The Embedded Optics Market: COBO and Its Alternatives: 2017-2026

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Report Description

CIR believes embedded optics is creating a major business opportunity for optical components, modules and communications chips companies. Embedded optics has been available as a niche technology for many years, but the recent success of the Consortium for on-Board Optics (COBO) has transported embedded optics into the limelight and has made embedded optics a key focus of firms expecting to build their businesses around next-generation optics.

It is tempting to treat COBO as just another MSA. However, CIR believes that something more important is going on here. As we see it, COBO is more similar to the old ATM Forum; an organization that took data communications and telecommunications in a whole new direction. We have been told for more than 15 years that an essential for high-speed modules is that they be pluggable, while embedded optics teaches completely the opposite doctrine. Embedded optics also imply an entirely new direction for switch design – one in which the optics and electronics are positioned in close proximity.

This is the first industry analysis that looks at the market opportunities that the COBO standards will bring in their wake. It includes:

- An assessment of the likely role of the COBO standards in creating a healthy market for embedded optics going forward. Will other organizations challenge COBO or will pluggable optics find a way to move to much higher data rates without embedded optics? To what degree will integrated optics play a role in the transition in optical datacom that COBO says it will address
- An analysis of networking supply and value chain in the embedded optics space. We discuss which firms in the switch and router business are likely to be early adopters of embedded optics and why. We also examine how these OEMs can profitably message the advantages of embedded optics to data center managers, telecom companies and other end users.
- Based on such analysis, we build a roadmap for embedded optics and discuss alternative technology and market scenarios that will impact revenue generation from embedded optics over the coming decade. This roadmap will consider the pattern of adoption for embedded optics by equipment makers as embedded optics technology gradually transitions from the largest routers all the way down to the server level.
- A detailed ten-year forecast of the primary products and markets that will be impacted by the COBO standards and embedded optics more generally. The forecast is both in terms of unit shipments and revenues, with breakouts by the type of embedded optics,

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underlying technologies, equipment in which embedded optics is used, and the type of ultimate end users for this equipment

- A discussion of how important firms in the transceiver space and IC space are likely to adapt their product/market strategies to the embedded optics future. We will also look at how those firms plan to drive embedded optics into smaller data centers and then into telecom. Several important module firms have already said how they plan to leverage the COBO standards and more will follow

This report is designed for marketing, business development and product managers in components, modules and related businesses. It will help them understand the technological potential of embedded optics, how the COBO story will be sold to customers and how components firms will build their strategies for the COBO/embedded era – the "post-pluggable era" – as some people are calling it. The report will also be useful to professional investors in the optical networking sector who want to better understand what embedded optics will mean to their investments.

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Chapter One: Introduction

1.1 Background to this Report

In 2018 and beyond the high end of the data communications market will begin a steady march to 400 Gbps, and then perhaps on to Terabit data rates. We will find such data rates at first in high-performance computing (HPC) and then in some storage and enterprise networking applications. For now, and for the next few years, 400 Gbps and beyond will be a *niche.* But the history of data communications since the 1980s has proved conclusively that what starts as an ultra-high data rate for HPC and high-end routers inevitably migrates downwards to servers and even personal computing.

The bottom line is that shipments of 400+ Gbps boards could, by the beginning of the next decade, reach very high volumes indeed, making them a substantial business opportunity for the optical networking and module sector. Moving to the next generation has always been challenging and produces a slew of new designs and MSAs. But what is now clear is that at the data rates that we have now reached, the change that will be required from the module makers may well be *paradigmatic* in nature.

The point here is this, 400 Gbps circuit boards and beyond will require on-board speeds and densities that will gradually obsolete the current generation of pluggable optics. The consensus is that the way forward will be via a standardized form of embedded optics, characterized by miniaturized transceivers fixed to circuit boards. By this method, the length of the copper traces on the board can be reduced because the optics and electronic processors/ASICs are positioned in close proximity to each other. With embedded optics the I/O density can be significantly increased by terminating the fiber with an MPO or MPX connector on the faceplate.

The immediate impact of this move is to improve signal integrity, but the hope of some firms is that ultimately the use of embedded optics in this way will actually reduce the cost of manufacturing the board.

1.1.1 Embedded Optics Rises

CIR believes the rise of embedded optics is creating major new business opportunities for optical components, modules and communications chips companies. Embedded optics has been available as a niche technology for many years in the form of SNAP12, optical backplanes and optical engines (See Exhibit 1-1), but the recent rise to prominence of the Consortium for on-Board Optics (COBO) has apparently driven embedded optics into the limelight making embedded optics a key focus of firms expecting to build their businesses around next-generation optics. More specifically, COBO promises the first embedded optics solution that is both standardized and operates at very high data rates.

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Exhibit 1-1: Varieties of Embedded Optics

Type	Status
SNAP 12	Mature parallel optics standard. Modules are still commercially available but are limited in terms of data rate and density. Likely to continue as a niche effort for specialist applications
Optical backplanes	Several firms—notably Oracle (through its Sun acquisition), IBM and Ericsson—have developed proprietary optical backplanes for large systems. Although these are commercial to some extent, there is apparently no intention to create industry wide standards or practices with these efforts. Efforts will continue but may be overtaken by industry wide optical board standards setting
Optical engines	Currently being produced by a handful of firms, these on-board modules bring the optics closer to processors and this helps to promote high data rates. However, these efforts are not standardized in any way and some firms have found this area unprofitable and dropped out of the optical engine business. In the next five years, CIR anticipates that proprietary optical engines will be replaced by industry standard embedded optics of some kind. Meanwhile, optical engines have the potential to grow their data rates and add management functionality.
COBO	Two-year-old industry-wide effort to create standardized embedded optics for data rates at 400 Gbps and over. Has attracted considerable interest in the data communications community—partly because there is really no other game in town. And has also made progress in that its connector standards have been recently settled.
Other approaches	As yet, there do not seem to be any well-defined alternatives to the types of embedded optics that are set out above. However, there is the potential for new organizations such as COBO (although this would seriously dilute the market power of COBO's standardization efforts) or ways to preserve current ways of doing on-board optics for a generation beyond 400 Gbps. Pluggable optics may survive at 400 Gbps with the latest MSAs, and beyond the general COBO approach lies a future that may be dominated by co-packaged embedded optics.

Source: CIR

1.1.2 Embedded Optics: Still Many Outstanding Issues

Seen from a purely technological perspective, all of the options profiled in Exhibit 1-1 almost certainly will provoke a level of fascination among those who have followed the optical networking space for a couple of decades. However, from a revenue generation

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point of view, the mainstreaming of embedded optics is problematic in multiple ways. (See Exhibit 1-2).

As CIR sees it, the most likely way forward towards resolving these problems appears to be COBO, primarily because it is the only game in town right now. But even after two years, COBO cannot be said to be so established that it has ruled out rival approaches. What CIR is hearing is that while several important companies are embracing COBO as *the* way forward in embedded optics, others are not so sure. We would not be surprised to find other organizations emerge as challenge to COBO, although they may not emerge for another data rate generation.

Exhibit 1-2: Market Introduction of Embedded Optics: Issues and Resolutions

Issues	Resolutions
Standardization	Since SNAP12 embedded optics technology has largely been proprietary, COBO (and possibly other similar forums in the future) seems well advanced on resolving this issue
Marketing against pluggables	For almost 20 years equipment makers and end users have been told that pluggables are the way to go because investment in bandwidth can be made on an as needed basis. With embedded optics, boards are populated with transceivers from the get go and it may be hard to convince all the but the largest end users (who typically already fully populate boards) that this is an attractive option
Timing	COBO is assuming that a commercially significant proportion of boards can be transitioned to embedded optics at 400 Gbps. Others think that it will take until the next generation of modules (800 Gbps or 1 Tbps) before there will be much of a real need for embedded optics
Politics	Standards setting has always been a political process and is influenced by inter-firm rivalry in important ways. Thus, we note that COBO is led by Microsoft. This is encouraging in that it is unusual for an effort of this kind in data communications to see active participation by large end users. An open question is, therefore, how willing will Google, Facebook and other large cloud providers be to adopt COBO and how aggressively might they pursue alternatives.

Source: CIR

In the end, CIR believes that the biggest barrier to the adoption of embedded optics may be the impact of the messaging around pluggables, which has been quite effective over the past almost twenty years. Module makers have done an excellent job convincing both system makers and end users, that pluggables save them money, because they allow boards to be populated on an as-needed basis.

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Until system designers reach the point where pluggable I/O simply cannot deliver the density and bandwidth required by new applications, embedded optics, this message will be very hard for systems makers and data center managers to unlearn.

1.2 Scope and Objectives

The objective of this report is to identify the business opportunities that will emerge in the embedded optics space over the coming decade and to quantify these in the form of a series of ten-year worldwide forecasts. These forecasts are presented both in terms of unit shipments and revenues, with breakouts by the type of embedded optics, underlying technologies, equipment in which embedded optics is used, and the type of ultimate end users for this equipment. We have also broken out the projections by the geographic regions/countries where sales of embedded optics will be made. The principal products with which we are concerned in this report are SNAP12 modules, optical backplanes and motherboards, optical engines and COBO-related products. We also provide some discussion of embedded optics based on co-packaging.

To carry out these objectives we build a roadmap for embedded optics and discuss alternative technology and market scenarios that will impact revenue generation from embedded optics over the coming decade. This roadmap will consider the pattern of adoption for embedded optics by equipment makers as embedded optics technology gradually transitions from the largest routers all the way down to the server level. It is largely based on similar analysis that CIR has carried out for other interconnect-related technologies.

We also include in this report a discussion of how important firms in the transceiver space and IC space are likely to adapt their product/market strategies to the embedded optics future. In addition, we look at how those firms plan to drive embedded optics into smaller data centers and into telecom. Several important module firms have already said how they plan to leverage the COBO standards, and more will follow.

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1.3 Methodology of this Report

This report has been put together using multiple sources. One of the most important sources of information are interviews that CIR has conducted with important companies and other organizations in this space. In some cases, these interviews were telephonic

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and in others they were in person. CIR researchers have also collected current information at trade shows, including OFC 2017 in the U.S.

The information sourced in the ways listed in the previous paragraph are supplemented by secondary sources including CIR's own reports that cover important topics relevant to the embedded optics space. We have also made use of articles from the trade and business press, government statistics, corporate financials, etc.

The forecasting methodology used in this report is explained in more detail in the main body of this report, but the basic forecasting philosophy is to consider how rapidly embedded optics will penetrate the main systems types where CIR believes it will have an impact. Our numbers are initially drawn from our in-house forecasting model for optical interconnection, but we take it to the next level of granularity here.

1.4 Plan of this Report

In Chapter Two of this report we discuss the technical evolution of embedded optics, outlining the kinds of embedded optics that have emerged to date, with a special focus on the leading edge COBO solution and various enabling technologies that are being developed that will support the shift towards embedded optics adoption.

Then in Chapter Three we analyze the emerging markets for embedded optics and provide ten-year forecasts for them, broken out in the ways we discuss above. Finally, Chapter Four provides strategic profiles of the leading firms operating in this space.

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