prominence.

© 2009 Communications Industry Researchers, Inc.

1.1.2 Lasers at the Low-End: PONs and Next Generation Data Networks

Lasers for the new carrier network will be high value-added products that can be sold on the basis of performance and superb engineering. Indeed, as we have already noted, many of the laser requirements for the highest performing networks currently under development have yet to reach full commercialization.

PON laser markets continue to grow: But the low-end of the laser market now looks on the verge of growth too. The big hope for volume sales of FPs and DFBs seems to be from the continued growth of FTTH. This is mostly (but not exclusively) implemented using PONs and has proved surprisingly resilient to the worldwide economic downturn. This is because Internet users must make use of broadband connectivity these days to get the full benefit of the services offered over the Internet and PONs offer a way to provide broadband with minimized operational expenditures for the telco. (This is less obviously the case for non-telco service providers.)

The lasers used for most of the PONs being deployed today are fairly conventional, but the likelihood that we will see the next generation of PON deployment that will operate at 10 Gbps and/or use WDM will create some interesting opportunities and challenges for laser makers.

New patterns for copper deployment shape laser opportunities for datacom: In the data center and enterprise networks, optical LANs, SANs and short-haul interconnects (of the InfiniBand kind) have been dominated by VCSELs technology for many years and will continue to be so. In addition, this part of the laser market has been hit in recent quarters by a serious decline in IT spending. This is probably going to hurt laser sales over the rest of 2009 and into 2010. However, longer term the prospects for laser in the “enterprise networking” segment look better than they have done for some time, although again, we are specifically talking about in volume not in value terms.

In the not-too-dim-and-distant past, fiber optics was mostly used in exceptional circumstances in data com. Thus, for example, fiber optics has long been used for LAN extension, even the earliest IEEE LAN standards provided for this. But the need to extend LANs in this way is an unusual occurrence. Fiber optics obviously becomes more likely to be used in a given networking technology the higher the data rate requirements for that technology and laser volume demand from this technology increases once this technology becomes mainstreamed.

There is, however, a caveat. Fiber optics is often deployed as a quick way to get to higher speeds, but once some time has gone by, clever ways are found to deploy copper. Of course, using copper becomes harder the higher the data rate involved; specifically the copper cable becomes thicker and more expensive and copper can be used over shorter and short distances as the data rates go up.

 © 2009 Communications Industry Researchers, Inc.

Still, the ability of copper to serve at higher data rates has been astonishing; 10 years ago nobody would have taken seriously the concept of using copper connections operating at 100 Gbps over a useful distance. But, this is exactly what is now being proposed for the 100 GigE standard that is being developed. Obviously, to the extent that copper can be used rather than optical connectivity, the opportunities for laser makers are constrained.

GigE is a good example of how fiber has been used at first and then has been overtaken by copper in the LAN. Initially Gigabit networking was mostly a fiber optic standard, because fiber was all that was available initially that could operate at Gigabit speeds, but GigE fairly quickly evolved to being a copper standard. Today, GigE is widely deployed on almost all servers and desktops (and many laptops) and it is mostly implemented in copper; the fact that the servers and PCs involve very short reach connections make the use of copper more feasible and the fact that PC shipments outnumber data center equipment shipments by orders of magnitude means that copper has easily to dominate the GigE market.

It is significantly harder to operate 10 Gbps networks over copper than it is to do so with GigE. The CX4 standard for 10 GigE has been around for a while, but has never really taken off in volume terms. An improved "T" format is now available and at least some observers expect that will ultimately take up a large share of 10 Gbps networking; as 10 GigE begins to be used on higher end PC. This is certainly plausible, and if this is what happens at 10 Gbps, it will simply be a repeat performance of the scenario that we have seen played out over the past few years with GigE and with the same limiting effect on the laser business.

But this time, there are other issues and possibilities. In particular, there is the potential that at long last optical networking will not lose huge chunks of the market as an Ethernet standard matures and that optical networking interfaces will start to become common on desktops (not just servers) and eventually on laptops too. With this in mind, Intel has been pushing the idea of using active optical cabling as a universal optical interface for PCs and we note also that the latest USB interface standard has an optical option, and in the next iteration of USB that optical option may operate at 10 Gbps The adoption of a standard optical interface for PCs at 10 Gbps in whatever form would mean a huge leap forward in volume requirements for lasers.

There do seem to be good reasons to suppose that PCs in the not-too-distant-future will need to make extensive use of 10 Gbps interfaces. This is primarily because processor speeds are beginning to catch up with 10 Gbps in the sense that they now actually need 10 Gbps speeds to support the data throughput of which they are capable. Formerly, most processors simply weren't capable of "sucking up" or "throwing out" data at 10 Gbps. Soon this kind of power will become commonplace and will be

© 2009 Communications Industry Researchers, Inc.

justified at the application layer by the burgeoning need for IP-based video. As the next generation of processors spread from servers to desktops to laptops, 10 GigE seems likely to go down the same "mass market" road as GigE has done in the past five years or so. Good news for the VCSEL business it would seem if the garden variety of 10 GigE interface ends up being optical.

Unfortunately, no one really knows for sure whether "mass market" 10 GigE will be optical or not. It does seem certain that at some time in the future PCs will come with optical interfaces as standard, it is far from clear that the time is now. If optical interfaces for PCs do turn out to be an idea whose time has come around at last, the volume opportunity for VCSELs will shoot up, but there will be even more price pressure on laser makers serving the datacom market than there is at the present time.

Laser requirements for the data center: Yet another wrinkle on the whole optical datacom market is the fact that while the PC interface segment would presumably be multimode, there is likely to also be an expanding market for single-mode/LW lasers, since data centers and enterprise networks are making a slow transition to single-mode. From the perspective of the VCSEL maker, one issue that may have to be addressed in this context is the credibility of LW VCSELs. These have been available at relatively low data rates for some time, but a new generation of 10 Gbps LW VCSELs are about to appear and in our research we have determined that there is considerable skepticism about whether LW VCSELs at high speeds represent a viable technology.

The data center and related high-performance computing (HPC) market also opens up some other opportunities for laser makers. One might have expected this to have been one of the first places that fiber optics would have made its presence felt and to some extent this is the case. However, mostly, until very recently, copper-based InfiniBand (and Escon) has served this market very well. Fiber optics is quickly making its impact felt in this area too.

HPC centers have always been at the leading edge of high-speed networking and have been involved in many of the early trials of the latest datacom and telecom technologies. These centers were among those that lobbied successfully for a 100 GigE standard, for example. However, it is not so much the need for especially higher data rates that has really given the impetus for the use of fiber optics in the large data center, but rather the need to avoid bulky copper cabling, which, at times, is now heavy that floors need to be specially supported to bear the weight. Replacing copper with fiber in this environment can avoid this major problem; moving to ultra-high data rates may be a secondary consideration.

There is various ways that this could be done. For example, as early as the 1990s, a few very large data centers were already making use of WDM boxes for concatenating and managing data. The areas of fiber optics that is attracting much of the interest these days for use in data centers are parallel optics and the related area of active optical cabling (AOC). Active optical cabling especially has garnered

© 2009 Communications Industry Researchers, Inc.

excitement in the industry because it provides a direct plug in replacement for conventional data center copper and even more so, because it seems to potentially address very high volumes markets in the consumer electronics area.

The data center is therefore yet another area where an area that didn't formerly make much use of fiber optics is now beginning to adopt optics and, once again, this is good news for the for the laser maker. The presumption is usually that this new market will belong to the VCSEL maker. And this is probably correct, although the dominance of the VCSEL is not a completely settled matter. In particular, we note that the well-respected Luxtera AOC solution does not use VCSELs, but rather derives its economics by spreading the cost of a DFB laser over multiple channels using silicon photonics.

1.1.3 Beyond the Communications Market: Of Mice, Computer Interconnects and Consumer Electronics

This report specifically deals with communications lasers, which we take to mean those lasers used in data centers, SANs, LANs, MANs and WANs. However, lasers that are, more or less, identical to those used in these traditional networking applications also have some potential markets that are not usually referred to as "communications" markets. This has always been true to some extent; pump lasers used for optical amplifiers are quite similar to those used in certain medical markets and a few laser companies have attempted to leverage their core pump laser technology to both markets.

However, this kind of thing was of marginal importance until very recently. What has changed is that potentially there are large markets for lasers very like the ones used in communications. These markets could swell the addressable markets for product range ranges supplied by lasers firms that have traditionally focused on communications lasers. By doing so, they enhance the potential for economies of scale, especially in the areas of fabrication and R&D for communications lasers. A second reason for thinking about these newer areas alongside those that are usually referred to "networking" is that sometimes the distinction seems to be more a matter of definition than anything else. An optical interface designed to join up a DVD player and a television really isn't so very different – at least in terms of function -- from one intended to connect a storage system and a server.

There are three areas outside of traditional networking areas that it seems reasonable to suppose will supply new business revenues for manufacturers of lasers which, until recently, have been sold into traditional data communications markets. The first of these areas consists of lasers for laser mice, which recently became the largest applications for VCSELs, surpassing the traditional communications market for the first time. The second of these markets is the consumer electronics market. We have already mentioned the incorporation of optics in the next-generation USBs that are beginning to appear

© 2009 Communications Industry Researchers, Inc.

and note also that much of the excitement generated by AOCs is that they will find a bulk market in the "videophile" market serving as HDMI extenders and high quality cabling for home theaters. Finally, there is the potential for a market for internally connecting up computing and telecommunications equipment, first board-to-board and then chip-to-chip.

1.1.2 ASPs and Innovations

So far the story we have told should be very encouraging to laser makers. If the need for IT and carrier Capex is excepted, the future seems to be one of growth in most of the market segments served by communications lasers, with some additional new markets expected to pop up in the coming years. However, the fly in the ointment is that the pressure on ASPs is huge and likely to remain that way. Many laser firms therefore face the prospect of expanding volumes, but only marginally increasing sales revenues at best.

This phenomenon is partly due to where the newer opportunities are or are appearing. PONs, the one existing communications laser business that continues to expand, has always been very cost sensitive, in part because there are a relatively small number of large customers for PONs; the large telcos, such as Verizon and NTT primarily. The consumer electronics and PC applications that are mentioned above are all very cost sensitive by the very nature of the markets themselves; nobody is likely to pay $200 for a laptop interface.

A number of strategies are available to laser firms to head off the problems caused by declining ASPs. These include the economies of scale mentioned above produced by spreading fabrication and R&D costs over larger production volumes. Another possible route is through the economies of scale – and other economies -- produced through the consolidation of companies. Consolidation of companies in the optical components space has been a feature of the industry since at least the end of the optical boom industry and it continues. The most notable merger recently has been that between Bookham and Avanex. This merger was carried out for a number of different reasons, but lasers certainly figured high in the strategic thinking of the management involved. Specifically, Bookham had a strong pump laser product and will now be selling this product to Avanex's successful optical amplifier business. (Avanex was formerly supplied with pumps by JDSU.) Of course, laser-related issues were not the only driving force for this merger; consolidation of sales forces played as a big a role.

A major force for the good in combating future ASP collapse is optical integration and certain kinds of packaging innovation. CIR has been advocating optical integration as an important part of business strategy in the optical components field for many years, but now it seems to have become essential to survival. Since laser makers are very much price takers these days, optical integration provides some potential to reduce BOMs, in much the same way that it does in the electronics industry. Also because, it adds flexibility/new possibilities for design it provides a way for laser makers to distinguish itself in the

 © 2009 Communications Industry Researchers, Inc.

marketplace and ultimately this can be reflected in better margins. During the optical networking boom days, many kinds of optical integration were developed; hybrid, monolithic, parallel and serial. Almost all of these approaches are now being used in laser, TOSA and transceiver applications. The one kind of optical integration that has never really manifested itself is monolithic optoelectronic integration; laser firms seem to prefer to work in partnership with networking silicon firms.

1.2 Goals and Scope of this Report

Given all of the above the communications laser industry seems to face some particularly crucial strategic decisions at the present time and clearly the way forward for the communications laser business will not be an easy one and the decisions that product and planning managers in this business will have to take will be challenging ones. With that in mind, CIR has produced this report to determine and quantify where the major opportunities are to be found in the telecom and datacom laser business over the next five years.

The report covers the full range of laser architecture and technologies (DFB, FP, DBR, VCSEL, tunables, pump lasers, etc.) and materials platforms. We also examine the laser requirements, market drivers and challenges for each of the main application areas; access/FTTH, metro, long-haul, LAN, SAN and HPC/InfiniBand environments. While this report is primarily a report about communications lasers, we also take a look at markets that are very closely related to traditional communications markets for lasers. Certain kinds of consumer electronics devices, it is now being suggested, will use optical interfaces in the near term future, for example. This would barely be considered an example of "networking" in the networking community. However, the kinds of lasers used in this application are very largely identical to those used in networking proper and more or less the same thing can be said about the lasers used in laser computer mice.

The scope of the report is comprehensive in terms of data rates supported. However, because the report is primarily concerned with new opportunities, we provide a special focus on networks operating at leading edge rates; which is to say at 10, 40 and 100 Gbps. In some cases, these are rates at which there laser technology is still some way from commercialization, especially at longer reaches. And while much of the analysis in this report is about technology, another major focus is – for the reasons explained above – average selling prices (ASPs), which are under extreme pressure in this business. In this environment, keeping costs low enough to produce respectable gross margins will be critical to the firms in this space and this goal will be achieved in part from innovations in packaging and integration, so these are also topics that we return to throughout the report.

While the forecasts at the end of the report are for five years only, we also comment on likely developments in the laser space beyond that timeframe including quantum dot lasers and silicon lasers.

© 2009 Communications Industry Researchers, Inc.

We have also included in this report an analysis of the strategies being adopted by laser firms both large and small and, as with all CIR reports, this study also includes a detailed five-year forecast of the markets covered.

1.3 Methodology of this Report

CIR has been covering the communications laser and transceiver/transponder markets for well over a decade and comes to this market with the ability to analyze the market from an insider's perspective. In addition, to provide the depth of knowledge required to create a market study of this kind CIR researchers have interviewed major laser and transceiver/transponder firms to "take the temperature" of the current market in the light of the worldwide recession; likely expenditures by service providers, IT departments, and network managers over the next few years and the rising tide of technological change.

CIR's primary research was supplemented with information from previous CIR reports covering related areas as well as knowledge gained during many custom consulting assignments related to optical components and modules. Product data sheets, marketing documents, and company Web sites also additional sources of secondary information.

The forecasting methodology used here is explained more fully later in the report, but ultimately goes back to assessment of port counts, some of which are provided in the main body of the report. These are derived by information gained from equipment manufacturers and end users combined with familiarity of the current needs of networks. Forecasts are broken down by laser technology, networking type and data rates as appropriate.

1.4 Plan of Report

Chapter Two of this report provides an analysis of the current state of technology for communications lasers including both established and evolving ones. The report continues with Chapter Three in which we examine the main markets for communications lasers, extending our analysis from previous CIR reports in this series to related consumer electronics and computing markets. Finally, based on our conclusions in Chapter Two and Three, we provide a detailed quantitative forecast of communications lasers of all kinds.

For additional details about this report please visit the CIR website at www.cir-inc.com or contact our offices at 804-360-2967 or via email at sales@cir-inc.com.

© 2009 Communications Industry Researchers, Inc.