Optical Networking Opportunities in 5G Wireless Networks: 2017-2026

June 2017

2025 Library Ave., Suite 402
Crozet, VA 22932
www.cir-inc.com sales@cir-inc.com
Tel: 434-872-9008 Fax: 434-872-9014

Optical Networking Opportunities in 5G Wireless Networks: 2017-2026

Report Description

5th Generation wireless systems (5G) are what's next in the personal mobile communications space and they will eventually replace the currently ubiquitous 4G systems. The key characteristics of 5G is higher capacity and lower latency which will (1) support a higher density of mobile users as well as provide (2) a comprehensive infrastructure for IoT and M2M communications.

While access to 5G networks will, by definition, be wireless, much of the rest of the infrastructure will use fiber optics. As CIR sees it, 5G will create considerable new opportunities for the optical networking industry going forward. However, while optical links have been widely used in the cellular industry for many years, revenue generation from optical networking in the 5G space will require carefully thought through strategies by the optical networking industry as a whole. 5G is poised to dramatically increase the use of fiber optics in some parts of the network, while actually reducing the use of fiber in others:

- There is a vision of 5G as a converged fiber-wireless network in which short-haul, but very high bandwidth wireless connections will support high data rates, but with fiber almost everywhere else. 5G as it is currently evolving seems more willing than previous generation to make fiber optic deployments a central part of the network and any general standards that emerge. This makes 5G potentially a huge opportunity for the fiber optics industry – including the makers of modules and components as well as the fiber/cable manufacturers themselves.

- On the other hand, 5G, with its high data rates, seems to imply fiber could present a significant challenge to long-held assumptions about the need for fiber-to-the-premises. This suggests that some of the fiber optic opportunities that have been baked into the product/market strategies of many optical networking firms may turn out to be wrong

- 5G deployment is currently at an early stage. Nonetheless there is no formal standard for 5G and there are many different visions of what 5G will ultimately look like. The votes are still out on what type of 5G network will ultimately evolve and this will impact the size and growth of the 5G network's need for fiber optics market accordingly.

In this highly uncertain environment, this report is designed to provide guidance to the optical networking industry and where and how 5G networks will present new opportunities over the coming decade. Included in this report are:

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

- An assessment of how current visions of 5G networks vary in terms of their impact on optical network products and fiber optics demand. How will optical links help to support the necessary bandwidth and latency for 5G networks? And what will the concept of an integrated wireless/fiber network mean in practice?

- A granular market ten-year market forecast of fiber optics-related opportunities flowing from 5G deployment. The forecast is provided in both unit shipment and market value terms. It is also broken out by type of transceiver product, cable type, data rate, network segment, country/region, etc.

- Discussions and assessments of how leading firms in the module and component space are preparing for 5G deployment and what this says about who the fiber optics-related winners and losers will be

- An analysis of the type of optical networking products that 5G will require. In this analysis we cover modules (by MSA, data rate, etc.), components and the types of fiber that would be used in an integrated wireless/fiber network. The report also takes a look at how interfaces between fiber and base stations/hubs will evolve in the 5G network

- A discussion of how the deployment of 5G networks will impede the planned use of fiber in the access network. In particular, the report will take a look at how optical networking firms can readjust their marketing strategies to new product and customer types as the 5G “revolution” takes hold.

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

Table of Contents

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

List of Exhibits

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

Chapter One: Introduction

1.1 Background to this Report

New generations of mobile phone technology have appeared every eight-to-ten years or so, and we currently appear to be on the verge of a transition to a new generation of mobile technology. This will be the fifth-generation (5G) system, which starting in 2019 or 2020 will begin to slowly replace 4G and earlier systems. It has traditionally taken many years to develop and build mobile phone infrastructure—the development of 4G systems began in 2001 and the actual systems went live in about 2009 or so. Hence, vestiges of the old cellular infrastructure technologies will coexist with 5G systems for quite a few years to come.

Cellular backhaul infrastructure has always consisted of both wireless/satellite and fiber. However, it seems pretty clear for 5G backhaul infrastructure, that fiber will have a bigger share of 5G backhaul than for any previous generation of cellular. In Exhibit 1-1 CIR summarizes the opportunities that 5G presents for the optical networking business.

1.1.1 Casting Bets on 5G Backhaul

Nonetheless, what CIR is hearing in our discussion with major equipment vendors and chip makers is that suppliers of fiber optic systems are already straining at the bit to design and sell their systems into the 5G infrastructure that is beginning to be built now. Indeed, CIR believes that 5G infrastructure markets/5G backhaul is one of the biggest opportunities in the fiber-optics business that has emerged for some time. Pre-5G trials are already taking place in some countries and real-world 5G infrastructure will start to be deployed soon. For those who place their bets right, CIR sees large revenues flowing from 5G and the 5G backhaul business in particular.

However, as our reference to “bets” above indicates, CIR also believes that there are major uncertainties surrounding 5G, especially since the standards have yet to fully emerge in the 5G space. Also in the long run, 5G infrastructure expenditures will depend on the take up of 5G services and, at present, customer projections for 5G can vary by an order of magnitude depending on whom one asks.

In practice, some early entrants among fiber-optic infrastructure providers will be able to create barriers to entry in the 5G backhaul market by making the standards-making process their own, while others will get it wrong and creep out of the 5G backhaul market within a couple of years.

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

Exhibit 1-1: Opportunities and Stumbling Blocks for Fiber in 5G Backhaul Networks

Topic	Status	Opportunity	Risks
Standards	5G standards are emerging although data rate and latency requirements are well understood	Equipment vendors can help set standards and, therefore, create barriers to market entry in their favor	Standards once set may prevent certain types of equipment being widely used in 5G networks, so there is a risk for 5G backhaul equipment firms to enter the market at this early stage
Number of subscribers	No current subscribers with very large differences in expectations of what the take up of 5G will look like	The number of subscribers will ultimately determine the size of the backhaul infrastructure needed to support them	Hard to plan for backhaul infrastructure sales when expected subscriber counts can sometimes vary by as much as an order of magnitude
Protocols	Fiber protocols could be of many types, but WDM-PON seems to have the edge for many backhaul applications	Equipment vendors can crystallize their efforts around PON technology	Backhaul trunking technology not certain—could be Carrier Ethernet, native fiber or WDM.
Alternatives to fiber	Share of fiber versus wireless in the 5G backhaul infrastructure not yet settled	Fiber infrastructure firms have the opportunity to make the case for fiber over wireless based on bandwidth and ROI	Fiber deployments may be overkill in some applications and fiber may be overused based on hyped expectations for 5G uptake

Source: CIR

Standards making in the 5G space is at an early stage. However, the 5G requirements stated above mean that not only will the coming 5G infrastructure need more bandwidth than 4G infrastructure, but will also need to supply lower latency. In particular, the infrastructure will have to support the Internet-of-Things (IoT) and machine-to-machine (M2M) communications as well as much higher data rates than previous generations of mobile communications.

This means that 5G backhaul must be constructed so that it can offer up to at least 10 Gbps and (again, at least) one millisecond of end-to-end round trip delay. Service providers are also expecting there to be dramatic reduction in energy usage in 5G networks. Once formal standards are pinned down we will know a lot more about what is required of the fiber infrastructure.

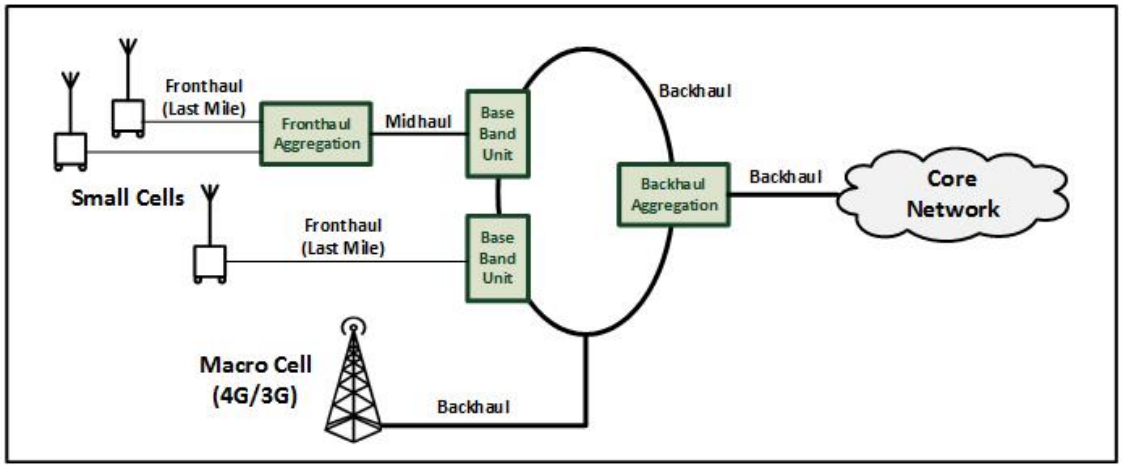
2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

CIR anticipates that while the lion's share of the revenues from 5G will go to big, established gear makers there will be room for start-ups in the 5G infrastructure space, notably those that have convincing stories about better enabling data rate and latency performance in the 5G infrastructure.

1.1.2 Market and Technology Segmentations

Exhibit 1-2 shows a diagram of a 5G network. As the Exhibit suggests, the backhaul network is relatively complex and each part of it has different need for transmission technologies. Among the possibilities mmWave and free-space optics for distances of a few kilometers have considerable potential. However, our primary interest in this report is in fiber optic-related solutions, notably PON-based solutions, which in many cases are what are being proposed.

Exhibit 1-2: 5G Backhaul Network Architecture (1)



Source: CIR

(1) Note that "fronthaul" and "midhaul" are often distinguished from "backhaul" in the literature, although in some cases the term "backhaul" is used for all parts of the backhaul network.

Otherwise, much of the 5G backhaul will be built using fiber. One vision of the 5G network is as a converged fiber-wireless network in which short-haul, but very high bandwidth wireless connections will support high data rates, but with fiber almost everywhere else. In any case, CIR believes 5G is potentially a massive opportunity for the fiber optics industry, with this taken to include opportunities for the makers of modules and components as well as the fiber/cable manufacturers themselves.

Also favoring fiber deployment in 5G backhaul are new microtrenching techniques for laying fiber, which are said to lower the breakeven point relative to microwave and other

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

wireless technologies from 18 to 20 years to six to eight years. Note, however, in many cases 5G backhaul will be built on existing fiber.

The strong fiber orientation of most current conceptions of 5G backhaul justifies the current excitement in the optical networking space with regard to 5G. However, yet another uncertainty exists here in the form of what kind protocols and architectures will be used. At present, the answer seems to be that NG-PON2, which is sometimes referred to as WDM-PON, will grab a substantial part of the 5G backhaul space.

This technology meets all the requirements for 5G backhaul, and tier one companies such as Cisco, Nokia, Huawei, Calix, Adtran, Ericsson and Alcatel-Lucent are all active participants in developing this technology for 5G backhaul. Also existing PON standards, such as EPON, 10G-EPON or GPON, can be upgraded to NG-PON2 without the need to change the fiber in the ground.

To date, NG-PON2/WDM-PON2 is the only PON technology that can provide 10 Gbps in both direction. This will almost certainly give this type of networking protocol the edge in the parts of the network that are closer to the subscriber. However, deeper into the network—that is in the true backhaul—there may be better (i.e., faster and lower latency) fiber options. These include native fiber, carrier Ethernet and WDM of various species.

1.2 Objective and Scope of this Report

The objective of this report is to identify the business opportunities in optical backhaul infrastructure that will emerge as the result of the deployment of 5G mobile technologies over the coming decade. The goal is also to quantify these opportunities in both volume and value terms in ten-year forecasts, which are provided in both volume and value terms.

The coverage of this report includes both backhaul equipment and the fiber itself. Breakouts are also provided by the segment of the backhaul network where the fiber and equipment is installed and the protocols that are deployed over the fiber. We also break out the fiber by geographical region. Since many of the protocols used in fiber-optic backhaul networks for 5G are based on PON, we provide a relevant discussion of the state of play with PON technology. We also provide a similar discussion of Carrier Ethernet and WDM which will be used in the longer haul part of the 5G backhaul network.

Although our first concern is with optical networking/fiber optics, we also provide coverage in this report of traditional/niche technologies that are used in the 5G backhaul; principally free-space optics (FSO) and mmWave radio. This is first and foremost a report on the market for 5G backhaul hardware, although we acknowledge and briefly mention that software-related consideration—virtualization, for example—will shape the architectures for 5G backhaul and this in turn will make a difference to the demand for mobile hardware.

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

Finally, we examine possible strategies for optical networking and other firms to better penetrate the 5G backhaul market. These include both generic strategies and strategies of interest being deployed by specific firms.

1.3 Methodology and Information Sources for this Report

The methodology used to compile this report is similar to that used in other reports published by CIR. That is to say it is based in part on telephone interviews with a variety of players in this space ranging from key suppliers and users to relevant industry journalists. We have also conducted "live" interviews at major trade shows; most notably the OFC 2017 trade show in the U.S.

To the primary information mentioned above we have added data that was collected by CIR from third-party sources such as corporate websites, financials and presentations, as well as reputable trade and technical publications, including papers delivered at conferences.

1.3.1 Forecast Methodology

The forecasting methodology is explained in more detail in the chapters that include the forecasts themselves. Here we note that the framework for the methodology is similar to that used in other CIR reports. This is essentially to determine a baseline addressable market and then establish a relationship between that and the time series being established in the forecast.

In the case of 5G we begin with a projection of the number of subscribers to 5G and then relate the number of terminations and aggregation points back to that number, which produces a forecast of the hardware used. This forecast can then be extended to a forecast for fiber, by making assumptions about the length of fiber links, etc., as well as the cost of fiber itself.

As we note several times throughout this report, a major uncertainty is introduced into our projections by the fact that there is a very wide range of projections for the number of 5G subscribers that will emerge over the next decade. Because infrastructure deployments are so tied to subscriber levels this must be considered a possible source of error throughout the forecasts included here.

1.4 Plan of this Report

In Chapter Two, the markets for 5G and earlier related technologies are analyzed and their implications for backhaul are presented. Also, the different segments of backhaul are described along with their relevance to the overall system and their technology and market characteristics. Here, a comparison is also made into the different backhaul technologies, including wireless and fiber. Lastly, the use of 5G technology as a replacement for FTTH is examined.

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com

In Chapter Three, we focus on the development of the subscriber base and how it impacts 5G backhaul deployment. Our analysis here is based in part on what happened during previous mobile technology generation change overs. Also, a ten-year forecast is produced on the share of specifically fiber backhaul technology globally and regionally as well as a forecast by value for fiber backhaul. A close look is carried out at the candidates for 5G fiber backhaul and a clear winner emerges.

In Chapter Four, opportunities for the supply of 5G-related cable and components is examined, including fiber-optic cable, splitters, coexistence elements and transceivers. Also, the use of new technologies for FTTH are examined.

2025 Library Ave., Suite 402,
Crozet, VA 22932
Tel: 434-872-9008 Fax: 434-872-9014
www.cir-inc.com sales@cir-inc.com