Independent market research and competitive analysis of next-generation business and technology solutions for service providers and vendors

HEAVY READING
WHITE PAPER

Open and Disaggregated Packet and Optical Networks:
A 2020 Heavy Reading Survey

A Heavy Reading white paper produced for Infinera, IP Infusion, Volta, and TIP

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EXECUTIVE SUMMARY

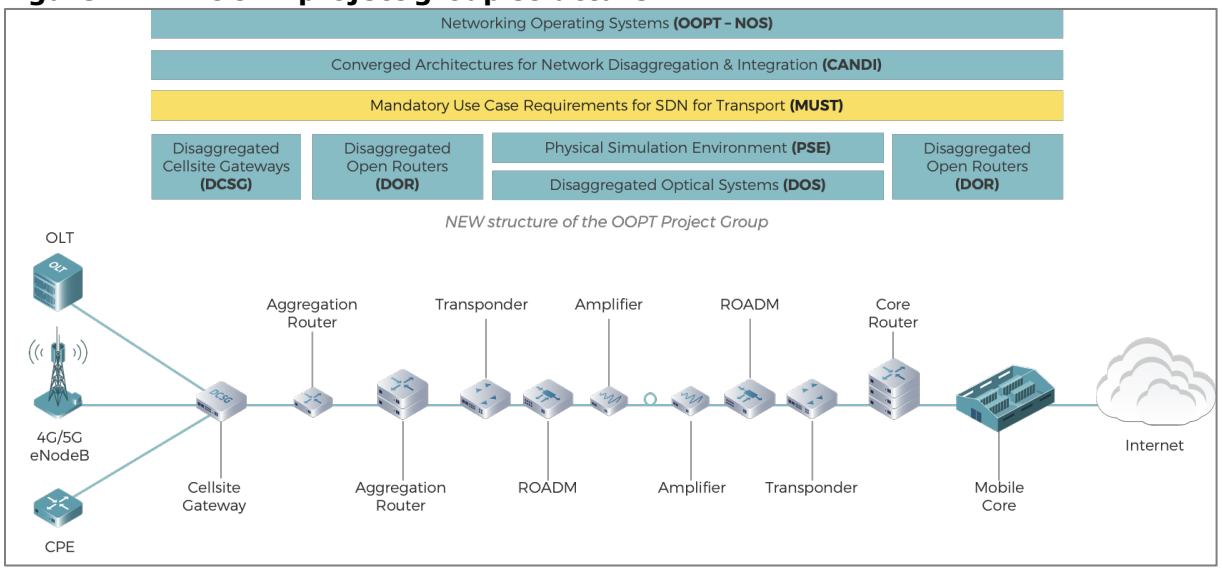
The disaggregation concept comes from the IT world. It refers to the separation of a system into resource components—including the separation of hardware components as well as the separation of software components from the underlying hardware. Adapting the IT concept to the networking environment, Heavy Reading has crafted the following definition:

The separation of networking equipment into functional components and allowing each component to be individually deployed. Ideally, provided in the smallest form factor capable of delivering a specific function. Equipment should be self-contained, require no additional common equipment to operate, and incorporate open APIs to enable software-defined networking (SDN) control.

Although it started at the IP layer, disaggregation has grown in popularity and appeal across the networking segments that Heavy Reading broadly defines as transport networks. These segments consist of IP routers, optical systems, including transponder shelves and line systems, and packet-optical systems that combine functions across optical, Ethernet, and IP layers.

The Telecom Infra Project (TIP) has taken a leadership position in defining a community to accelerate open and disaggregated transport networks, specifically through the projects within TIP's Open Optical and Packet Transport (OOPT) group (see **Figure 1**).

Figure 1: TIP OOPT project group structure



Source: Telecom Infra Project

Significantly, while it is an important industry contributor, TIP is not the only organization dedicated to open and disaggregated transport networks today. Other important groups and standards bodies include the Internet Engineering Task Force (IETF), the Open Reconfigurable Optical Add/ Drop Multiplexers (ROADM) Multi-Source Agreement (MSA), the Open Networking Foundation (ONF), the Open Compute Project (OCP), and the Optical Internetworking Forum (OIF). They work together to contribute to the future of transport networks.

Given the momentum, Heavy Reading decided the timing was ideal to launch an in-depth global operator survey on the future of open and disaggregated transport networks—with a scope generally in line with the TIP OOPT group's scope of work (**Figure 1**). Project partners included active TIP members **Infinera**, **IP Infusion**, and **Volta**, along with **TIP**.

This white paper is based on the survey results and provides the industry's most in-depth look at the current state and future trajectory of open and disaggregated transport networks. Full demographics and survey key findings are detailed below.

Key findings

The following are the key findings from this study.

Disaggregation plans and challenges

On a global basis, operators are fairly early in deploying disaggregated networks. As a group, 55% of respondents reported being in the early stages of education/pre-proof-of-concept (PoC) and PoC, and 45% reported being in the more advanced stages of trials and commercial deployments. 27% reported that deployments have begun.

Deployment status varies by network segment and by geographic region. Data center networks are the furthest along as measured by current deployments, followed by core networks and customer premises equipment (CPE). Disaggregated cell site gateways (DCSGs) registered the lowest percentage of current deployments but are expected to accelerate beginning in 2021. Geographically, North American operators are reporting more advanced deployment phases compared to non-North American operators.

Faster innovation and flexibility in adopting the latest technology is the top driver for leading operators to adopt disaggregated networks based on the survey results. This factor was selected by 51% of respondents. Forming a second tier of motivators is the ability to launch new services and increase revenue and capex reduction. Faster innovation and increasing revenue are related factors, as faster innovation plays a crucial role in launching new services. It is notable that while important, capex reduction is not the main driver for operators to pursue disaggregation.

There are dual issues standing in the way of deployments: strength of features/ functions and accountability for the disaggregated system. The first inhibitor is a technology challenge. Regardless of the potential benefits of disaggregation, if features and functions fall short of application requirements or if they lag behind advanced functions offered by traditional products, operators will not choose disaggregation. The second inhibitor is an operational challenge. At its essence, moving from the monolithic suppliers of the past to the diverse supplier environments of disaggregation leaves an operational hole in procuring, managing, updating, upgrading, troubleshooting, and performing myriad other operational functions.

The dual challenges standing in the way of disaggregation are very different (one is technology, one is operations). The disparate challenges indicate an all-encompassing approach will be needed to overcome them—one that makes use of a broad and deep industry ecosystem.

Regarding disaggregated network software pricing models, the needle is moving toward subscription models versus traditional perpetual licensing models. In the survey, more than half of respondents (55%) reported a preference for subscription-based pricing. Not surprisingly, subscription-based pricing holds less appeal for disaggregated hardware. At 66%, the majority prefer perpetual licensing for white box hardware.

5G and routing

Survey results provide a strong endorsement for split radio access network (RAN) architectures for 5G. While the traditional distributed macro architecture will account for roughly a one-quarter share of emerging 5G RAN, nearly two-thirds (63%) are expected to be some form of partial or full centralization involving functional splits. 42% expect to deploy some form of fronthaul.

While operators anticipate significant disaggregation in the 5G RAN, they also anticipate significant virtualization of the RAN functional components. At 93%, an overwhelming majority of operators surveyed anticipates some level of RAN function virtualization. Among the options, virtualization of both centralized unit (CU; Layer 3) and distributed unit (DU; Layer 2) functions scored the highest, selected by 48% of survey takers. At a distant second, 28% of respondents are interested in CU virtualization only in locations where DU functions are also virtualized.

In selecting a network operating supplier, the ability to provide customer service for both network operating system (NOS) software and hardware, along with the maturity of the NOS software, topped the list of criteria. Third on the priority list is completeness of feature sets. Significantly, if a vendor provides support for the full system, has a strong deployment record, and offers crucial features, that vendor (or partnership of vendors) mitigates the primary challenges standing in the way of commercial deployments. It is up to the vendors to hit the mark, but operators have laid out a clear blueprint for overcoming challenges.

Open optical networks

When deploying open optical networks, operators are looking to eliminate vendor lock-in, lower their capex, and innovate faster. While similar to the benefits of disaggregation, there are some differences. Specifically, operators place a somewhat higher priority on eliminating vendor lock-in and lower capex for optical networks compared to disaggregated networking benefits overall.

The operational complexity of dealing with multiple vendors and a lack of standards/ immature standards are the top barriers to adopting open and disaggregated optical networks based on the survey results. Each of these barriers to adoption was selected by more than half of operators surveyed.

Operators are gearing up for 400ZR and, a little bit later, for 400ZR+. Survey results show a strong ramp for 400ZR in 2021 (during which 27% of respondents expect to deploy the pluggables in routers), followed by an additional 20% in 2022. By the end of 2022, 59% of respondents expect to have some level of 400ZR deployments in their networks. While 400ZR+ near-term expectations are lower, by the end of 2022, just over half of respondents expect 400ZR+ pluggables in their networks.

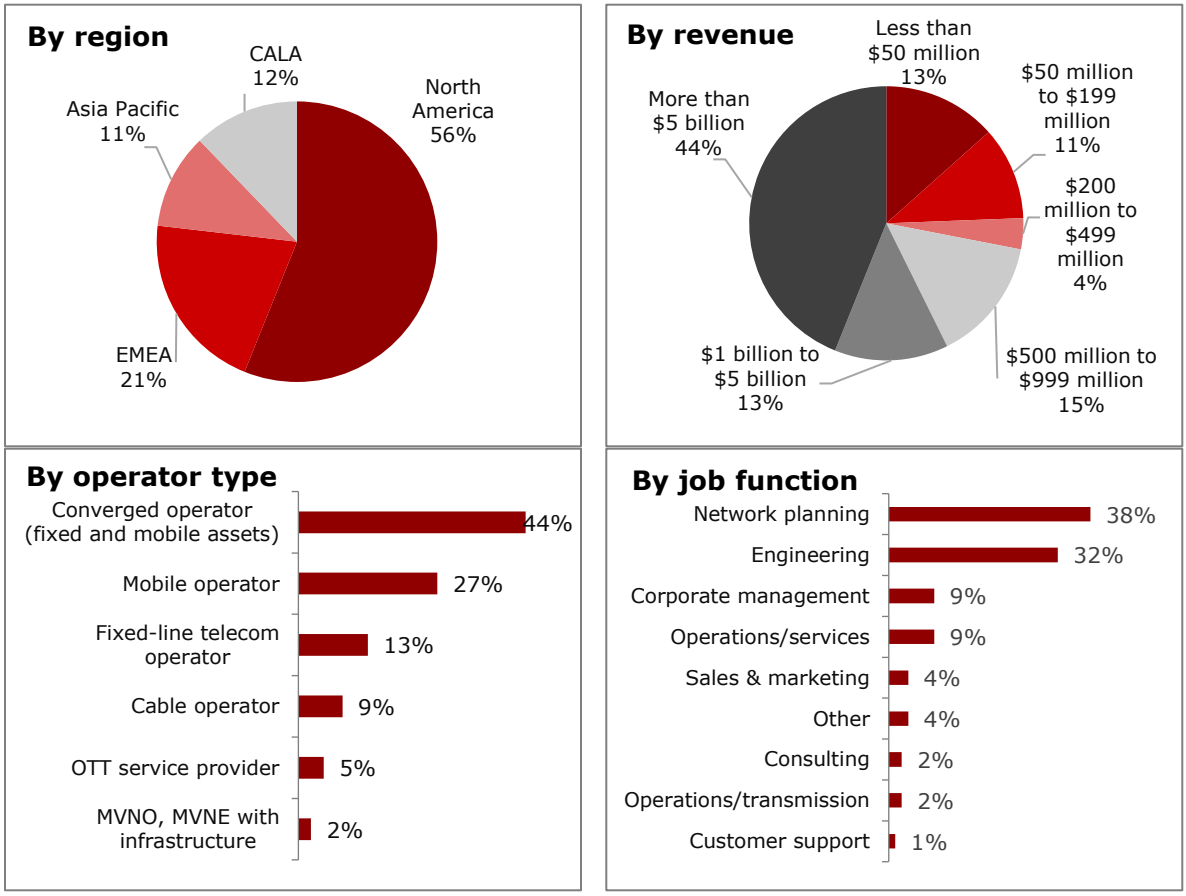
Management and control

Existing management systems will play a crucial role in disaggregation even as operators migrate to new suppliers and network architectures. 50% of respondents expect to use an even mix of management for disaggregated networks, divided between new management platforms and existing systems (including element management systems [EMS], network management systems [NMS], business support systems [BSS], and operations support systems [OSS]). At a distant second place, 23% of operators expect only limited use of existing systems and will rely on new platforms for their new disaggregated networks. To be successful, suppliers must find a way to integrate the new technologies into the old.

Survey demographics

This Heavy Reading report is based on a web-based survey of network operators worldwide conducted in December 2020. Respondents were drawn from the network operator list of the Light Reading readership database. After reviewing responses, 82 were deemed qualified participants and were counted in the results. To qualify, respondents had to work for a verifiable network operator and be involved in network planning and/or purchasing network equipment. The full survey demographics are detailed in **Figure 2**.

Figure 2: Survey response demographics



n=82
Source: Heavy Reading

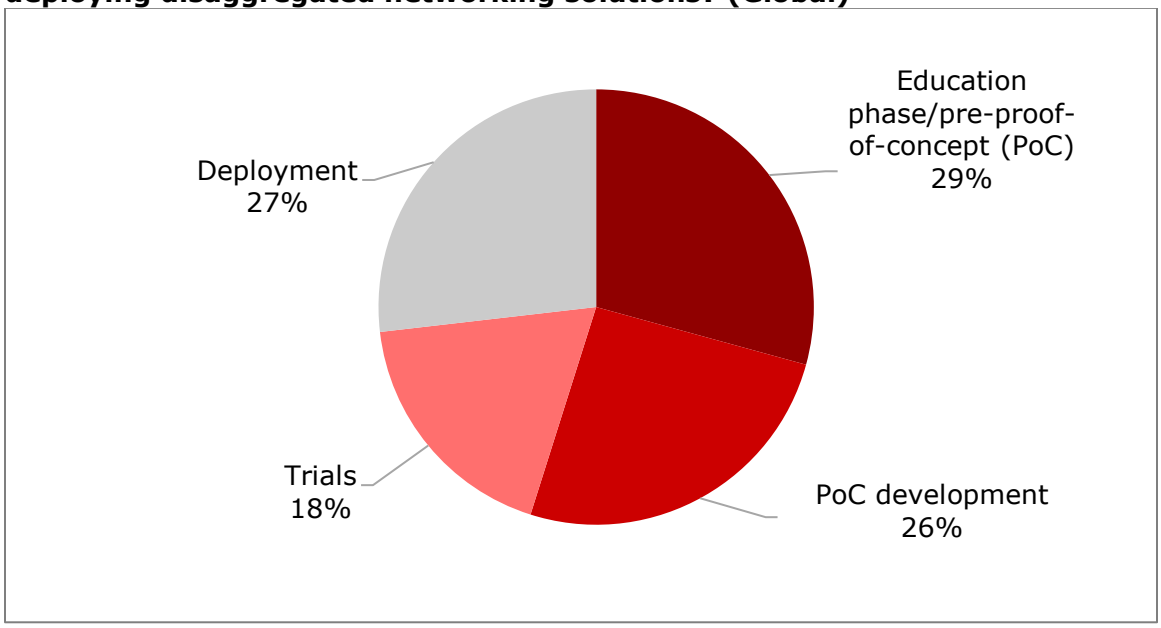
It is important to note that the survey was promoted as a Heavy Reading research survey. By design, TIP played no role in respondent solicitation and was not mentioned as a survey project partner. Heavy Reading wanted completely candid industry responses.

DISAGGREGATION TIMELINES, MOTIVATIONS, AND CHALLENGES

Heavy Reading wanted to better understand operators' current phase of deploying disaggregated networking products as well as their timelines for implementing disaggregation in different network segments. **Figure 3** shows the current deployment phase for the global group of network operators surveyed.

Not surprisingly, operators are fairly early in the process. As a group, 55% of respondents reported being in the early stages of education/pre-PoC and PoC, and 45% reported being in the more advanced stages of trials and commercial deployments. 27% reported that deployments have begun.

Figure 3: Which statement best describes your organization's current phase of deploying disaggregated networking solutions? (Global)

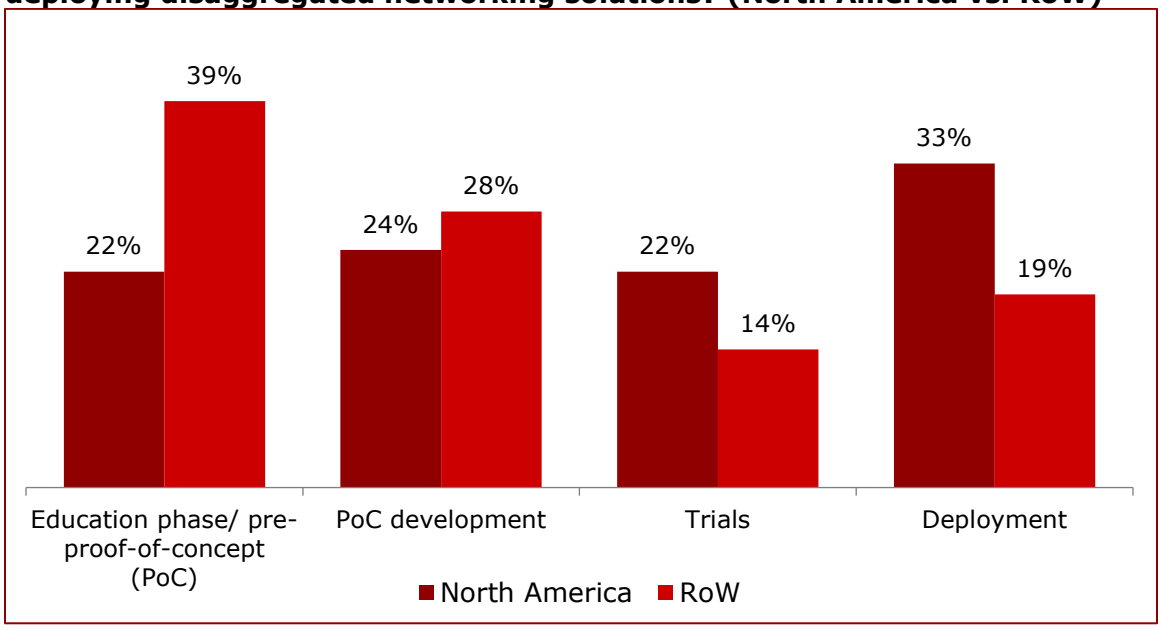


n=82
Source: Heavy Reading

While **Figure 3** accurately describes the status of the survey sample group, the deployment expectations shown likely skew more aggressive than the wider population of operators globally. This is due to the survey methodology. Operators self-select whether they want to respond to Heavy Reading surveys, and it is natural that operators with a higher interest in the topic will take the time to fill out the questionnaire. As a result, surveys tend to under-represent the industry laggards.

Digging a bit deeper, deployment status also varies significantly by geography, with North American operators reporting more advanced deployment phases compared to non-North American operators (labeled as Rest of World, or RoW, throughout this paper). **Figure 4** compares the disaggregation deployment status between North American and RoW respondents. Outside of North America, a far greater percentage of respondents are in the earliest education phase (39% RoW vs. 22% North America) and a much lower percentage are in current deployment (19% RoW vs. 33% North America).

Figure 4: Which statement best describes your organization's current phase of deploying disaggregated networking solutions? (North America vs. RoW)



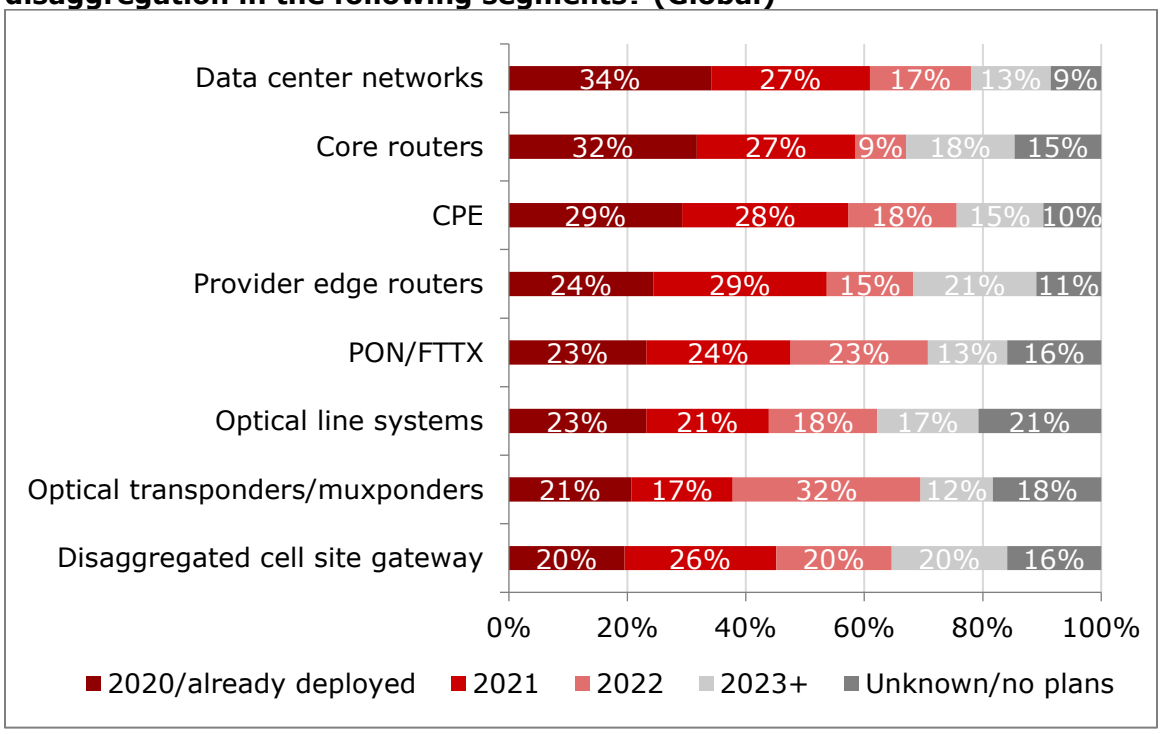
n=46 North America, 36 RoW
Source: Heavy Reading

Disaggregation will not be applied to all networking segments equally. Heavy Reading asked respondents to identify expected timelines for deploying disaggregation in various segments. **Figure 5** below shows timelines for eight networking segments (arranged in descending order according to percentage deploying today).

Dominating current deployments are data center networks, core routers, and CPE. Provider edge routers ranked fourth in terms of current deployments, but respondents expect a significant boost in disaggregated provider edge router deployments in 2021 and another jump in 2022.

Expected timelines for DCSGs are also notable. Led by organizations like TIP and OCP, global interest in white box routers is high. However, survey results indicate that deployments will lag behind most other networking segments, at least in the near term. Just 20% of respondents reported DCSG deployments today (the lowest percentage of any segment). Even with an additional 26% expecting DCSG deployments in 2021, the segment is expected to rank sixth of the eight networking segments by the end of that year.

Figure 5: What is your organization's expected timeline for deployment disaggregation in the following segments? (Global)

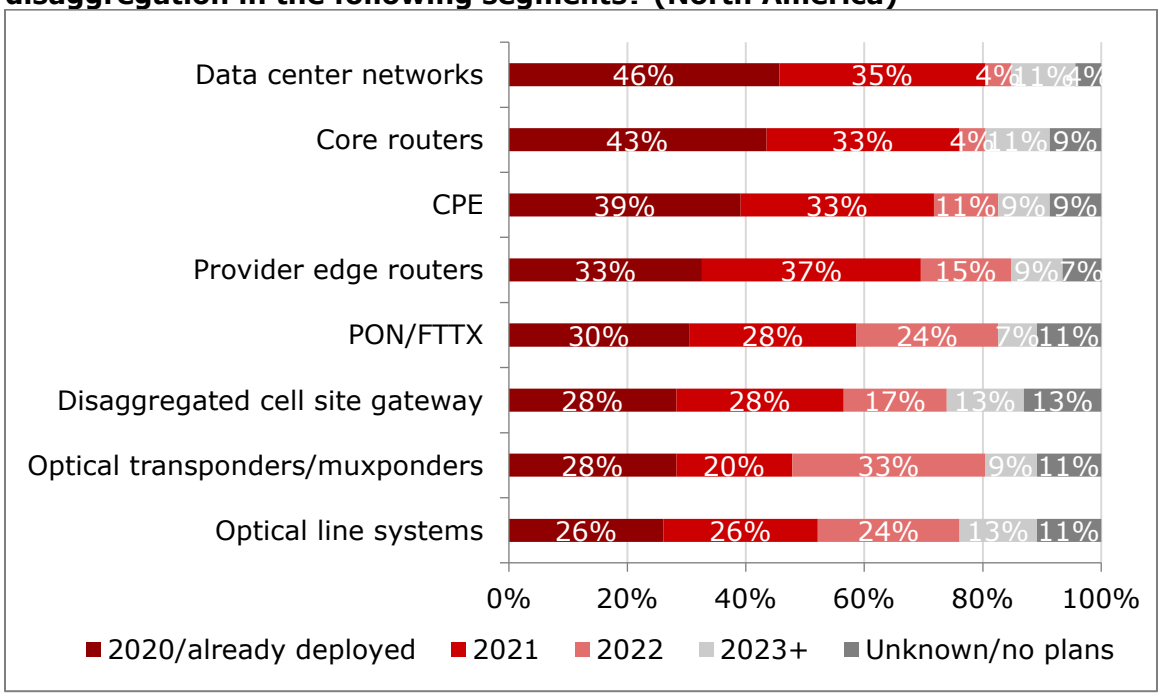


n=82
Source: Heavy Reading

As with disaggregation deployment status overall, expected timelines for various segments differ significantly by geography. North American operator deployment expectations skew more aggressive than those of RoW operators across all networking segments. The North American lead in current deployments was particularly pronounced in data center networks, core routers, and DCSG—with 20 percentage points or greater separating North American and RoW respondents in each of the segments (for current deployments). Among the segments, North American and RoW respondents are most aligned for optical open line system deployments.

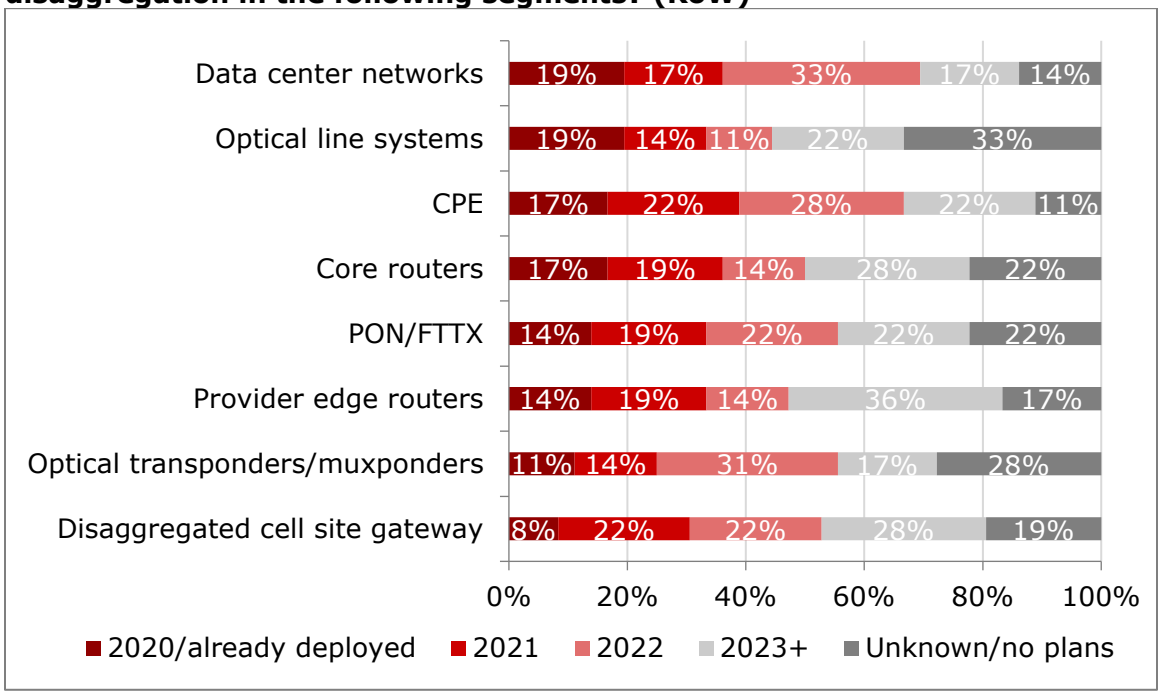
Figure 6 below shows expected timelines for North American respondents only and **Figure 7** shows the timeline expectations for RoW respondents.

Figure 6: What is your organization's expected timeline for deployment disaggregation in the following segments? (North America)



n=46
Source: Heavy Reading

Figure 7: What is your organization's expected timeline for deployment disaggregation in the following segments? (RoW)



n=36
Source: Heavy Reading

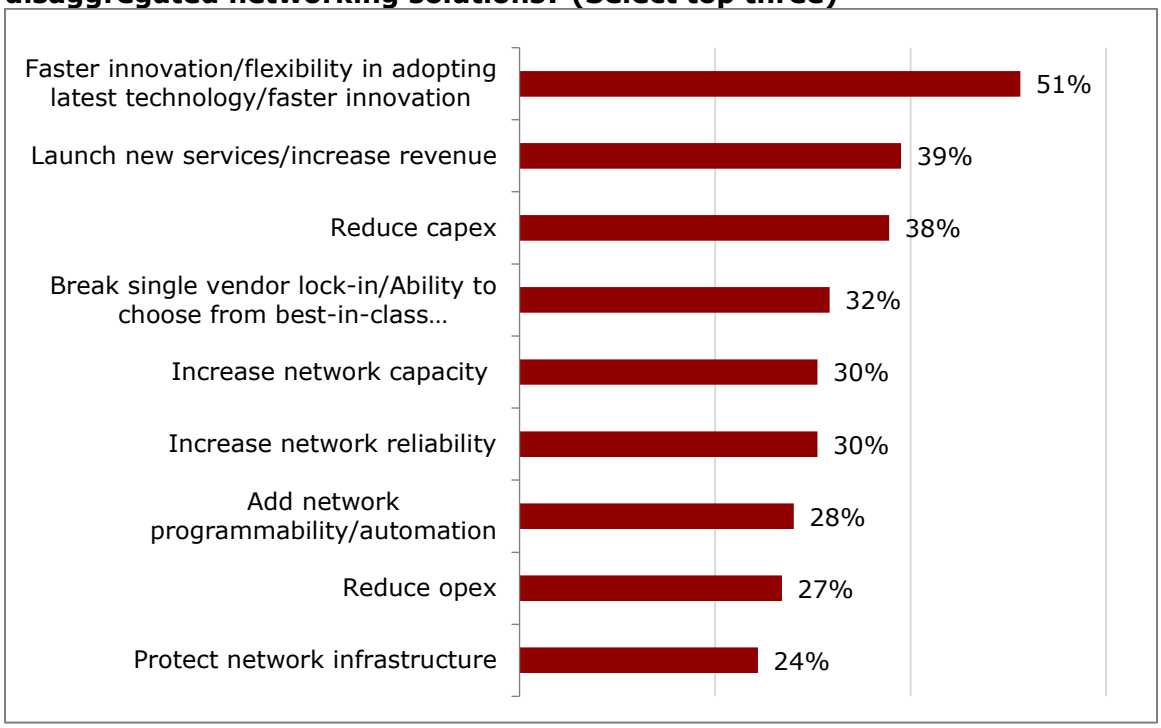
Faster innovation and flexibility in adopting the latest technology is the top driver leading operators to adopt disaggregated networks based on the survey results. This factor was selected by 51% of respondents (see **Figure 8**). Forming a second tier of motivators is the ability to launch new services and increase revenue (selected by 39% of respondents) and capex reduction (selected by 38%). Faster innovation and increasing revenue are related factors, as faster innovation plays a crucial role in launching new services.

It is notable that, while it is an important factor, capex reduction is not the primary driver in deploying disaggregated networks. In the early days of white box and virtualization, capex reduction typically scored at the top of the list in terms of drivers. However, as time has progressed, operators have increasingly focused on services and revenue benefits—exactly as respondents have indicated in this survey.

Looking at results by region, faster innovation was the top choice across geographies, but one factor showed significant difference in comparing North America and RoW results: increasing network capacity. While increasing network capacity was the least likely motivating factor for RoW respondents, it ranked second among North American respondents—above new services and above capex reduction.

While increasing network capacity is a common need among network operators globally, North American operators have seized on disaggregation as a means to this goal in a way that operators outside of North America have not (yet) done. It is possible that network capacity will increase in importance as RoW operators progress further in their disaggregation strategies and deployments.

Figure 8: What are the top factors motivating your organization to adopt disaggregated networking solutions? (Select top three)



n=82
Source: Heavy Reading

Like any emerging communications trend, network disaggregation is not without its set of challenges. Heavy Reading asked operators to identify the biggest challenges to adopting and deploying disaggregated network technologies. From a list provided, respondents were asked to select up to three. **Figure 9** below shows the results.

Results show that dual challenges have risen to the top in terms of inhibiting disaggregated network deployments:

- Technology maturity level and available features (the top selection, at 61%)
- Internal processes and lack of operational models to deal with disaggregated networks (selected by 50%)

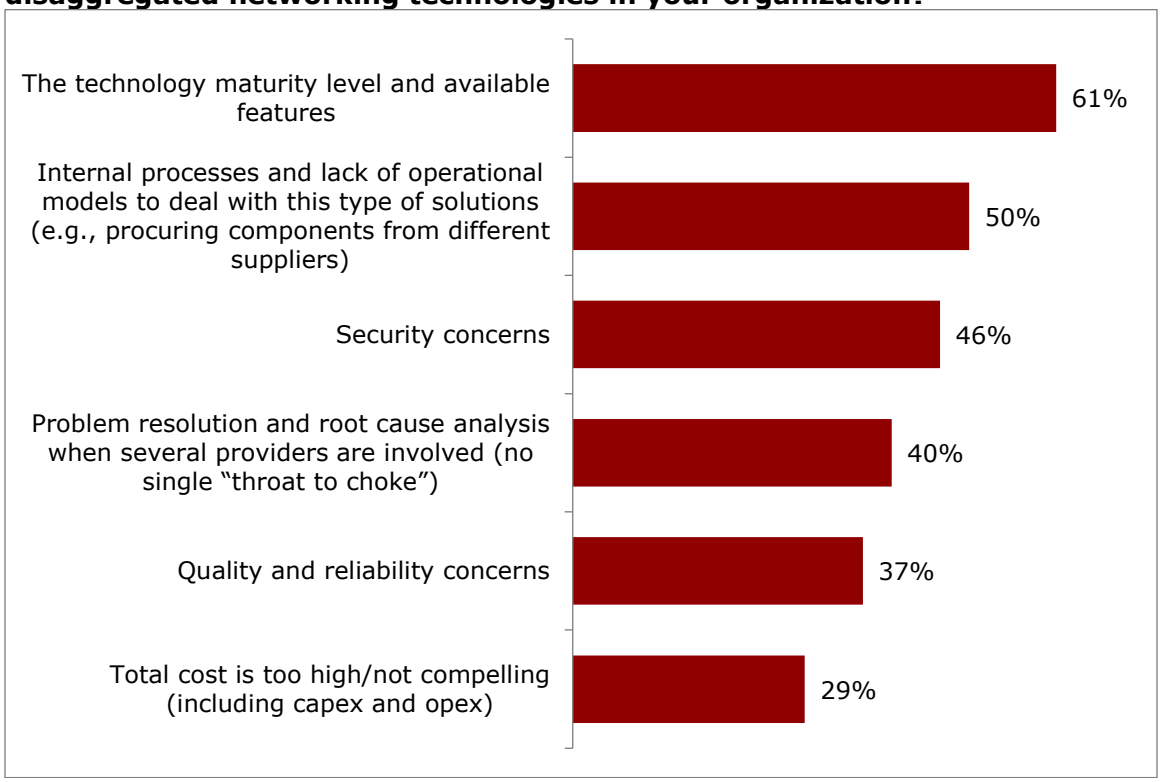
Heavy Reading notes that these challenges are very different in nature. They indicate that an all-encompassing approach will be needed to overcome them—one that makes use of a broad and deep industry ecosystem.

The first inhibitor is a technology challenge. Regardless of the potential benefits of disaggregation, if features and functions fall short of application requirements or if they lag behind advanced functions offered by traditional products, operators will not choose disaggregation. For each segment, suppliers must build to specific requirements and with a path to operators' future roadmaps.

The second inhibitor is an operational challenge—and a recurring theme among Heavy Reading SDN surveys over the past nine years. At its essence, moving from monolithic suppliers of the past to the diverse supplier environments of disaggregation leaves an operational hole in procuring, managing, updating, upgrading, troubleshooting, and performing myriad other operational functions. Some early movers, such as AT&T, Telefónica, and Vodafone, have moved aggressively to bring necessary operational expertise in-house. Other operators (even Tier 1 operators) are unable to take on such operational responsibilities and must rely on outside help for a range of functions.

Here, systems integrators are set to play a large role in filling the operational expertise gap. Beyond systems integrators, disaggregation ecosystems must be developed to address specific segments and use cases (such as DCSGs for 5G). And common architectures and standardized approaches must be developed and agreed upon by a large number of operators and suppliers. Groups such as TIP and OCP play essential roles in building common architectures, as do traditional standards organizations, including the IETF, OIF, and others.

Figure 9: What are the biggest challenges to adopting/deploying open disaggregated networking technologies in your organization?

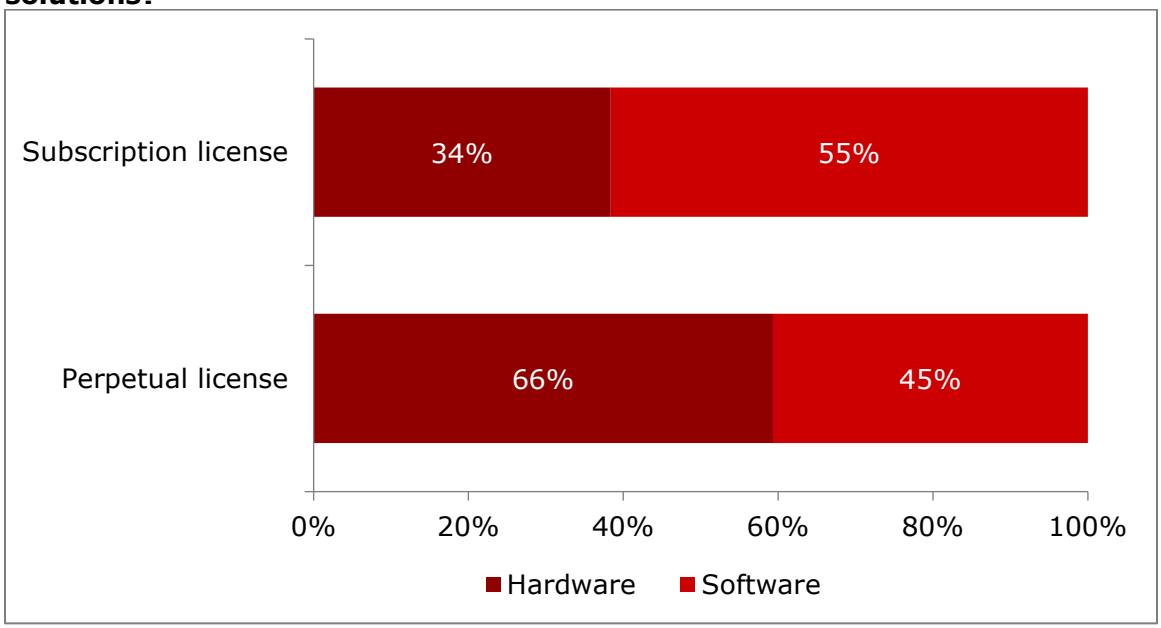


n=82
Source: Heavy Reading

Finally, Heavy Reading asked operators about their views on pricing models for disaggregated hardware and software. Although not an unmitigated endorsement for subscription models, the results (shown in **Figure 10** below) do indicate that the needle is moving in this direction, particularly for disaggregated network software. At 55%, more than half of global operators surveyed reported that they prefer subscription models for network software versus 45% that prefer perpetual licenses. Under the traditional networking models, operators have bought hardware and software upfront (often at discounted prices) but then have been locked into suppliers for ongoing support and maintenance. Preference for a subscription model represents a change.

Not surprisingly, the subscription model holds less appeal for operator hardware purchasing. Just 34% of respondents prefer subscription hardware purchases versus 66% that prefer the perpetual license.

Figure 10: What is your preferred pricing model for disaggregated networking solutions?



n=82
Source: Heavy Reading

5G AND ROUTING

Historically, the RAN has remained closed and proprietary; all the RAN components and the interfaces between them have been controlled by a single vendor. Spurred by the development of 5G, the momentum is shifting with the introduction of the open RAN concept. Heavy Reading defines open RAN as the ability to integrate, deploy, and operate RANs using components, subsystems, and software sourced from multiple suppliers. In 5G, the subsystems are the antenna unit , the remote unit (RU), the DU, and the CU.

Major operators, including AT&T, China Mobile, Deutsche Telecom, NTT DoCoMo, Rakuten Mobile, Telefónica, Vodafone, and many others, are leading the charge in opening the RAN. They are working through organizations such as 3GPP, the O-RAN Alliance, TIP, Small Cell Forum, and others.

Functional decomposition in the RAN presents operators with several architectural options for the transport network. These options include fully distributed RANs (like traditional macro cells), a fully centralized RAN, and split RAN options. Heavy Reading asked operators to estimate the 5G RAN functional splits options they expect to deploy in their emerging 5G RANs between 2020 and 2023.

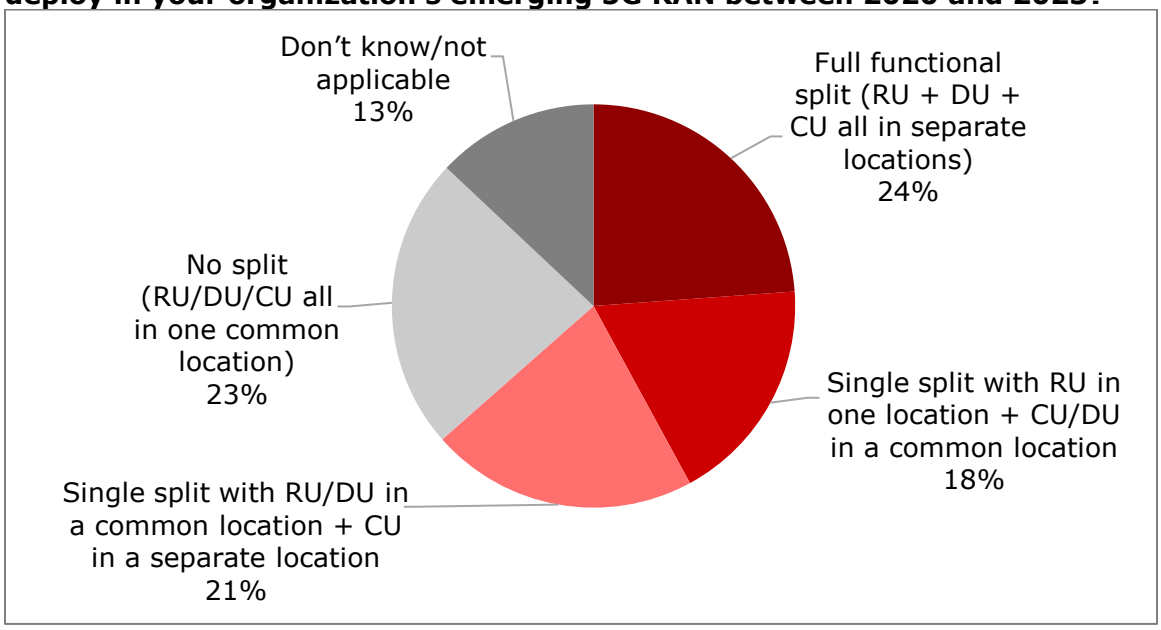
For each individual respondent, functional split percentages had to tally 100%. **Figure 11** below shows the average functional split breakdown for the full survey group.

While individual preferences swing widely across the options, on average, the results show a remarkably even breakdown among the four options. At the high end, both the traditional macro architecture and the fully split RU+DU+CU option garnered nearly equal share (at 23% and 24% share, respectively). Single split RU/DU+CU (associated with midhaul

transport) averaged 21%, followed by single split RU+DU/CU (associated with fronthaul transport), which averaged 18%. The smallest percentage (13%) selected don't know/not applicable.

While there is no single standout, the results are a strong endorsement for split architectures generally. The traditional distributed macro architecture will account for roughly a one-quarter share of emerging 5G RAN based on the results, but nearly two-thirds (63%) are expected to be some form of partial or full centralization involving functional splits. Heavy Reading finds this result to be a strong endorsement of centralized/split architectures and a departure from Heavy Reading surveys in previous years in which the majority of respondents favored traditional macro architectures for 5G.

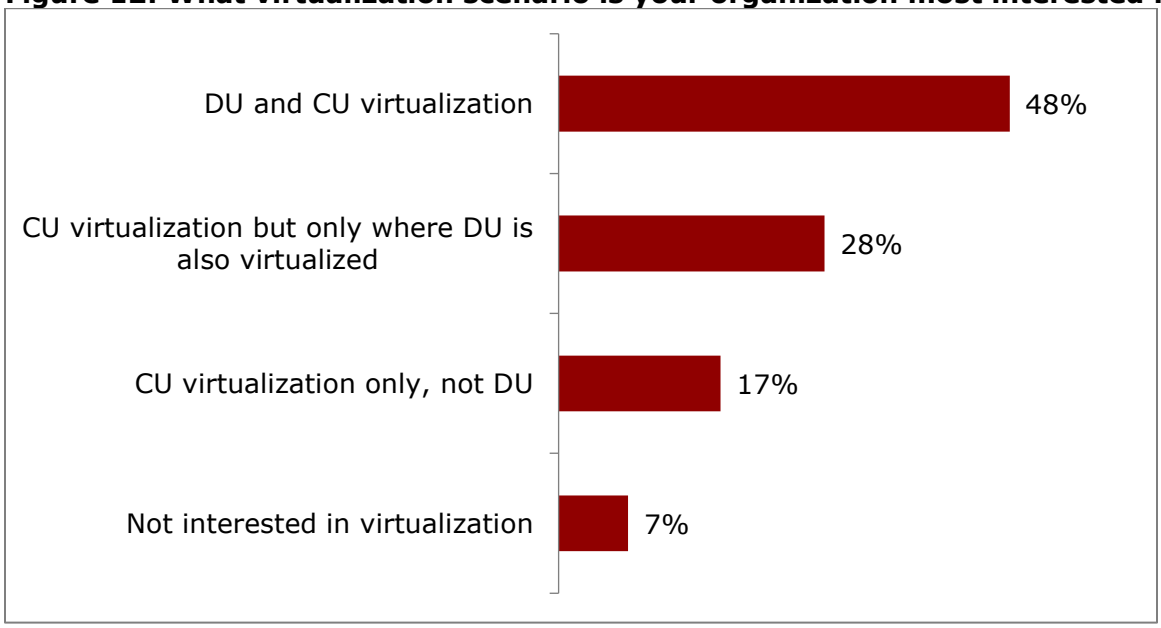
Figure 11: What percentage of 5G RAN functional split options do you expect to deploy in your organization's emerging 5G RAN between 2020 and 2023?



n=82
Source: Heavy Reading

Although operators anticipate significant disaggregation in the 5G RAN (**Figure 11**, above), they also anticipate significant virtualization of the RAN functional components. As shown in **Figure 12** below, an overwhelming majority of 93% of respondents anticipate some level of RAN function virtualization. Among the options, virtualization of both the CU (Layer 3) and DU (Layer 2) functions scored the highest, selected by 48% of survey takers. At a distant second, 28% of respondents are interested in CU virtualization only in locations where DU functions are also virtualized.

Figure 12: What virtualization scenario is your organization most interested in?



n=82
Source: Heavy Reading

Operators' edge cloud and 5G strategies are tightly interlinked because edge locations are required to meet the application latency requirements of advanced 5G ultra-reliable low latency communications (URLLC) use cases. In other words, 5G alone cannot address latency in URLLC use cases. 5G must be coupled with processing and storage in close proximity to the users (at the edge), whether that is to ensure <20ms round-trip time (RTT) at the near edge or <5ms RTT at the far edge.

Heavy Reading asked survey respondents to identify where they expect their network edge computing functions to physically reside. From a list of locations provided, respondents were able to select all locations that apply. **Figure 13** below shows the results.

At 56%, central office locations topped the list of preferences, but the surprising finding is that all locations are in play—from the cloud data center to the cell site to the customer premises. Each location was selected by at least 40% of operators.

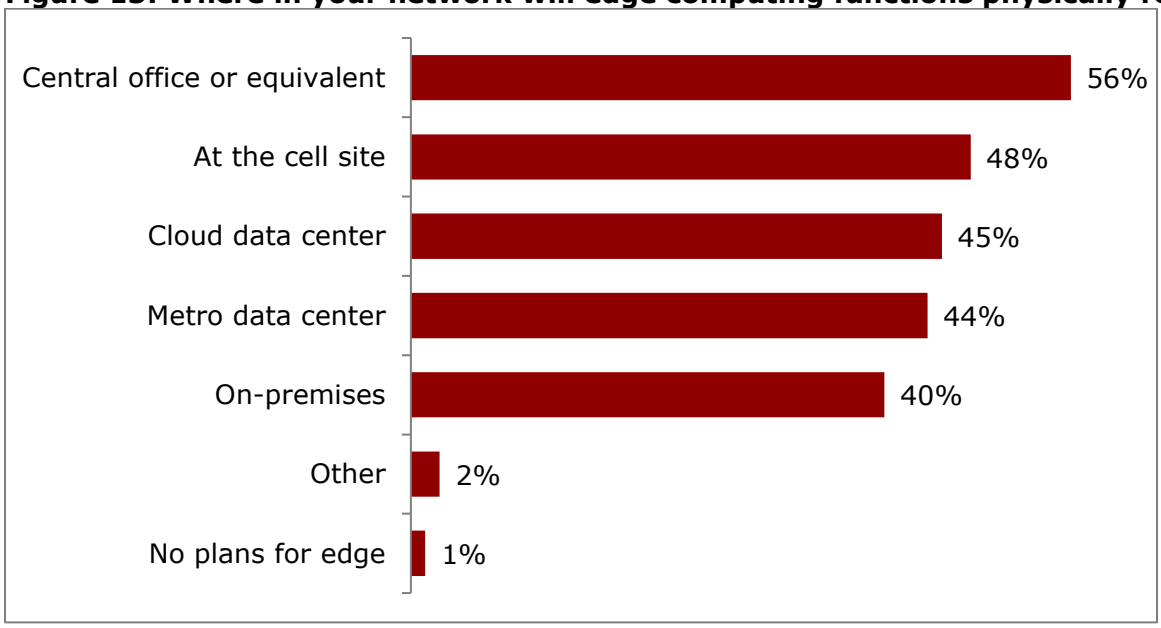
Operator interest in the on-premises edge is not surprising. Manufacturing, distribution, transportation, and education are all big industries that expect to benefit from computing and storage placed onsite. Operators can offer these private 5G networks as a service to enterprise and government customers or enterprises and governments may opt to build their own private networks.

High operator interest in data center edge (whether metro or cloud) is also not surprising, as past Heavy Reading surveys have yielded similar results. Data center-based edge locations provide two strong benefits:

- Physical proximity to users in densely populated areas.
- A gathering place for entire edge ecosystem of partners, including hyperscalers, cloud providers, other connectivity providers, and enterprise customers.

The strength of cell site-based edge is a bit of a surprise; in past Heavy Reading surveys, the cell site has scored lower on the priority list. Heavy Reading has heard of operator interest in placing edge functions at macro cells where they also have physical space. Yet, the amount of physical space will limit the amount of processing and storage (certainly compared to a central office or a data center location).

Figure 13: Where in your network will edge computing functions physically reside?



n=82
Source: Heavy Reading

Hardware and software disaggregation allows operators to source their switching hardware and their network operating systems software from separate suppliers. If successful, this disaggregation approach yields key benefits in eliminating vendor lock-in, increasing flexibility/ agility in responding to network change, speeding innovation to market, and reducing capex—consistent with operators' stated goals in adopting disaggregation (as detailed in **Figure 8**). This approach has become particularly important in IP routing. The DCSG segment, promoted by TIP, is one prominent example of the hardware and software disaggregation model, but the NOS/hardware separation model extends to other segments as well, including edge and core routing.

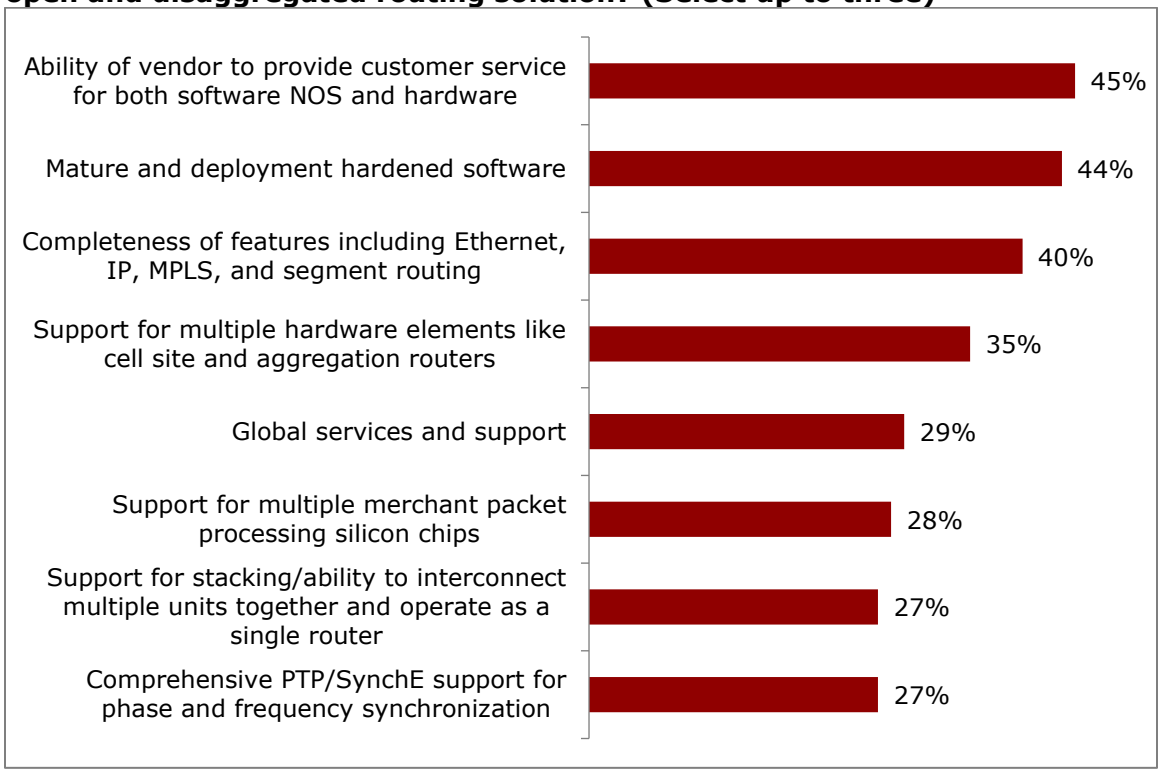
Heavy Reading wanted to better understand operator criteria for selecting a NOS software supplier, including the relationship between software and hardware platforms in the purchase. Given a list of criteria, respondents were asked to select the most important ones (up to three). **Figure 14** below shows the survey results.

Topping the list of criteria (and statistically tied) are the ability of the vendor to provide customer service for both NOS software and hardware (selected by 45% of respondents) and the maturity of the NOS software (selected by 44%). Third on the priority list is completeness of feature sets (selected by 40%).

Heavy Reading notes that these criteria align very closely with the top disaggregation challenges that respondents identified in **Figure 9**, specifically, technology maturity and available features and the internal process and operational models. If a vendor provides support for the full system, has a strong deployment record, and offers crucial features, that vendor (or partnership of vendors) mitigates the primary challenges standing in the way of commercial deployments.

Although it is up to the vendors to meet the mark, operators have laid out a clear blueprint for overcoming their inhibitors.

Figure 14: What are the most important criteria in selecting a NOS supplier for open and disaggregated routing solution? (Select up to three)



n=82
Source: Heavy Reading

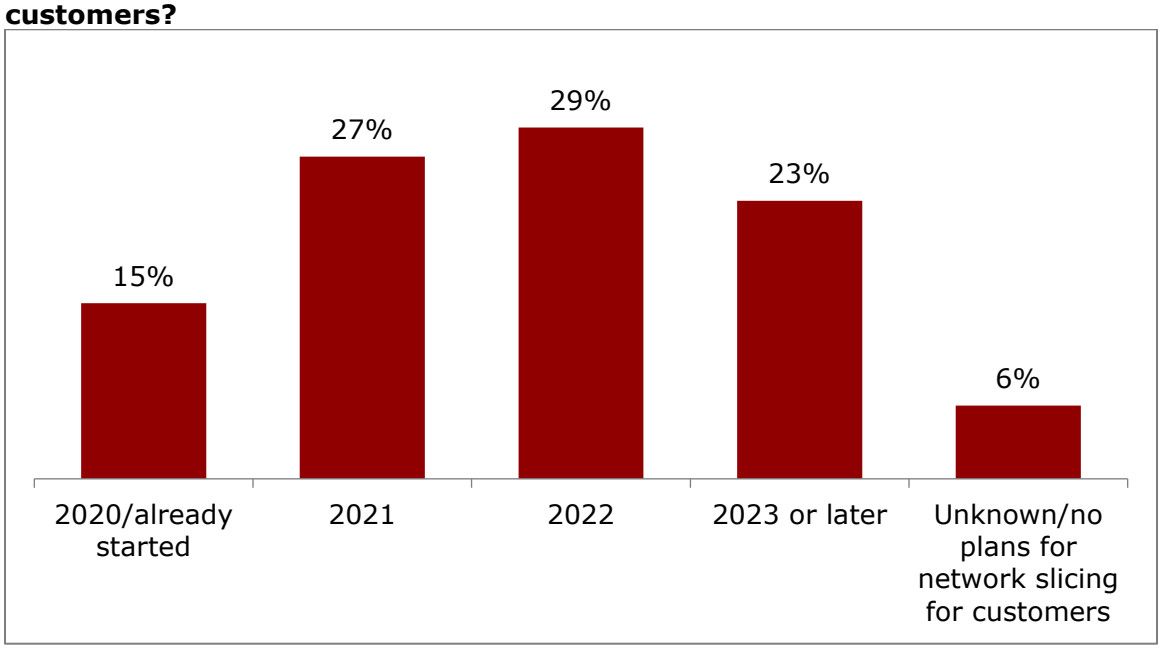
Lastly in this section, Heavy Reading asked service providers about their timelines for introducing network slicing. Network slicing is the use of virtualization to divide physical networks into multiple virtual connections by which different customers get different access to the shared physical network resources. Operators view end-to-end network slicing as critical for addressing customer requirements across the diverse set of 5G use cases—including enhanced mobile broadband (eMBB), URLLC, and massive machine-type communication (mMTC). The transport network is part of the end-to-end slice, and thus operators see slicing as essential for next-generation routers that will support 5G services.

Figure 15 below shows expected operator timelines for introducing network slicing for customers. As slicing is tied to Release 16 and Phase 2 services, it is not surprising that there is minimal slicing in networks. Operators, however, anticipate a strong ramp in slicing in the 2021–22 timeframe, during which 56% of operators surveyed expect to introduce this

function. At 23%, nearly one-quarter have longer-term expectations for slicing (2023 and beyond).

Certainly, slicing can exist without disaggregation; for example, a traditional router with segment routing or Ethernet VPN (EVPN) functions can slice IP networks. However, as the survey data has shown, disaggregated network elements must meet next-gen feature sets or they will not be adopted. For suppliers, the pressure is on to meet slicing feature requirements beginning this year.

Figure 15: When does your organization plan to introduce network slicing for end customers?



n=82
Source: Heavy Reading

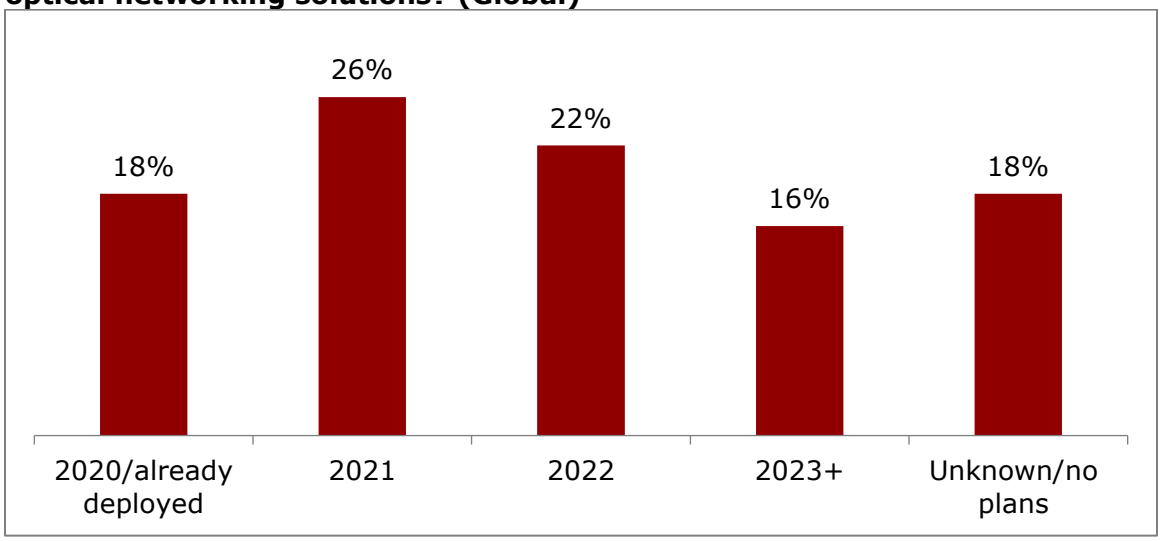
OPEN OPTICAL

Optical and disaggregated optical networks are an increasing area of focus for network operators, and in the survey, Heavy Reading dedicated a set of questions specifically to this trend. For clarity in addressing the optical questions, Heavy Reading provided the following definition for open optical networking:

A multi-vendor environment where service providers can mix and match transponders/ muxponders from multiple vendors with an optical line system from another supplier.

Heavy Reading asked operators to identify their expected timelines for deploying multi-vendor open optical networks. **Figure 16** below shows the results. At 18%, a minority share of operators has deployed open optical networks to date. Respondents have high expectations for the 2021–22 timeframe, when an additional 48% expect to deploy open optical networks globally. Operator expectations are encouraging given that, so far, they have prioritized IP layer disaggregation initiatives ahead of the optical layer.

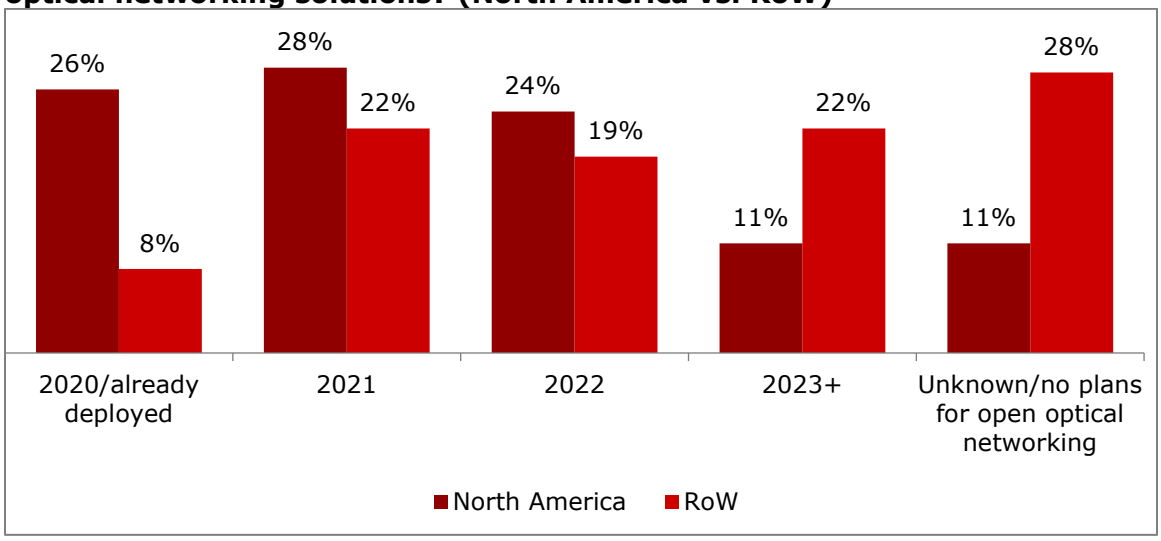
Figure 16: When does your organization intend to deploy multi-vendor open optical networking solutions? (Global)



n=82
Source: Heavy Reading

Behind the global figures, there are some major differences in expectations by geographic region, which Heavy Reading shows in **Figure 17**. To date, open optical networking has largely been led by North American operators, based on the survey results, which show 26% of North American operators having deployed open optical networks compared to just 8% of respondents outside of North America. Results also show operators outside North America are much more likely to have longer-term plans for open optical networks (22% selecting the 2023+ timeframe) and much more likely to be undecided or have no future plans (28% selecting undecided/no plans).

Figure 17: When does your organization intend to deploy multi-vendor open optical networking solutions? (North America vs. RoW)

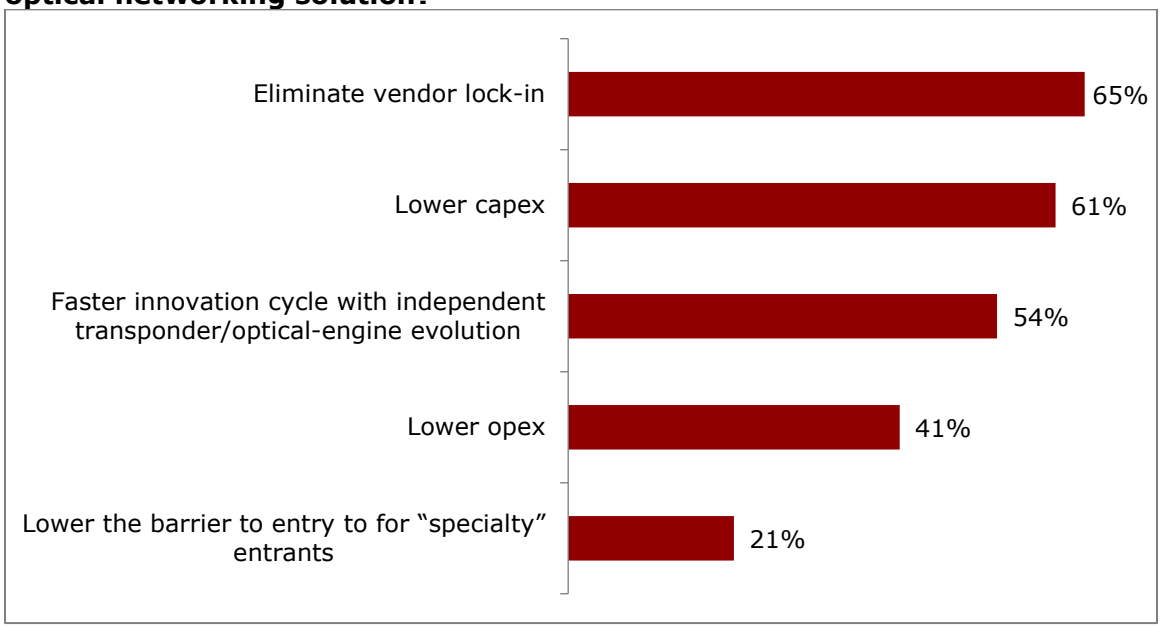


n=46 North America, 36 RoW
Source: Heavy Reading

When deploying open optical networks, operators are looking to eliminate vendor lock-in, lower their capex, and innovate faster. Each of these factors was selected by more than 50% of respondents when asked about benefits, as shown in **Figure 18**. Operators were asked to identify up to three benefits from a list provided.

While similar to the drivers of disaggregation overall (as detailed in **Figure 8**), there are some differences. Specifically, operators place a somewhat higher priority on eliminating vendor lock-in and lower capex for optical networks compared to disaggregated networking benefits overall. In general, the IP layer is closer to services and revenue compared to the optical layer—which takes on the bulk of the transport burden. Although optical suppliers do not like to hear it, operators often think of optical networks as the plumbing. In this context, it is not surprising that operators seek to use disaggregation to drive down the cost per bit of optical transport as they seek to drive more revenue out of IP layer disaggregation.

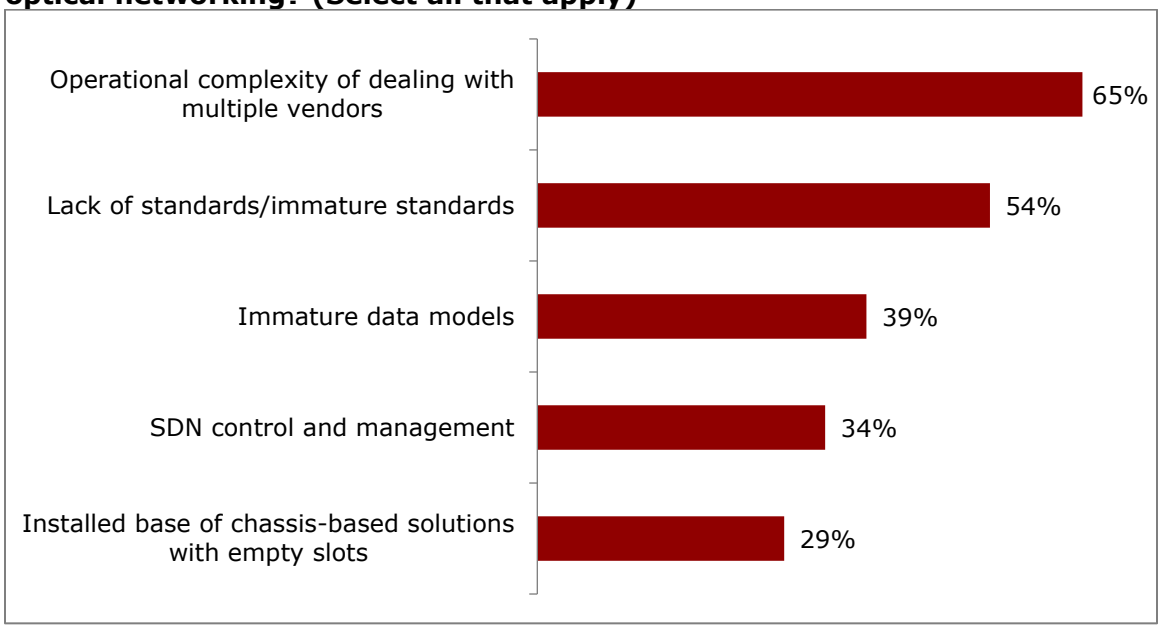
Figure 18: What are the biggest benefits of deploying of a multi-vendor open optical networking solution?



n=82
Source: Heavy Reading

When asked about barriers to adopting open and disaggregated optical networks, nearly two-thirds (65%) of respondents cited operational complexity of dealing with multiple vendors, followed by lack of standards/immature standards (selected by 54%). **Figure 19** below shows the full results. Operational complexity and lack of standardization are partially linked, as standardization can help reduce some of the challenge of working with multiple vendors. But operational complexity goes beyond standards interfaces, and, as with disaggregation in general, most operators will need industry help in operating these disaggregated networks.

Figure 19: What are the biggest barriers to the adoption of multi-vendor open optical networking? (Select all that apply)



n=82
Source: Heavy Reading

Finally, Heavy Reading asked operators about one of the biggest trends in optical networking in 2021—OIF's 400ZR specification and the extended distance 400ZR+variant that is not part of the OIF. 400ZR plays into network disaggregation by separating transponder vendors from line vendors (a form of partial disaggregation) and by allowing standardized pluggable optics from multiple suppliers to be plugged into routers from multiple suppliers. The pluggable architectures reduce capex costs, break vendor lock-in, and promote faster innovation—all major disaggregation goals for operators.

To better understand the future of 400G pluggable optics, Heavy Reading asked respondents to detail expected deployment timelines for both 400ZR and 400ZR+. **Figure 20** below shows the global results.

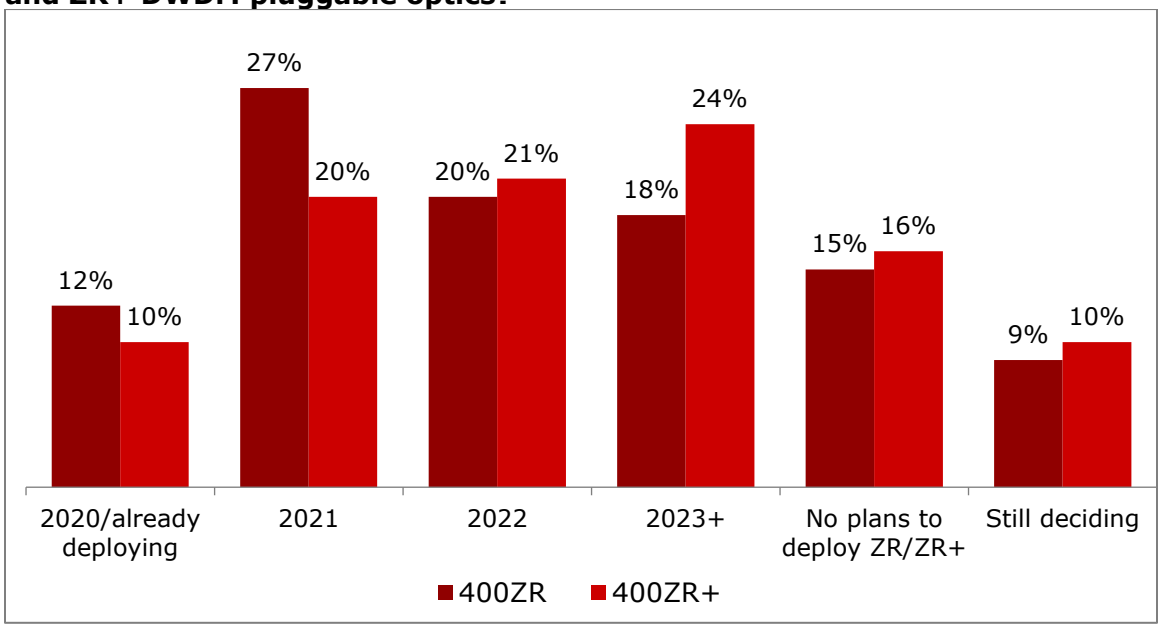
Adoption timelines for 400ZR are more aggressive than those for 400ZR+ in the near term, which is not surprising since 400ZR is more mature and is fully specified by the OIF. 400ZR+ is gaining industry momentum but does not yet have a standards organization (or dominant MSA) pushing it forward.

In any case, results show a strong ramp for 400ZR in 2021 (during which 27% of respondents expect to deploy the pluggables in routers), followed by an additional 20% in 2022. By the end of 2022, 59% of respondents expect to have some level of 400ZR deployments in their networks.

While 400ZR+ expectations for 2021 are lower (20% expect to deploy 400ZR+ during the year), an additional 21% expect to deploy the technology in 2022. By the end of 2022, just over half of respondents (51%) expect to have 400ZR+ pluggables in their networks. Results indicate strong operator endorsements for both 400ZR and 400ZR+ over the next two years and beyond.

Lastly, as in other areas of disaggregation analyzed in this report, North American operators are more aggressive in their timelines compared to their RoW counterparts. Still, over time, operators outside North America expect to accelerate deployments—particularly for 400ZR. By the end of 2022, nearly half of RoW operators surveyed (45%) expect to have 400ZR deployments while more than one-third (36%) expect to have 400ZR+ in their networks.

Figure 20: When does your organization expect to deploy routers with 400G ZR and ZR+ DWDM pluggable optics?



n=82
Source: Heavy Reading

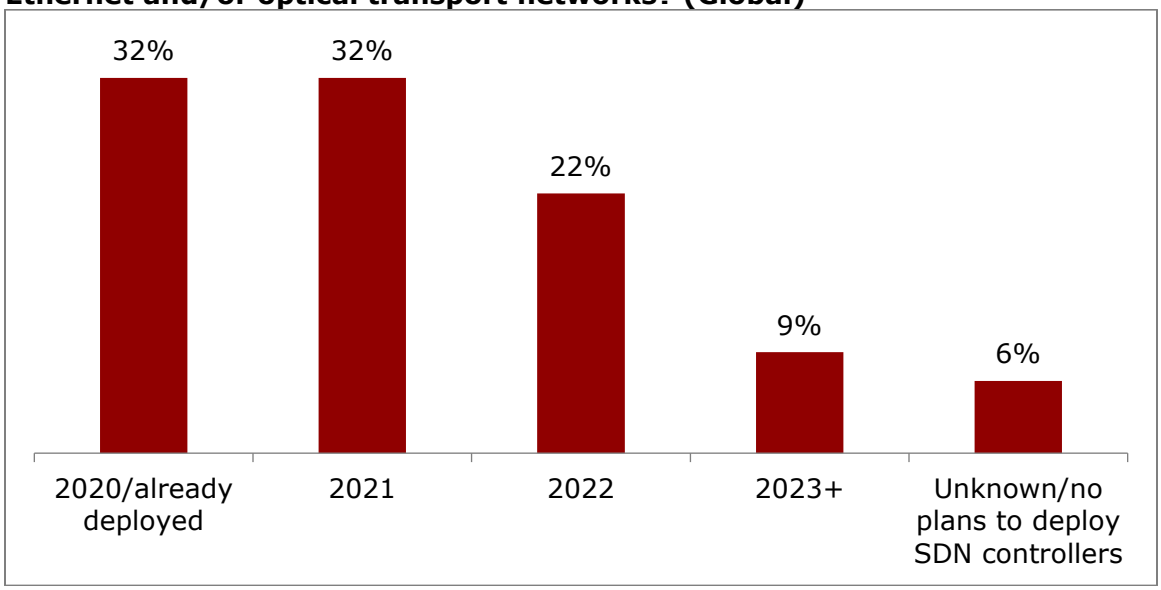
MANAGEMENT AND CONTROL

This section details key findings related to the management and control of disaggregated networks—topics commonly associated with SDN. In the first question, Heavy Reading asked operators to identify timelines for deploying SDN controllers in their IP, Ethernet, or optical transport networks (see **Figure 21** below).

Heavy Reading has been researching and writing about SDN for telecom networks for nearly a decade, so it is not surprising that SDN control has gained a solid amount of production network traction. Just under one-third of respondents (32%) reported some level of SDN control in IP, Ethernet, or optical networks. The question did not drill into specific segments, but based on past research, operators globally are further along in centralized control of IP and Ethernet networks and somewhat less advanced in optical networks, generally speaking.

For operators that have yet to use SDN controllers for transport, 2021 is expected to be a big year, with an additional 32% of operators expecting to deploy controllers, followed by 22% in 2022. If expectations hold, an overwhelming 86% of operators will have SDN control in their transport networks by the end of 2022—amazing progress that was academic less than a decade ago.

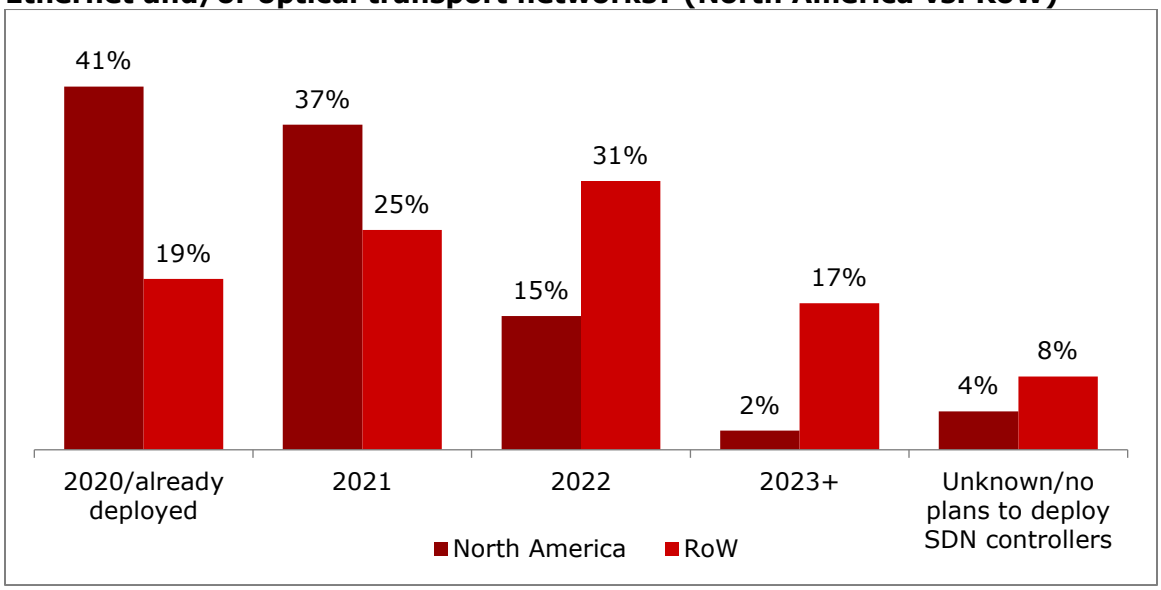
Figure 21: When does you organization intend to deploy SDN controllers in its IP, Ethernet and/or optical transport networks? (Global)



n=82
Source: Heavy Reading

As with other timeline-related topics throughout this survey, North America is more aggressive in deployments and plans compared to RoW. **Figure 22** shows results broken out by North American and RoW operators. Looking at 2020, North America had more than double the share of SDN controller deployments compared to RoW (41% of respondents for North America compared to just 19% for RoW). However, deployments outside North America are expected to ramp strongly in 2021 and particularly in 2022.

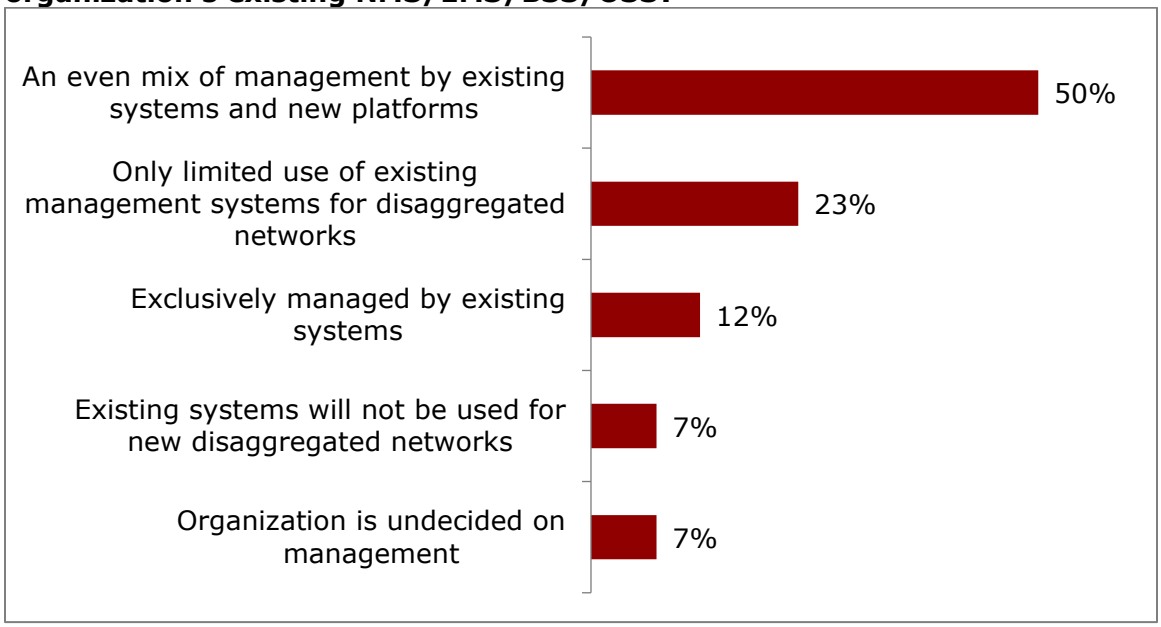
Figure 22: When does you organization intend to deploy SDN controllers in its IP, Ethernet and/or optical transport networks? (North America vs. RoW)



n=46 North America, 36 RoW
Source: Heavy Reading

Lastly, Heavy Reading asked operators about managing disaggregated networks with existing management systems, including EMS, NMS, BSS, and OSS. Exactly half of respondents (50%) expect to use an even mix of management for disaggregated networks, divided between new management platforms and existing systems. At a distant second place, 23% of operator expect only limited use of existing systems and will rely on new platforms for their new disaggregated networks. Still, overall results indicated that existing management systems will play a crucial role even as operators migrate to new network architectures. For disaggregation networking suppliers, finding a way to integrate the new technologies into the old will be crucial.

Figure 23: To what extent will your disaggregated networks be managed by your organization's existing NMS/EMS/BSS/OSS?



n=82
Source: Heavy Reading