



Markets for Active Optical Cables 2017 -2026

December 2016

2025 Library Ave., Suite 302
Crozet, VA 22932
www.cir-inc.com sales@cir-inc.com
Tel: 434-872-9008 Fax: 434-872-9014

Chapter One: Introduction

1.1 Background to this Report

CIR's reports on AOCs have been the reliable source for business development and marketing executives in the active optical cabling (AOC) business for more than a decade. CIR believes that the *basic value proposition* of AOCs—that they are a cost-effective way of deploying fiber optics—has not changed.

Page | 1

Nonetheless, CIR also believes that in 2017 we are going to see four profound market and technology trends in the AOC business that will spur revenue growth for AOC suppliers savvy enough to latch on to them. The four growth trends that we expect to drive the AOC market are (1) a high-level growth and especially *structural change* in the data center market for AOCs; (2) technology chaos as new MSAs, fiber and laser technologies emerge to take data center networking into a new 100/200/400 Gbps (and eventually a Tbps) era; (3) the first signs—primarily from the emergence of Thunderbolt technology—that AOCs might finally achieve a mass consumer market; and (4) a rise into the mainstream by Chinese suppliers—but a shaky one.

1.1.1 AOCs and the Remaking of the Data Center Market

A number of factors point to strong growth in data centers over the next few years and there are also indications that these new and extended data centers will use a lot of AOCs. As far as data center growth goes, the biggest positive factor is acceleration of cloud adoption, and some observers believe that the data center industry may actually double in size over the next five years.

We think that the cloud boom will lead cloud service providers to extend their data centers to serve the needs of medium-sized firms who beginning to buy into cloud technologies. We also expect to see more data center space emerging from colocations. Other factors that will help grow the addressable market for AOCs will be an accelerating number of 10-year data center lease expirations from the first big wave of data center leases a decade ago. These may also lead to rebuilds and renovations of data centers, as does the need for retrofits to improve on power consumption. All of these trends are extremely healthy for the AOC market.

Impact on the AOC market: With all this going on, CIR has no doubt that data centers will remain the dominant market for AOCs. We think that while new data center space could be implemented with field terminations and all-optical data centers based on embedded optics, the charms of AOCs—flexibility, ease of implementation and so on—will be hard to resist.

One argument for this is that, as we just indicated, more medium-sized firms will be building data centers and will require fiber optics for just a few bandwidth hungry links in the data center infrastructure. Here AOCs seem like the perfect solution. But CIR believes that much larger data centers are going to have a lot of use for AOCs. Here, we note recent

data from Facebook for its large data centers, which says that 36 percent of the cabling infrastructure was built with AOCs in 2015, while the proportion for 2016 was 43 percent. CIR believes that this growth in the large data center use of AOCs will continue for several more years. Finally, we note that the proven attraction of data center managers to opt for white box servers suggests an overall zeitgeist in which AOCs might be preferred to more elaborate fiber-optic interconnection in the data center.

All this said, we do not expect the growth in the data center AOC business to be even across geographies. There is a consensus that the Asia-Pacific region will be the fastest growing region for data centers (and hence for data center AOCs), simply because (except for Japan) they need to catch up on Europe and the U.S. in terms of the power and sophistication of their data-center infrastructure. Another factor is data sovereignty laws, which we anticipate will become more forceful in the current political climate, which tend to restrict data centers geographically.

Page | 2

1.1.2 AOCs and the New Era of Technological Fervor

The economics of the AOC business is—and will remain—reactive in the sense that leading suppliers tend to offer AOCs that embody the latest connectors/MSAs and data rates. By staying ahead of the game, while their early offerings become increasingly commoditized and open to marginal players with low manufacturing costs. Thus, there is certainly still demand for SFP+ AOCs but no profit in it anymore and the big players can happily leave it to Chinese suppliers while they work on products that operate at 200 Gbps and employ the latest incarnation of QSFP.

The above describes a perennial trend that is core to the AOC business. However, what CIR is seeing is the beginning of an era of technological fervor in the data networking space that we think will create new opportunities for AOC makers for at least the next four years. The proximate cause of this “fervor,” is that the data networking world is now beginning to actually *deploy* the 100-Gbps data networking paradigm and is seriously beginning to think about what comes after.

MSAs: As a result of all this, CIR believes that AOCs have a new palette of technology options available to it. As far as MSAs are concerned we think that the latest incarnations of QSFP present the biggest opportunities for AOC (and also other optical interconnect) makers. This is because QSFP is so embodied, CIR believes, in the consciousness of data center managers.

The QSFP variants that we are thinking of especially in terms of market potential are (1) QSFP28 which supports 40 and 100 GigE, and are built around four electrical lanes that can operate at 10 or 25 Gbps; and (2) the new QSFP-DD MSA which specifies eight lanes that operate at up to 25 Gbps via NRZ modulation or 50 Gbps via PAM4 modulation, which would support optical transmission of 200 Gbps or 400 Gbps aggregate.

Other new MSAs also spring to mind that may also need to be embodied in AOCs at some point. These include the just announced OSFP MSA and the CDFP MSA. Indeed, it would be no surprise to see entirely new MSAs for higher data rates emerge in coming years.

Of lasers and fiber: We note that much of what is going to happen in the 100-Gbps and beyond era will be reminiscent of what happened in the era of adoption of 10 Gbps infrastructure a couple of decades ago and that this was the era in which AOCs took off in the marketplace.

Page | 3

CIR believes that the up-and-coming opportunities for AOCs will extend beyond incorporating novel MSAs into AOCs. We are also seeing new technology directions for lasers and fiber that provide AOC firms ways to differentiate themselves in the AOC market. Thus, lasers are creeping up in terms of core data rates and there is a growing number of reasons why data centers are using SMF, including the need to support a DWDM infrastructure. And it seems likely that, as a result of these trends, we will see more SMF AOCs in the future.

Finally, it should be remembered that the once and future eras when there were/are many MSA/connector options for AOCs to build on are also eras of considerable risk in which it will be easy for AOC firms to go down blind allies commercially in terms of adopting particular MSAs, data rates or adoption roadmaps.

1.1.3 Thunderbolt: The Gateway to AOCs in the Consumer Electronics Space?

CIR has discussed the role of AOCs in the consumer electronics market since the first of our reports on AOCs almost a decade ago. So far, what we have seen in this space are a slew of HDMI AOCs and the occasional DVI or USB AOC.

For the most part, however, these aren't really consumer products but rather are intended for professional video applications and monitor interconnections in bars and pubs. The one truly consumer application in which this kind of AOC has made some kind of impact is in home theater, but they are still not used that often. And it still remains unclear whether the consumer electronics market with a growing range of very high-data-rate electrical interfaces really needs optical networking.

On a more positive note, for quite a few years optical extenders—often with a large amount of external electronics—have been available and HDMI AOCs seem to be able to offer cost improvements. In addition, we note that for a very long time optical Ethernet was just a niche extender business and then turned into something much bigger as data rates moved up and streaming video became important.

Thunderbolt 3: For now, the jury is out on much of this and it is important to remember that consumer electronics is an area where it is easy to get the future of technology badly wrong—3D TVs and 8-track tapes are a testimony. However, we think that the latest developments with the Thunderbolt cable system at least suggests a future for optics in consumer electronics (and also in personal computing) and more specifically for AOCs.

Thunderbolt is currently an active copper cable solution, although there have been several attempts to create optical versions of Thunderbolt. None of these attempts has been especially successful, although Corning is selling a Thunderbolt AOC. However, CIR doubts that these are being sold in very large quantities.

CIR believes that much in this space is about to change with the arrival of the latest version of Thunderbolt 3. This version will operate at 40 Gbps and is designed to create one cable technology that allows users to connect every type of peripheral to their computers, and to do so with as much bandwidth but as little cabling as possible. Some observers believe that this will let Thunderbolt 3 eventually replace HDMI and USB, although we think this sounds a little fanciful at the present time.

To date, Thunderbolt has been adopted primarily in Apple products, but we think that the revisioning of Thunderbolt as a low-cost consumer electronics-oriented interface running at 40 Gbps will win Thunderbolt support from other OEMs. Intel—which designed the chips for Thunderbolt 3—certainly believes that this new Thunderbolt will move beyond the Apple world.

The bottom line, therefore, is that if Thunderbolt 3 is successful then it could become a major consumer electronics interface with an installed base large enough to build AOCs for. What also encourages us about the future of Thunderbolt is that an optical version of Thunderbolt 3, which will extend its reach to 60 meters from today's two meters, is expected to arrive in 2017, which is when the first big wave of Thunderbolt 3 products are expected to appear in dealers.

It is easy to see how many consumer electronics applications may need more than two meters in range, so Thunderbolt AOCs may turn out to be the first mass market consumer AOCs.

1.1.4 The Chinese are Coming

The final one of the factors that we see impacting the AOC market during the next five years is the influence of Chinese suppliers. Such suppliers have been around almost since the beginning of the AOC business but were mostly mom and pop firms with very low costs. They could easily undercut major AOC firms, but were not well respected in terms of quality. CIR doubts that they ever made a sale to a large data center.

Starting in 2016, CIR began to see the Chinese role in the AOC business change significantly. Where there were once mom-and-pops, there were now substantial firms with better AOCs and much more sophisticated market messaging and enhanced manufacturing strategies than formerly. Western and Japanese firms must think up new and effective strategic responses to this new challenge and we believe that the competition will be even more intense because the Chinese domestic market for 100 Gbps AOCs is at least three years behind the European and North American market.

As CIR sees things, however, there is one aspect where there may be some room for cooperation between Chinese firms and more established firms in the West. The world is not entirely rosy for Chinese AOCs either, since most of them have weak supply chains to the national and regional markets that matter most in this business and especially to the largest end users of AOCs. And, as just noted, Chinese AOC firms cannot fall back on a domestic market for more advanced AOC products.

To us, this suggests cooperative arrangements in which Chinese firms sell through established Western supply chains perhaps using established brand names.

Page | 5

1.2 Objective and Scope of Report

The bottom line is that this report examines what it will take to be successful in the market for AOCs and we believe that it will be a high-value resource for marketing and business development managers in the components, cable, consumer electronics and personal electronics and IT industries, as well as at the AOC firms themselves.

This report is strongly focused on business strategy, analyzing the sectors in which AOCs are likely to find a market and examining the most important marketing issues faced by the AOC makers, such as the importance of branding and product differentiation. As a key part of this effort we analyze the product/market strategies of all the leading providers of AOCs. In analyzing the activities of these majors, we take into consideration the impact on the AOC sector of important on recent M&A activity such as Amphenol's acquisition of FCI and Broadcom's acquisition of Avago.

We also provide ten-year forecasts of the AOC business with breakouts by major applications and within those applications by MSA, data rate, cable length and cable type. Within the scope of this report we are including analysis of both the traditional markets for AOCs in data centers and emerging markets for AOCs in personal computing, digital signage and consumer electronics.

This report also provides forecasts and analysis of AOC business in various national and regional markets, with the focus being on North America, Europe, Japan and China. We pay special attention to the China factor, since, as we have already noted in this Chapter, CIR believes that the influence of Chinese suppliers will transform the AOC sector in important ways.

1.3 Methodology of this Report

The methodology used to compile this report is similar to that used in other reports published by CIR.

CIR has collected and analyzed data from third-party sources including (1) corporate websites, financials and presentations, as well as (2) reputable trade and technical publications, including papers delivered at conferences. The analysis presented here is

also based in part on interviews with different players in this space ranging from key suppliers and users of AOCs in the U.S. and throughout the world.

1.3.1 Forecasting Methodology

Over the decade that CIR has been covering the AOC market we have developed a sophisticated forecasting model for AOCs and have been able to test our estimates against the views of AOC industry insiders. This model and our accumulated understanding is the basis of the forecasts.

Page | 6

Our forecasting methodology is based on estimating the size and growth of the underlying addressable markets for AOCs and then adopting plausible penetration rates for each segment of the AOC markets as well as estimate of acceptable price points for each sector.

- The size of the addressable market is determined based on extrapolations and triangulations from publicly available data.
- Our penetration numbers are based on CIR's long experience of market adoption patterns in the data communications business.
- Pricing is based on list pricing for AOCs, which is widely available from almost all the major vendors. However, we have assumed that the actual prices are at somewhat of a discount from list prices.

Using this data, we construct a model that serves as the basis for both our projections and our overall analysis of the AOC market. For each of the AOC applications forecast we breakout the market by the following features and functions of the AOCs:

- Type of transceiver/MSA
- Cable length
- Fiber type
- Electrical connectors supported
- Data rates supported
- End-user application
- Country of use

1.4 Plan of Report

This report consists of four chapters, an Executive Summary and an Appendix. The Executive Summary is intended to bring together the strategic conclusions from the report, while the Appendix contains our detailed ten-year forecasts for the AOC business with break outs by all the major MSAs, connector types, data rates, fiber types, etc.

Chapter Two is intended to provide an assessment of the current level of AOC technology and the evolution of AOC products. Chapter Three analyzes the markets in which CIR believes that AOCs can generate significant revenues. Finally, in Chapter Four we profile all the leading suppliers of AOCs worldwide and some of the minor ones.