400G and beyond: Driving next generation data centers

OMDIA

Brought to you by Informa Tech

Contents

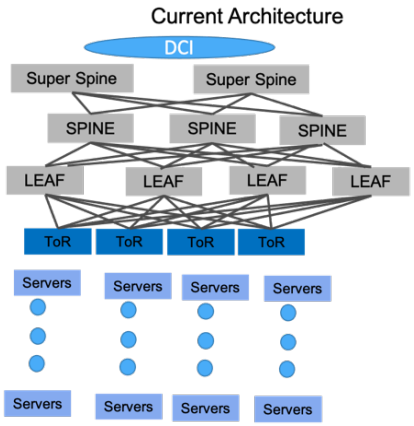
Introduction

400G is accelerating the data center evolution. The landscape is shifting away from 100G as operators upgrade their data centers to higher data rates. This report explores the 400G market, data center requirements, adoption, and technology options available.

The networking technologies that have been deployed in Internet Content Provider (ICP) data centers over the last five years range from 10G to 400G. In 2015, 10G server connections were the norm with 40G in the leaf and spine. In 2017, 40G disappeared in favor of 100G active optical cables (AOCs) in the top-of-rack (ToR)-to-leaf connection and 100G transceivers in the leaf-to-spine connections, and servers being connected at 25G. In late 2019, the prevalent server connections are still 25G with 100G uplinks and multiple 100G in the leaf-to-spine connections, but several ICPs have started to deploy higher data rates. Installations have included 50G server-to-ToR (top of rack switch) connections and 200G in the form of 2×100G and 400G in the two forms (2×200G for leaf-to-spine connections and 400G-LR8) in leaf-to-spine and spine-to-super-spine. Now, 50G and even some 100G servers are becoming the norm, with several forms of 200G and 400G through the rest of the network.

Exhibit 1 shows the current state of the ICP data center network and how it is expected to progress in the next few years.

Exhibit 1: ICP data center architecture



Optics 2020	2021/23 ramp Optics
ZR or IPoWDM	ZR or IPoWDM
100G LR optics	400G LR optics
100G CWDM4, PSM4	400G DR4 and FR4 optics
100G AOC – SR4	400G AOC – SR4
25G/50G DAC/AOC	50G/100G DAC/AOC

Source: Omdia 2020

The data center interconnect (DCI) connections are a combination of 100G-LR, ZR and IPoWDM solutions. These will transition to 400G versions of these same variants. Super-spine-to-spine and some leaf-to-spine connections are currently 100G-LR (10km) optics. Most leaf-to-spine connections are 100G CWDM4 or PSM4. These will transition to 400G DR4 (500m) and FR4 (2km) devices. The ToR- to-leaf connections are currently 100G AOCs or CWDM4 or PSM4 modules. These will move to either 400G AOCs or 400G DR4 optics.

ICPs have changed the optical transceiver market landscape over the last five years. Because they command high volume, they have been able to dictate new optical variants and drive standards and multisource agreements. From the custom 10×10G modules that were pushed by Google to the 100G-CWDM4 transceivers now being deployed, ICPs have had a hand in research and development (R&D). Google continues to push some custom solutions like 2×100G, 2×200G, and eventually 2×400G. While these variants will all see some volume, the more standard solutions will see more.

Technologies to support data center networking upgrades

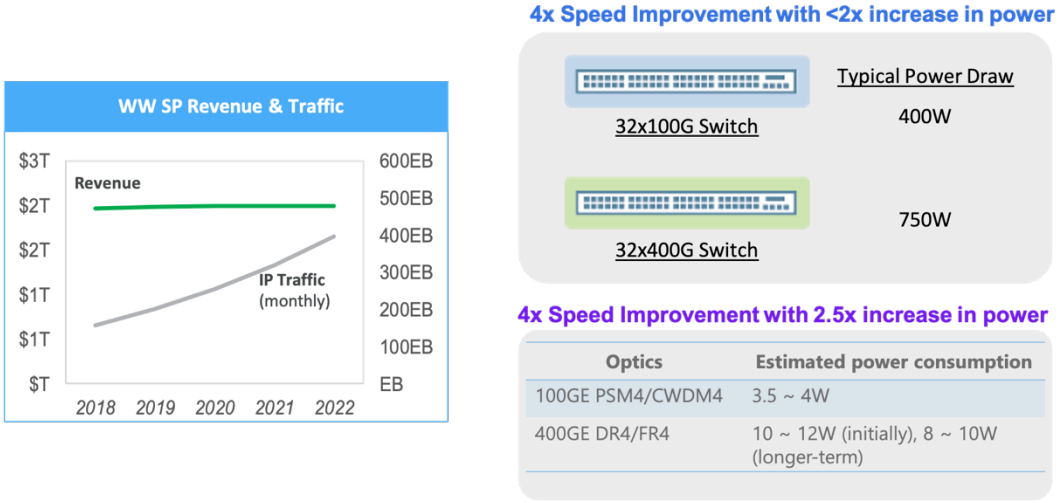
Incremental 400G deployment started in 2019 and transceiver manufacturers were geared to deliver higher volume in 2020. Delays in adoption have occurred for two reasons:

- **Power consumption:** All of the top ICPs have voiced concerns about both the OSFP and QSFP-DD modules consuming too much power – 12W or above. However, this concern is not stopping some from further investigation. For example, Amazon has been deploying a 2×200G version of the QSFP-DD in its leaf-to-spine configurations. None of the other ICPs have started widespread deployment yet because they need to figure out the power and cooling distribution to support it.

- **Price:** The price of the OSFP and QSFP-DD modules are still almost three times the cost of four 100G CWDM QSFP28 modules. When this reaches less than twice the cost, we expect volume to pick up – if the power consumption issue can also be solved.

Exhibit 2 below shows the dilemma facing ICP data centers. While the cost of some of the 400G variants has come down, the power consumption is still an issue, but Omdia believes this will be solved in 2021 and deployment will accelerate.

Exhibit 2: Driving down the cost and power of 400G ports

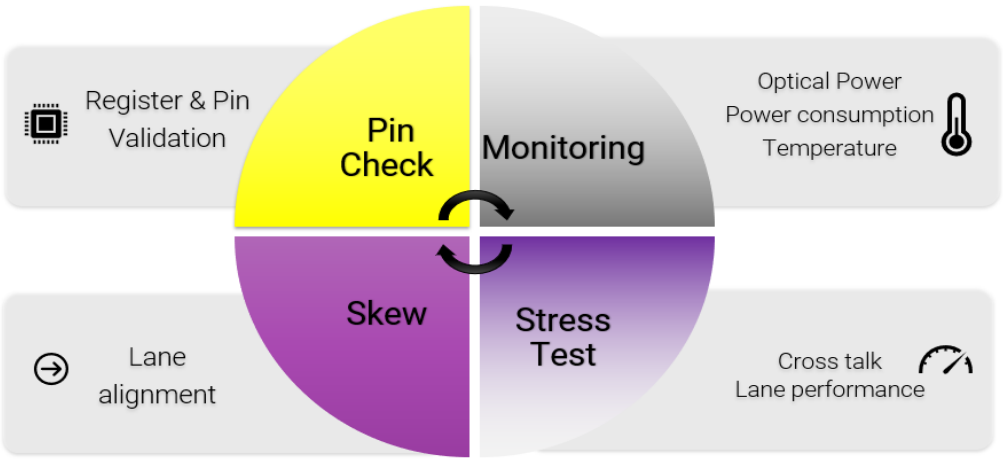


Source: Juniper Networks, 2020

Because higher data rates have added complexity to the optical modules, new testing strategies are needed. Pluggable optics are constantly evolving and have been a proven point of failure inside data center networks. In addition, as mentioned above, as data rates increase, the cost of these devices increases dramatically. This drives the need for pre-qualification prior to installation and tools for troubleshooting when in operation.

Exhibit 3 shows the testing methodology needed for 400G and above.

Exhibit 3: New testing methodology needed for 400G and beyond



Source: EXFO, 2020

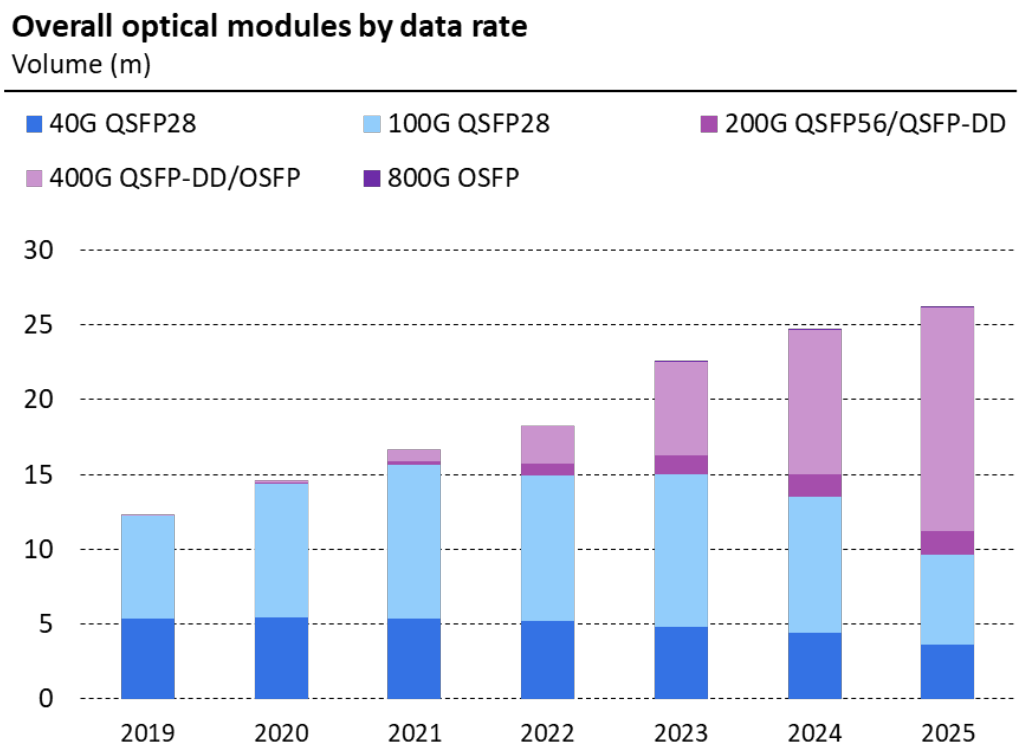
Transition to 400G inside the data center

We see a bright future for optical transceivers within the ICP data center. Leading ICPs' total revenue has reached over $1tn and continues to grow. Their digital and cloud services businesses continue to flourish, which will drive their data-center-construction roadmap. For example, online retail businesses require data center capability to support them; therefore, growth in online retail users will push new data center construction as well as the need to upgrade to the most efficient network. In addition, the COVID-19 pandemic has pushed bandwidth needs from enterprises to homes. Optical components will continue to be needed to run these networks. The evolution from 100G to 400G is now underway and will fuel the market for the next few years.

Omdia projects that the 100G to 400G transition will begin in earnest in 2022. Exhibits 4 through 8 show our forecasts for these devices.

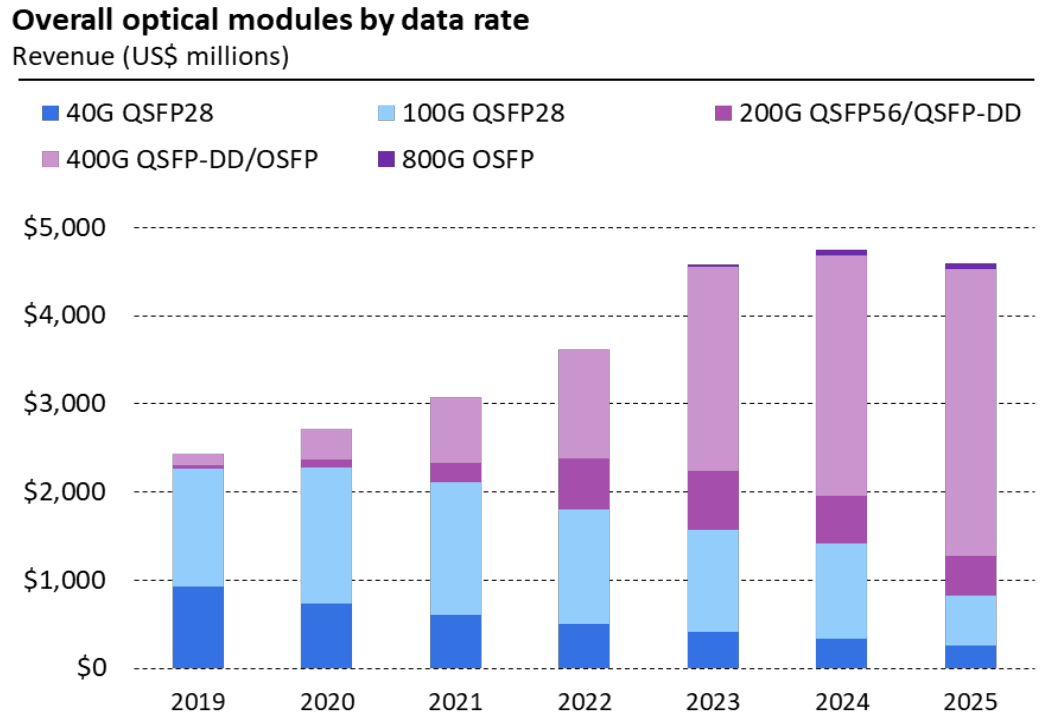
Exhibit 4 and Exhibit 5 on the next page include both ICP and enterprise data center optics. 100G connections will start to decline in 2022 but will be bolstered for many years by deployment in enterprise data centers. 400G will take over the majority of the volume by 2025, but revenue by 2023 – evidence of its higher average selling price as compared to 100G.

Exhibit 4: Optical transceivers used in data centers



Source: Omdia 2020

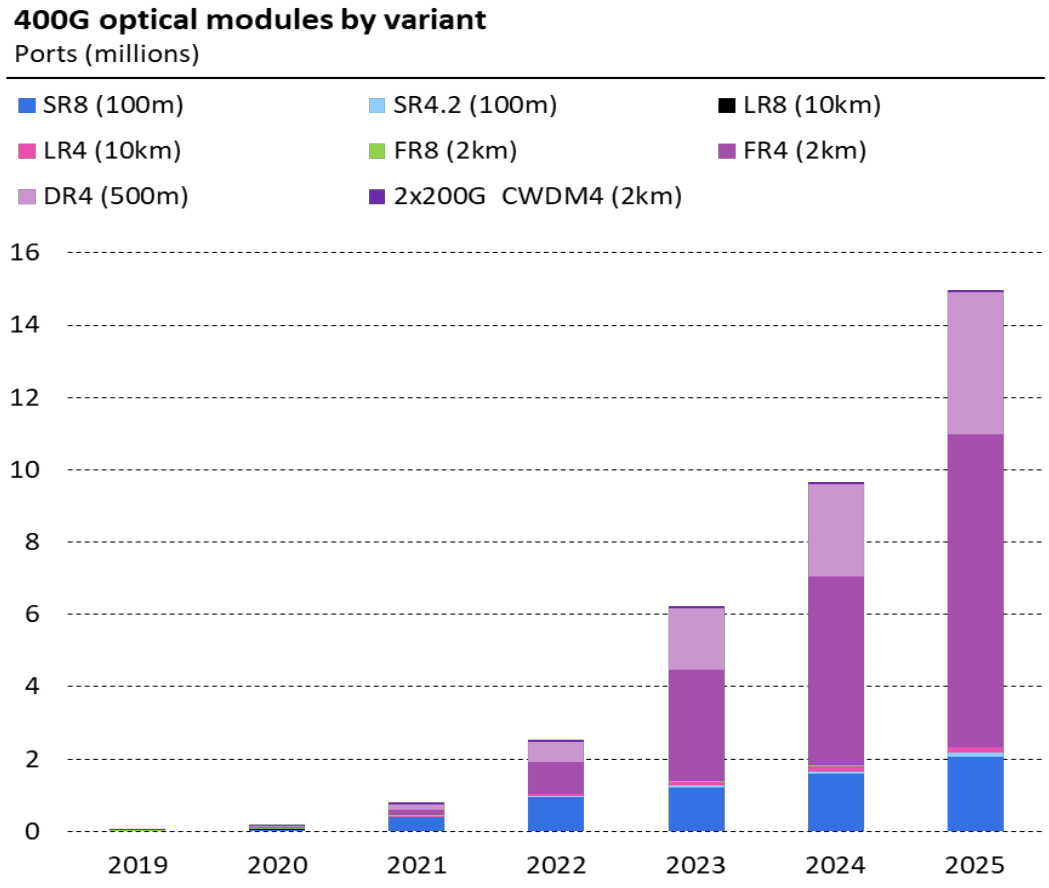
Exhibit 5: Optical transceivers used in data centers



Markets typically begin with “low-volume time to market” solutions and then transition to the high-volume solutions. For 400G, Omdia sees DR4 and FR4 emerging as the high-volume solutions starting in 2023.

Exhibit 6 shows that the high-volume variants will be FR4 (2km) and DR4 (500m). The six-year volume CAGR is 169% and the revenue CAGR is 72%.

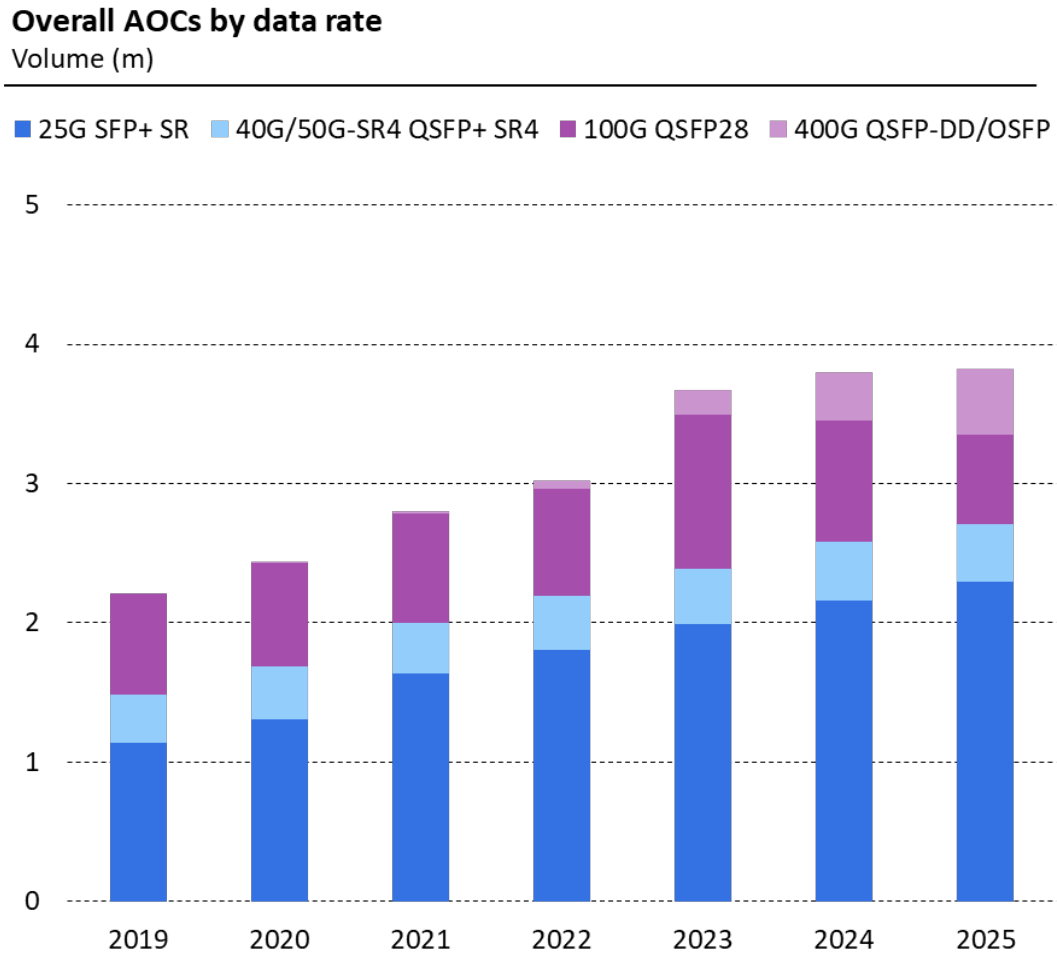
Exhibit 6: 400G optical transceivers used in data centers



AOCs will continue to grow inside the data center with 25G AOCs being driven by Chinese ICPs using them for server connections; enterprise data centers transitioning to 100G: and ICP data centers transitioning to 400G

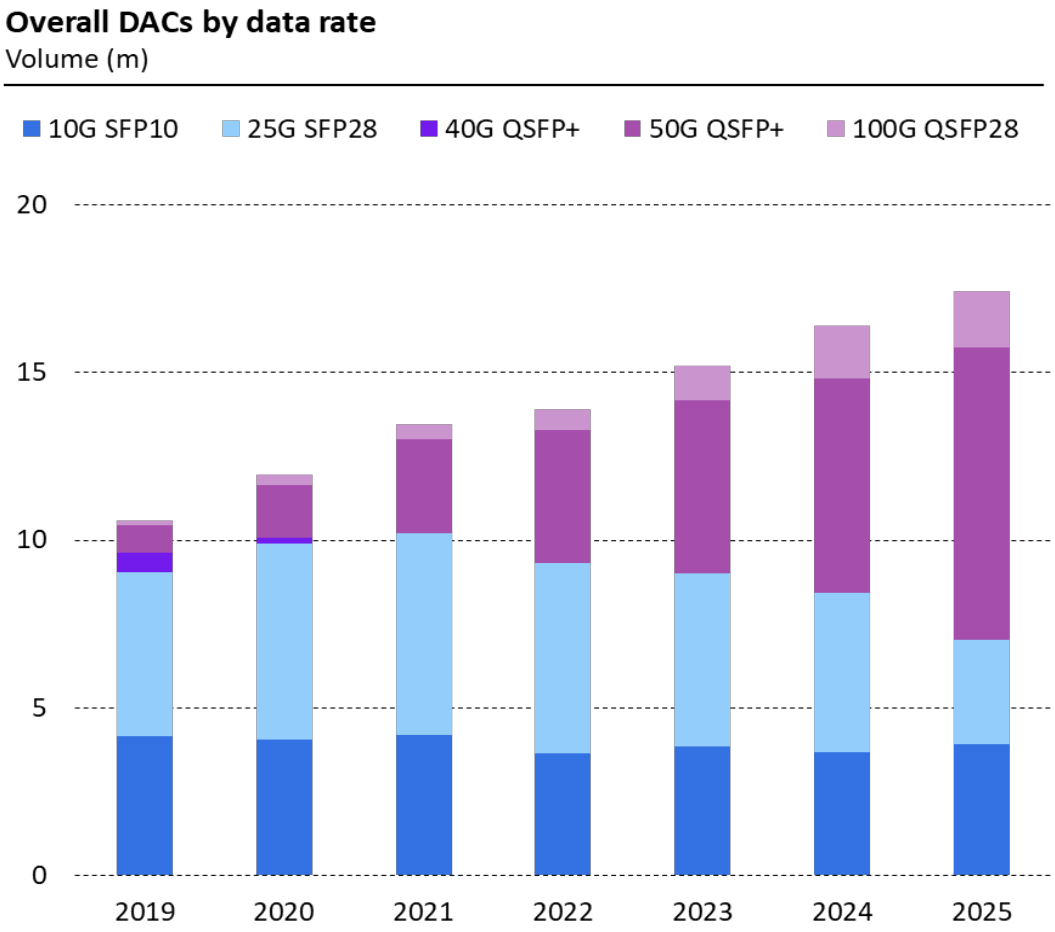
DACs will continue to be used for the majority of server connections in all vertical markets.

Exhibit 7: AOCs used in data centers



Source: Omdia 2020

Exhibit 8: DACs used in data centers



Source: Omdia 2020

Bottom line

- ICPs' bandwidth needs are driving the evolution of data center optical components and the need for 400G.
- ICPs are deploying 400G mainly in spine to super-spine and some leaf-to-spine connections.
  - Volume variants will be DR4 (500m) and FR4 (2km)
- ICP data centers will continue to grow as enterprises and small and medium-sized businesses continue to adopt cloud technologies.
- Switching and optics ecosystem is ready to power the 400G data center.
- New server deployments are transitioning to 50G and above connections using DACs and AOCs.
- New testing technology is needed to support deployment of 400G and above data rates in data center networks.

To learn more

Watch this free webinar

400G and beyond: Driving next generation data centers

presented by Omdia and our partners

The webinar can be accessed at: https://bit.ly/33JfSif

For additional Omdia events, visit:
https://gateway.on24.com/wcc/eh/753397/Omdia+Webinars

Follow the conversation @OmdiaHQ

Author

Lisa Huff
Senior Principal Analyst, Optical Components
lisa.huff@omdia.com

Get in touch

www.omdia.com
askananalyst@omdia.com

Omdia consulting

Omdia is a market-leading data, research, and consulting business focused on helping digital service providers, technology companies, and enterprise decision-makers thrive in the connected digital economy. Through our global base of analysts, we offer expert analysis and strategic insight across the IT, telecoms, and media industries.

We create business advantage for our customers by providing actionable insight to support business planning, product development, and go-to-market initiatives.

Our unique combination of authoritative data, market analysis, and vertical industry expertise is designed to empower decision-making, helping our clients profit from new technologies and capitalize on evolving business models.

Omdia is part of Informa Tech, a B2B information services business serving the technology, media, and telecoms sector. The Informa group is listed on the London Stock Exchange.

We hope that this analysis will help you make informed and imaginative business decisions. If you have further requirements, Omdia's consulting team may be able to help your company identify future trends and opportunities.

Copyright notice and disclaimer

The Omdia research, data and information referenced herein (the “Omdia Materials") are the copyrighted property of Informa Tech and its subsidiaries or affiliates (together “Informa Tech”) and represent data, research, opinions or viewpoints published by Informa Tech, and are not representations of fact.

The Omdia Materials reflect information and opinions from the original publication date and not from the date of this document. The information and opinions expressed in the Omdia Materials are subject to change without notice and Informa Tech does not have any duty or responsibility to update the Omdia Materials or this publication as a result.

Omdia Materials are delivered on an “as-is” and “as-available” basis. No representation or warranty, express or implied, is made as to the fairness, accuracy, completeness or correctness of the information, opinions and conclusions contained in Omdia Materials.

To the maximum extent permitted by law, Informa Tech and its affiliates, officers, directors, employees and agents, disclaim any liability (including, without limitation, any liability arising from fault or negligence) as to the accuracy or completeness or use of the Omdia Materials. Informa Tech will not, under any circumstance whatsoever, be liable for any trading, investment, commercial or other decisions based on or made in reliance of the Omdia Materials.