Trends in Metro Optical Networks

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IHS Markit Technology | **Report Excerpts**

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Exhibits

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Introduction

The shift to coherent optics at 100G drove a massive and sustained wave of long haul optical network infrastructure investment that peaked in 2016. With the increasing availability of metro-optimized solutions at more attractive price points, momentum has swung from long haul investment to metro optical investment. This report will explore the opportunity, technologies, and challenges ahead for the metro optical market, highlighting excerpts from recent IHS Markit reports: the 26 February 2018 1Q18 *Optical Network Equipment Market Tracker* and the 20 December 2017 *Optical Network Strategies: Global Service Provider Survey*.

Full steam ahead for the metro optical market

The metro optical market in 2018 is multi-faceted, service oriented, and highly competitive. Diversity comes from the range of applications, with different requirements and different target customers that call on metro optical solutions. These applications include data center interconnect (DCI), mobile transport (backbone, backhaul, and fronthaul), wholesale services, and enterprise wavelength and packet connectivity services. Service-orientation is critical—today's applications are dynamic and temporal and cross multiple service provider boundaries. Optical networking is shifting from "fix and forget" to providing the agility and flexibility to match service requirements in an efficient manner. Finally, the optical networking market continues to be highly competitive with large-scale end-to-end solution providers, smaller regional and technology specialists, and a new generation of vendors specializing in aspects of the emerging open and disaggregated optical networking market.

IHS Markit anticipates a continuing ramp in overall network capacity to address growing bandwidth demand. In the metro, burgeoning bandwidth demand to, from, and between DCs is the primary driver. Not to be ignored is the coming broader introduction and adoption of consumer 4K and higher video content and services on a variety of devices. The shift from data to video to VR/AR will add yet another set of bandwidth-intensive and latency-sensitive services to the mix starting in the outer years of the forecast. In preparation for 5G, deep fiber architectures for cable access evolution in mobile transport architectures will provide additional drivers for optical transport network investment.

We do not see any significant substitute or replacement technologies in our forecast timeframe for WDM equipment. However, we consider distributed computing, analytics, machine learning, AI, and SDN to contribute to overall optical network utilization and efficiency. Over time, these will reduce the amount of WDM equipment required to service a given bandwidth load. Disaggregation and open optical networking will provide alternative and potentially lower cost vehicles for delivering WDM solutions.

Based on these industry trends and the balance of growth drivers and cost reduction factors, IHS Markit forecasts a net positive total optical equipment market CAGR of 5% from 2017 through 2022.

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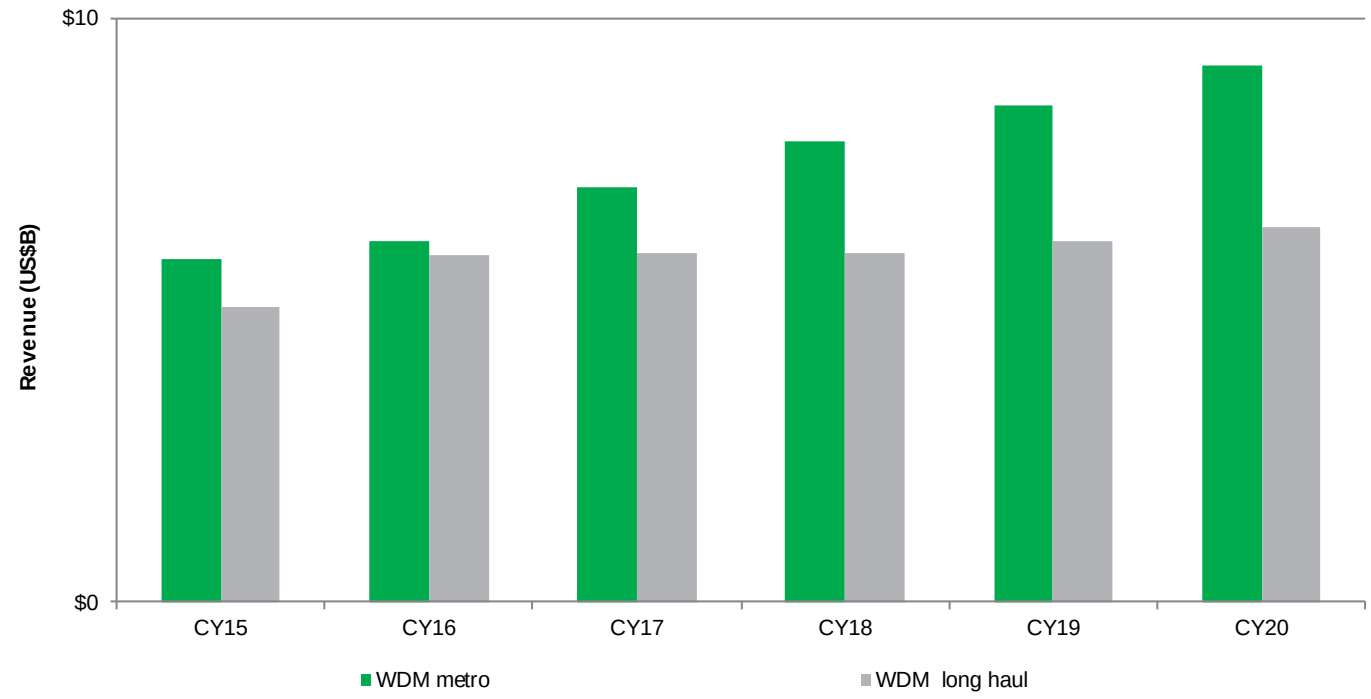
Exhibit 1 Optical network hardware revenue forecast: Metro takes center stage



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Metro optical market evolution: Service provider survey

In the December 2017 edition of the IHS Markit *Optical Network Strategies Service Provider Survey*, we set out to explore the continuing evolution of metro optical network technologies including wavelength speeds, configurations, and the role of pluggable optics. We also focused on exploring service provider sentiment toward disaggregation in metro optical networks.

In our interviews with service providers, it is clear that although 100G remains a key technology in metro networks, the market is already looking at what comes next. 200G and 400G deployments have started and will become increasingly important by 2020. Service providers are actively preparing for this next jump in wavelength speeds by moving to flexible grid ROADMs in a big way.

Disaggregation in terrestrial optical networks is already starting to happen—we are seeing the separation of transponders from line systems in metro DCI applications and the separation of software from the underlying hardware layer with the introduction of transport SDN controllers and applications. The key perceived benefits include reducing reliance on individual vendors and being able to further drive down network costs. The key challenges center on integrating and operating a diverse range of equipment and software from different vendors.

Key findings from our optical network equipment strategies service provider survey pertaining to the metro:

- Lower cost metro-optimized 100G hardware is the top desired technology for the evolution of metro optical networks.
- In the metro, on average, 43% of new wavelengths were at 100G in 2017, increasing to 51% in 2020. 200G and 400G will see strong growth over this period while 10G deployments will decline.
- Service provider deployment of 100G+ wavelengths in the metro-access (<100 km reach) will outpace metro-regional (100—600 km reach) deployments. In 2017, 46% of metro 100G+ deployments were in metro-access networks. Our survey respondents indicate this will grow to 53% in 2020.
- 47% of survey respondents indicated interest in the use of disaggregated optical equipment in their networks, up from 33% in 2016. There remains a significant 20% who are not familiar with disaggregation in optical networks, indicating that there is still room for more education in the industry on this topic in 2018.

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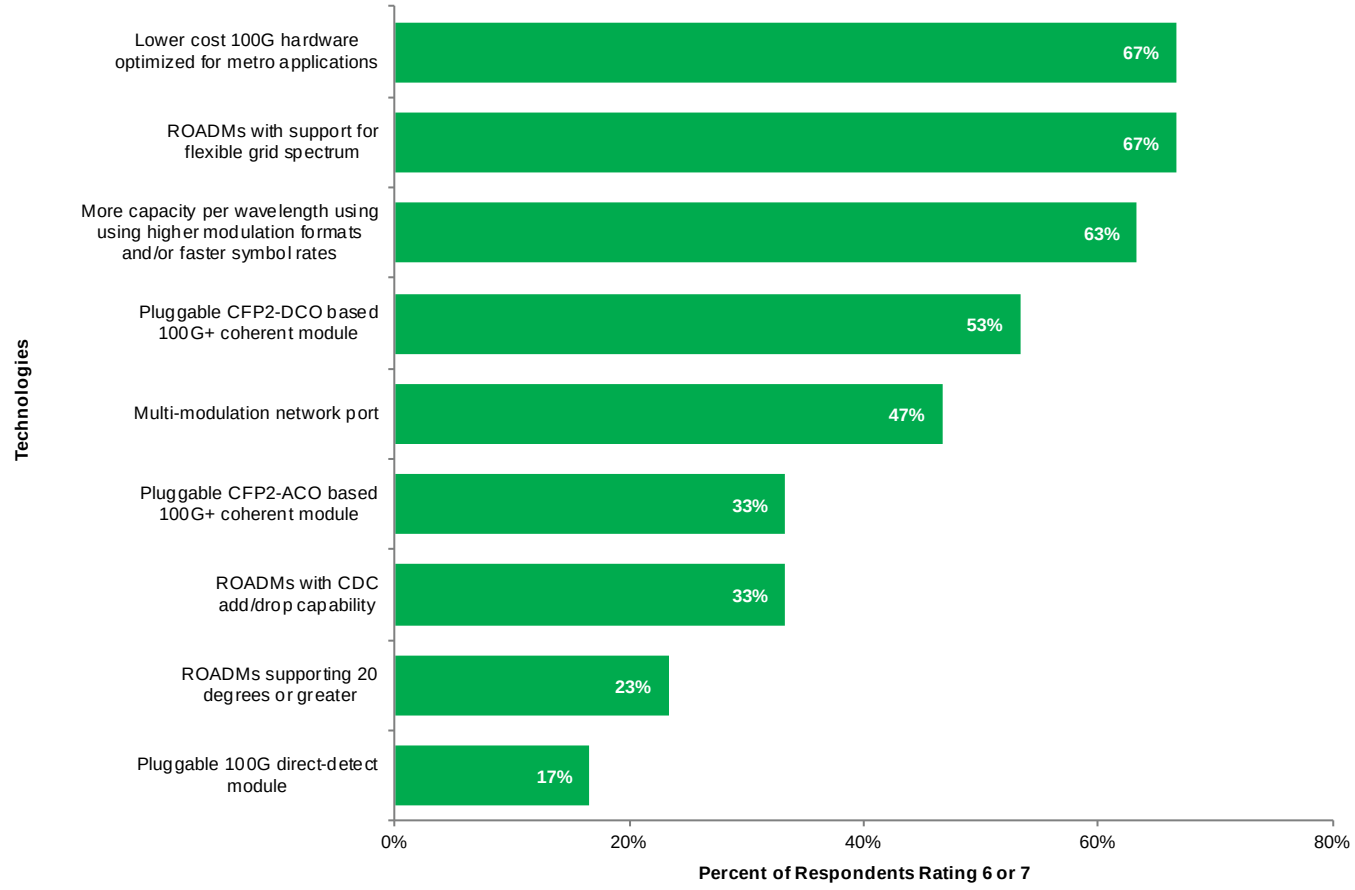
Key technologies for metro optical network evolution

To get an understanding of what service providers consider to be the key technologies for the evolution of metro optical networks, we asked respondents to rate the importance of various technologies when deploying optics for metro-regional spans of 100–600 km on a scale of 1 to 7, where 1 is *not important*, 4 is *somewhat important*, and 7 is *critical*. In the next chart, we show the percentage of respondents rating each factor 6 or 7, or *very important*.

Exhibit 2 Desired technologies for optics in metro-regional spans
n=30



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The results of the 2017 survey were very consistent with what we observed in 2016. The top three metro technology priorities for our service provider respondents continue to be driving down the cost of 100G optical equipment in the metro, introducing flexible grid (or grid-less) ROADMs, and driving even more capacity per wavelength through techniques including higher modulation rates and faster symbol rates. In short—drive down 100G cost, ensure line system flexibility for the delivery of higher speed metro wavelengths, and by the way, get me those higher speed wavelengths! Compared to our 2016 survey, the percentage of respondents ranking “lower cost 100G metro WDM equipment” as very important stayed consistent at just over two-thirds of respondents. Flexible grid ROADMs have grown increasingly important with 67% of our respondents rating it a very important technology in 2017, up from 54% in 2016. The importance of higher speed wavelengths in the metro has also increased, jumping from 46% in 2016 to 63% in 2017.

A key supporting ingredient to lowering 100G WDM costs in the metro is the availability of pluggable transceivers. Just over half of our respondents considered 100G+ CFP2-DCO transceivers a very important and desired technology. One-third of our respondents considered 100G+ CFP2-ACO pluggables very important. Both types of pluggable technology have increased in importance as compared to 2016.

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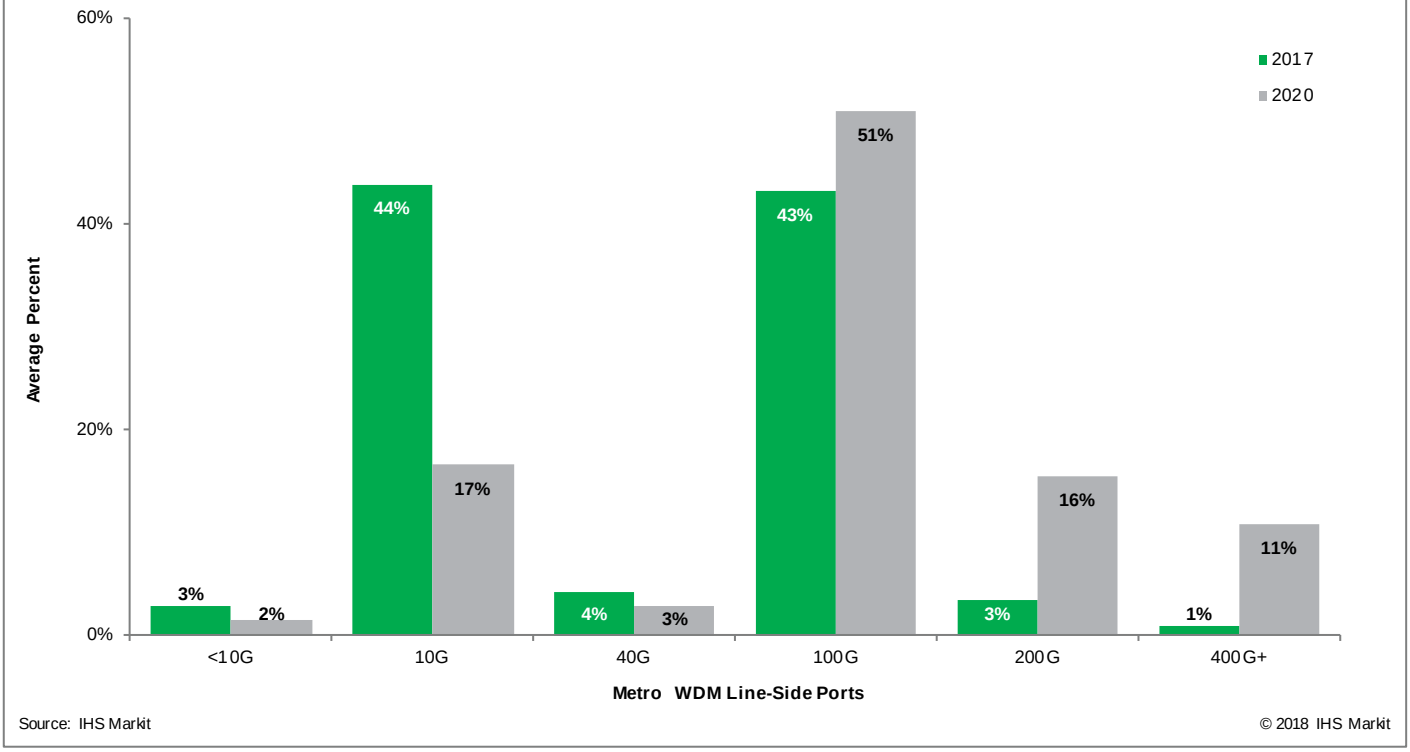
Steady shift to 100G+ wavelengths in the metro continues

100G is now well established in long haul networks, and industry focus has shifted to the optimization and deployment of 100G in metro networks. Throughout 2016 and 2017, several new metro-optimized WDM platforms were introduced to the market. Many of these platforms include support for 100G/200G CFP2-ACO pluggable coherent transceivers, providing a pay-as-you-go pricing model attractive to metro deployments. We expect the next generation of high-density, metro-optimized 100G/200G CFP2-DCO coherent pluggables to start shipping in volume in 2018, adding yet another element of flexibility to metro-optical deployments.

We asked respondents to estimate the percentage of metro WDM line-side ports (not clients) of each speed they will install during 2017 and during 2020. We were careful to ask for what they will deploy during each year, not for the existing installed base inventory of their networks.

Exhibit 3 New metro WDM installs: Port speeds
n=30



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Coherent to dominate metro-access for service providers

To gain an updated view of service provider interest in coherent versus non-coherent (e.g., PAM-4, DMT) for use in <100 km metro-access applications, we asked service providers what percentage of 100G metro-access wavelengths installed will be coherent versus direct detect or other non-coherent formats in 2017 and 2020.

It has been very interesting to observe the evolution in responses to this question over the past three years. In our 2015 survey, the market was clearly split with many service providers still undecided. On average, 21% of 2015 respondents indicated "don't know," and the remainder showed a roughly 2:1 bias in favor of coherent technology. In the 2016 survey, the picture became much more definitive with service providers indicating that during 2016, an average of 81% of deployed 100G metro access wavelengths would be coherent, increasing to almost 90% by 2019. In our 2017 survey, coherent continues to dominate metro-access wavelength deployments but to a lesser extent than what was seen in last year's survey. Based on our responses, on average, 18% of metro-access wavelengths deployed by service providers during 2017 will use some form of direct detect technology. This will remain steady into 2020, when the number increases very slightly to 19%. Of interest is that the number of "unknowns" increases from 7% in 2017 to 14% in 2020, indicating that for some service providers the jury is still out for this technology.

- Please note that this survey does not include Internet content provider (ICP) respondents, who are in general the largest proponents for direct detect technology in the metro-access space. This view is clearly more reflective of service provider intentions regarding coherent versus direct detect in the metro.

Exhibit 4 100G metro-access wavelengths: Coherent versus non-coherent
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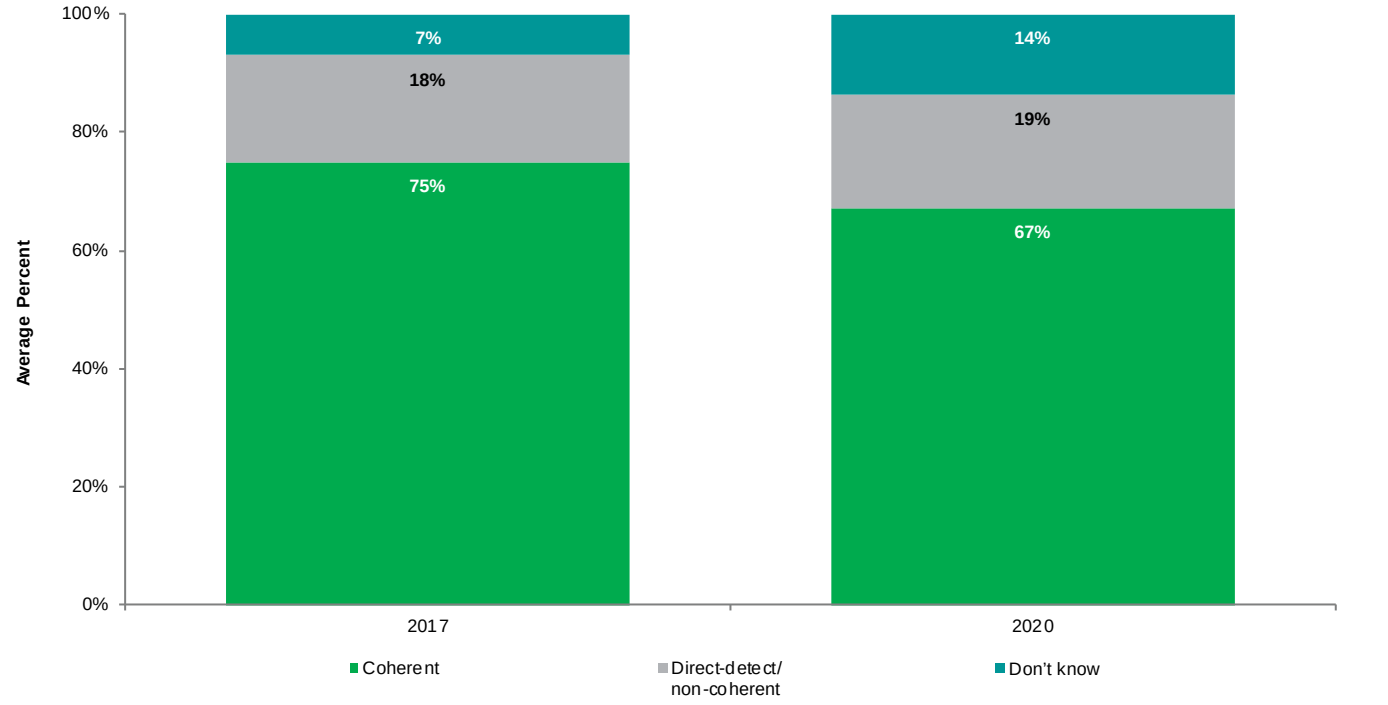

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Disaggregation in optical networking

The disaggregation of optical transport systems was first seen in the subsea market as wavelengths from third-party transponders were carried over existing line systems, enabling new SLTE vendors to enter the market and facilitate system upgrades to 100G technologies. Optical disaggregation took a further step into the mainstream as the web scale ICPs demanded a separation between line system and transponder equipment to enable more flexibility in network deployments and evolution (e.g., new generations of transponders come out faster than new generations of line systems) and to create a more flexible and competitive vendor environment. The emergence of AT&T's OpenROADM project and the Telecom Infra Project's work on open WDM systems has brought additional visibility to this area.

Although there has been significant focus on the hardware aspect of optical equipment disaggregation, the corresponding move to separate hardware from software is also being explored with different approaches. The availability of open APIs on optical platforms along with SDN control and orchestration solutions provides a framework for the delivery of a wide range of software-based features and functions that have traditionally been fully integrated on optical equipment. For some, the ultimate realization of this direction for disaggregation would be in the emergence of a vibrant optical white box market and a matching open software ecosystem. For most others, the more pragmatic end goal is to improve optical equipment interoperability and reduce reliance on a single optical equipment vendor.

In this survey, we were looking to gauge service providers' interest level in considering disaggregation for optical networking equipment as an aspect of future network evolution. We also wanted to gain a sense of what approaches have the most appeal, the challenges ahead, and the likely implementation timeframe.

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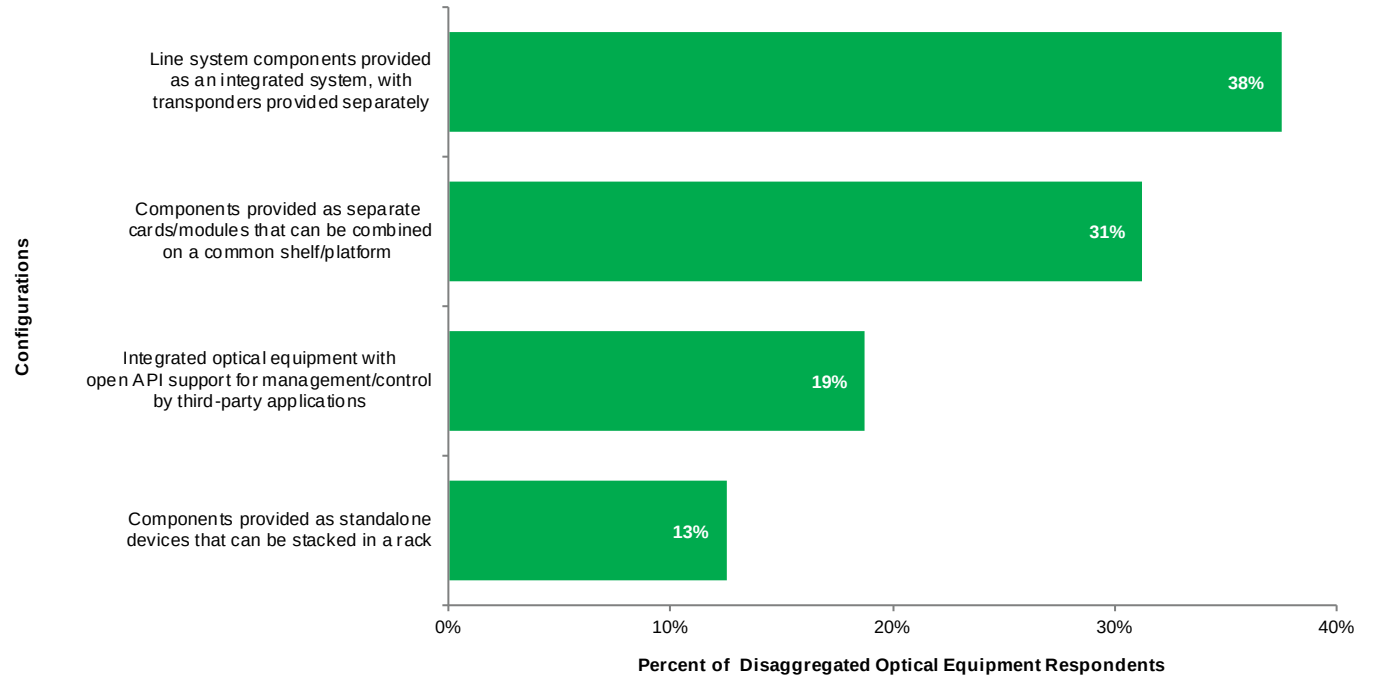
Separation of line system and transponders the most preferred configuration

Vendors are bringing to market a range of disaggregated optical networking solutions. Some are fully integrated transponder and/or line systems offering some separation in the software domain through open API support for management and control functions. Others are full-fledged white box platforms for ROADM functionality and for combined switching and coherent transport (bring/build your own software). Even the form factor can vary between vendors—everything from optical network functions on a blade for chassis-based deployments to self-contained stackable optical network elements to even pluggable transponders and amplifiers.

We asked our respondents to indicate their single preferred approach to building disaggregated optical networks. 38% indicated a preference for fully integrated line systems where only the transponders would be provided separately (and by extension, potentially from different vendors). This aligns with a level of acceptance in the industry for an open line systems approach. Close to a third favored a chassis-based approach where components would be provided in a card or module form factor. 19% are happy to continue with fully integrated hardware/software systems as long as they support open APIs, providing the ability to manage and control these systems as part of a multi-vendor network and/or by a third-party network controller. 13% indicated a preference for standalone stackable devices.

Exhibit 5 Disaggregated optical system configurations
n=16



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Metro WDM is the primary target market for disaggregated systems

We asked disaggregated optical equipment respondents which applications would they consider deploying disaggregated optical systems for.

Metro-access and metro-regional applications were cited as most likely for the deployment of disaggregated WDM systems. This is in line with the general perception that service providers are more willing to trade performance for interoperability and cost savings in the metro. For core/long haul and subsea applications, service providers will make decisions based on ability to maximize spectral efficiency, which today tends to favor integrated (single-vendor) solutions.

Exhibit 6 Disaggregated optical system applications
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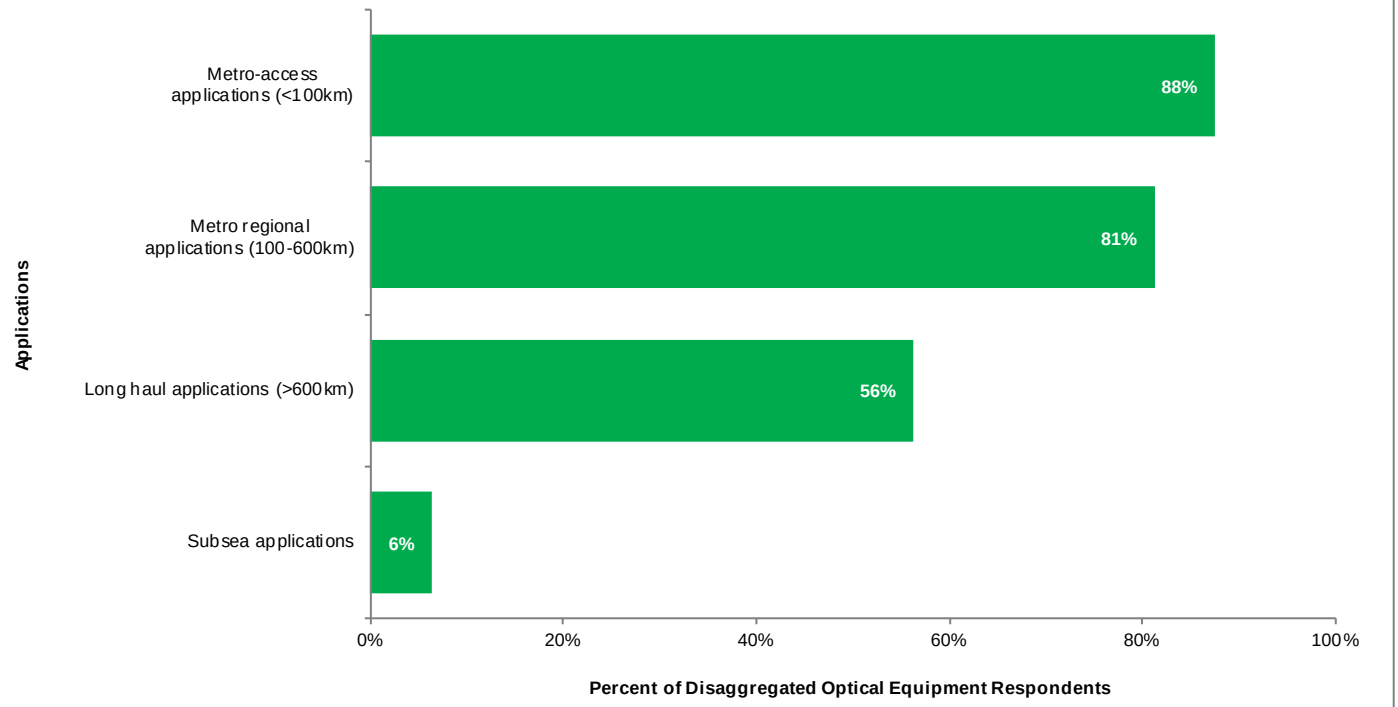

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The bottom line

Metro optical is a broad, dynamic, and growing area for network investment. DCI, enterprise services, fixed access, and mobile transport are all underlying drivers for metro optical investment. Growing bandwidth demand in the metro will be increasingly met by new metro-optimized 100G+ WDM platforms. 100G will be the dominant speed by 2020, with 200G and 400G wavelengths ramping up quickly in the same timeframe. Service provider interest in disaggregated optical equipment for metro applications is also increasing, setting the stage for more exploration and innovation in this area as we move through 2018 to 2020 and beyond.

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