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CABLE'S FIBER OUTLOOK SURVEY REPORT

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Despite the strong appeal of the technology, most cablecos have not gone ahead with their expected deployments of remote PHY, remote MAC/PHY, and other DAA options just yet. A couple of major MSOs are moving forward with DAA roll-outs, but most operators are still holding back and cautiously pondering their next-gen network options.

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Cable operators have been managing service delivery to their customers for more than 7 decades. But for most of that time, the services have been delivered primarily over the coaxial part of the industry's HFC plant.

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Fiber installations for cable operators are performed by a somewhat uneven mix of in-house technicians and outside contractors.



Introduction

Even more than they have before, cable operators are looking to load up their diets with more fiber. And for a very good reason.

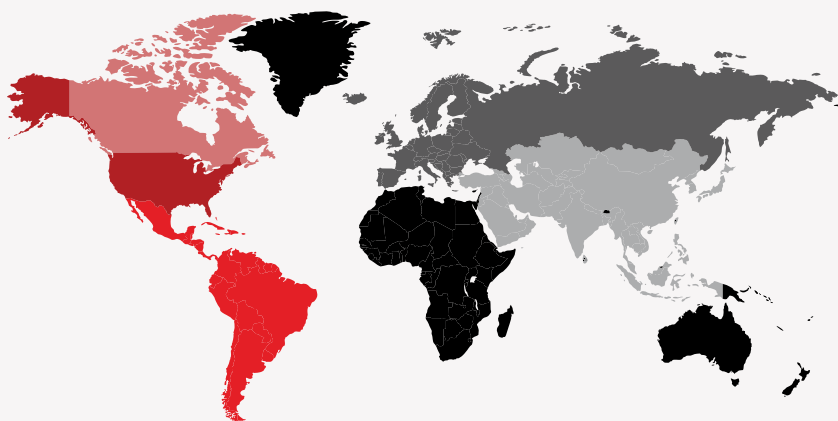
Even with some significant technical advances in other parts of the industry's hybrid fiber-coax (HFC) architecture, cablecos are moving to put more fiber lines in their plant. That's because fiber is the chief enabler of most, if not all, of the technological, financial, operational, and competitive gains operators are seeking to make. No matter whether they are aiming to go all-fiber like Altice, pursue a fiber deep strategy like Comcast and Cox, or simply split more fiber-optical nodes like Charter and many other multiple system operators (MSOs), operators are fortifying themselves with fiber. They aim to offer faster broadband speeds, slash operational costs, deliver advanced video services like UHD/4K TV, boost bandwidth capacity, support new wireless offerings such as 5G, improve service reliability, and perhaps most importantly, enhance their competitive positioning against other service providers.

As operators gear up for a new decade of jousting with telcos and other rivals by investing heavily in fiber, there remain many questions about how cablecos intend to take advantage of their increased fiber diets. While several major MSOs have discussed their general fiber plans, the industry has not settled on an overall fiber build-out strategy. Nor have cable operators revealed much about how they will carry out their ambitious build-out agendas in tandem with other key network initiatives. Examples include the adoption of 10G-enabling technologies like Full Duplex DOCSIS, Extended Spectrum DOCSIS, and next-gen passive optical network (PON); the shift to distributed access architecture (DAA); the virtualization of network functions; and the roll-out of 5G wireless and small cells. Nor has there been much discussion about the challenges that confront operators as they attempt to lay out, test, and monitor their new fiber links.



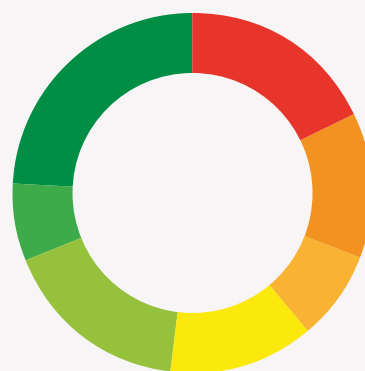
Profile of Survey Respondents

Where is your company located?



North America	65%
Europe	18%
Asia/Pacific (including Australia)	13%
Central/South America (including Mexico and the Caribbean)	4%

What is your company's annual revenue?



Less than \$50 million	18%
\$50 million to \$199 million	13%
\$200 million to \$499 million	8%
\$500 million to \$999 million	13%
\$1 billion to \$4.99 billion	17%
\$5 billion to \$10 billion	7%
More than \$10 billion	24%



Seeking to answer these and other critical questions, Light Reading and Heavy Reading teamed up again with SCTE/ISBE, as well as with five major industry vendors – ADTRAN, Ciena, Corning, Incognito, and VIAVI – to survey cable operators about their fiber build-out strategies. In this report, we present the responses to that comprehensive 51-question survey, look at what cable’s fiber-feeding frenzy is fueling, and examine what it all means.

This second annual Cable’s Fiber Outlook Survey, which was conducted online during August 2019, produced a healthy 191 fully complete and at least another 85 partially complete responses from cable tech executives. As might be expected given SCTE/ISBE’s prime role in promoting the survey again this year, a large majority of the survey responses came from the U.S. and Canada. In fact, those two countries generated 125 fully complete responses, or more than 65% of the 191 complete replies received.

But operators in other parts of the world also made significant contributions to the survey results. European cable executives accounted for 34 complete responses, or nearly 18% of the total. Southeast Asia followed with 12 complete responses, or more than 6% of the total. The Middle East & Africa, Northeast Asia, India, Australia, and Central/South America regions collectively accounted for the remaining 11% or so.

Somewhat similar to the results in 2018, a good portion of the survey responses streamed in from the largest cable operators in the world, especially those in the U.S. Nearly one-quarter, or slightly over 24%, of the responses came from companies making over \$10 billion in annual revenue. Almost one-half, or about 47%, came from companies producing at least \$1 billion in revenue each year.

However, small to mid-size cablecos had strong representation in the survey as well, with more than 18% of the responses coming from providers generating \$50 million or less in annual revenue. Another 13% came from operators producing between \$50 million and \$200 million. Overall, providers with less than \$500 million in annual revenue accounted for nearly 40% of the replies.

Not too surprisingly, most of the responses came from providers that have been offering fiber-based services to their subscribers for a while or just began offering such services in the past year. More than three-fifths of the respondents, or nearly 61%, said their companies have been delivering fiber-based services to customers for at least two years. Almost 18% said their companies started delivering fiber services in the past 12 months. Another 8% said their companies plan to start offering fiber-based services by the end of this year.

As might be expected, most respondents were acquainted with their company’s fiber deployment strategy. Nearly 90% said they were either “very familiar” or “somewhat familiar” with those plans.

Like last year’s results, most of the responses came from cable executives involved in network planning, operations, or engineering. Those three job categories combined for nearly two-thirds, or more than 64%, of the replies. Business strategy and development executives accounted for almost 17% of the responses and IT operations specialists accounted for another 11%.

IS CABLE READY FOR 10G?

In January 2019, cable industry leaders announced an industrywide initiative with a challenging goal: deliver 10 Gbit/s of internet speed, along with lower latency and tighter security. While most cable systems are still migrating to 1 Gig service, industry technologists are confident that the cable HFC infrastructure can produce a tenfold increase in that speed – and more. The keys will be to apply new DOCSIS innovations to existing plant, take advantage of fiber-optic technologies, and develop additional techniques to manage bandwidth. This section reveals cable providers’ interests in and plans for infrastructure technologies that together will make 10G a reality.



KEY TAKEAWAYS



HFC will remain a viable connection for customers. On average, respondents expect 46% of their residential and business customer connections to be coaxial-based in 2024, both with DOCSIS 3.1 (D3.1) and without. Full Duplex DOCSIS (FDX) is anticipated to serve only 14% of customers by then.



According to respondents’ estimates, 30% of cable customers are expected to be connected by FTTH/FTTP in 2024. Nearly 22% of connections will likely be enabled with 10G-EPON and 13% with XGS-PON.



More than 83% of survey respondents cited video streaming services as a leading driver for multi-gigabit services, along with greater broadband consumption per household (82%) and business services delivery (76%).



While providers expect to continue spending on fiber and move beyond 1 Gbit/s speeds quickly, 81% cited the cost of fiber and related technologies as a significant or moderate challenge and 81% cited construction and labor costs.





Cable's 10G Options

As cable providers look toward the promised land of 10G, how will they get there? This survey reveals the main routes that providers are taking and the technologies they will utilize in the future.

While the primary focus of cable's 10G initiative has been on DOCSIS and existing HFC plant, it also has been billed as a collection of technologies. Cable providers are relying upon a variety of technologies to meet current and future broadband demands.

Looking out 5 years to 2024, cable providers anticipate HFC will still be a viable connection for residential and business customers, both enabled with D3.1 and not enabled with it. When asked what percentage of residential and business customer connections will be made through various technologies by 2024, survey respondents estimated that, on average, 46% of their connections will be coaxial-based in 5 years (both D3.1 and not).

The results among North American respondents are nearly identical to the global results presented here; the percentage for D3.1-enabled HFC is 2 points higher among North American respondents (26.8% total). Among smaller North American cable providers (those with annual revenue of less than \$1 billion), 55% of connections are expected to be coaxial versus 41% for larger North American providers (those making \$5 billion or more annually).

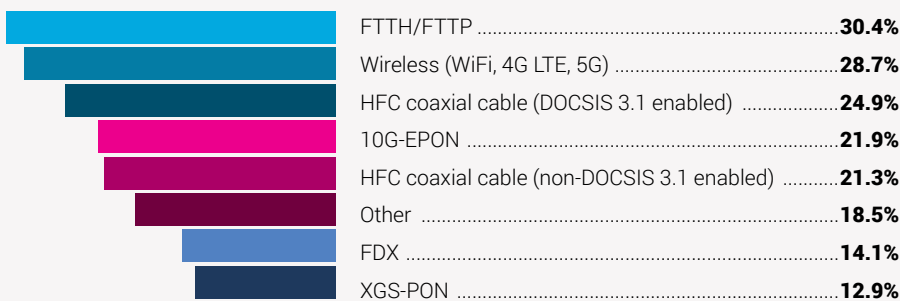
Both small and large North American providers expect FTTH/FTTP to be a significant part of their mix. Smaller North American providers actually anticipate a larger percentage of their customer base will be served through direct fiber connections than large providers, 30% versus 24%, respectively.

While DOCSIS and HFC appear to have a long life, the total global respondents estimated that, on average, only 14% of their customer connections in 2024 will be enabled with FDX, which will support multi-gigabit speeds symmetrically (downstream and upstream); North American respondents estimated 16%. FDX has been heralded as an important innovation, but it requires significant changes in the last-mile network. Some providers reportedly are concerned about that issue.

Meanwhile, 10G-EPON and the newer XGS-PON standard – two variants of Ethernet PON technology that can enable 10 Gbit/s symmetrically – are expected to play a key role. Respondents anticipate nearly 22% of their connections will be enabled with 10G-EPON and nearly 13% with XGS-PON in 5 years.

Wireless also plays a prominent role; global respondents expect to serve nearly 29% of their customers with Wi-Fi, 4G LTE, or 5G by 2024. These figures represent estimates of the average amount of coverage by a particular technology. With wireless and most other connections, at least some respondents expect their connections to deliver the technology to 100% of their customer base. For large U.S. cable providers, that is the case with wireless since they are seeking to blanket their markets with Wi-Fi and potentially other technologies in the future. Many respondents also selected "Other" in their estimates, suggesting that there are even more technologies of

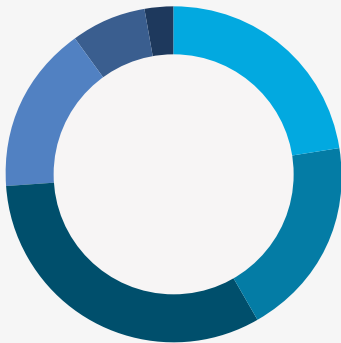
By 2024, what percentage of your current residential and business customer connections do you anticipate will be made through the following technologies?



choice when it comes to broadband connectivity.

Regarding 10G-EPON itself, 23% of respondents said deployments are already underway, 19% expect to make them in the next year, and 32% in 1-3 years. Only 3% indicated they will never deploy 10G-EPON.

When do you anticipate your company beginning 10G EPON residential/business deployments?



- Deployments are already underway **22.5%**
- In the next year **19.4%**
- In 1-3 Years **32%**
- In 3-5 Years **16.2%**
- More than 5 years away **7.3%**
- Never **2.6%**

In a related survey question, more than one-fifth of respondents (or 22%) estimated that 40% or more of their customer base will have access to 10G-EPON by 2024. Another 22% expect 10G-EPON to serve 20%-39% of their base. Nearly 28% said 10G-EPON will occupy less than 10% of their connections, while 6% said 80%-100% of their connections will be 10G-EPON-infused. Although there is fairly wide divergence over the amount that will be deployed, 10G-EPON clearly will play a significant role for many cable providers in their 10G initiatives.

Capital expenditures on fiber will continue to increase – just a handful of respondents think they will not. Nearly three-quarters of respondents said their fiber expenditures will increase significantly or moderately over the next 5 years. Only 22% expect a slight increase, 5% said no change, and 2% expect a decrease. With fiber being vital to cable’s 10G future, the results confirm the industry’s commitment.

When deploying more fiber connections, will cable providers just focus on greenfield areas? The survey asked respondents to indicate their agreement with the following statement: “I am only interested in deploying new fiber access in greenfield areas (for example, new builds or undeserved areas).” Interestingly, 40% strongly disagree or disagree while 24% strongly agree

or agree. The rest are in the middle. So for a large group of respondents, fiber builds are not just a new-build proposition.

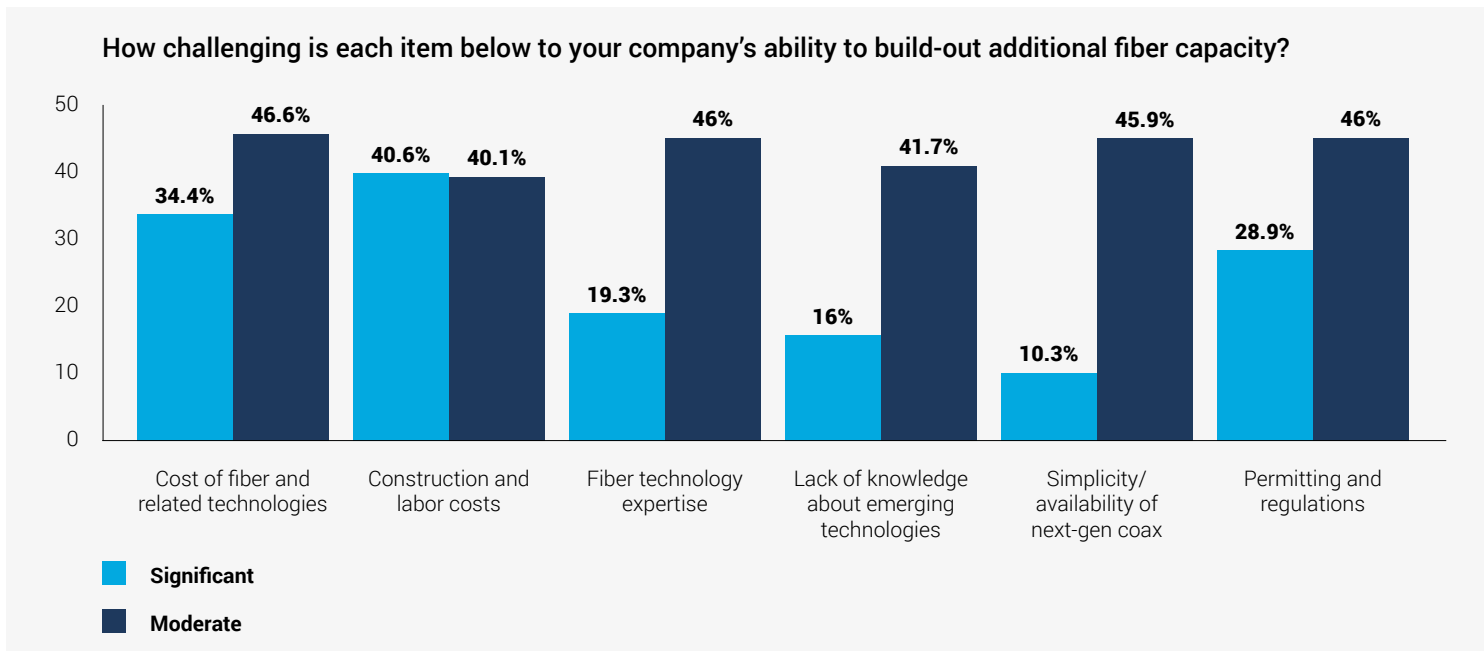
The march to 10G is driven by a number of factors, with video streaming services being the most significant, according to the survey results. The demands on broadband consumption are painfully obvious to any internet provider. The drivers for multi-gigabit services include video streaming services (84% said very significant/significant); greater broadband consumption per household (82%); and business services delivery (76%). Other external forces include increased fiber services competition from telcos or overbuilders (69% very significant/significant); interest in 5G backhaul (73%); and lowering maintenance costs compared to coax (69%).

When considering the delivery of multi-gigabit services, how significant are each of the drivers below?

	Very significant	Significant
Greater broadband consumption per household	39.0%	43.3%
Video streaming services	45.7%	38.0%
Business services delivery	34.2%	41.7%
Increased Fiber Services Competition (Telco or Overbuild)	24.6%	43.9%
5G Backhaul	34.4%	39.3%
Lowering maintenance costs compared to coax	27.9%	41.0%

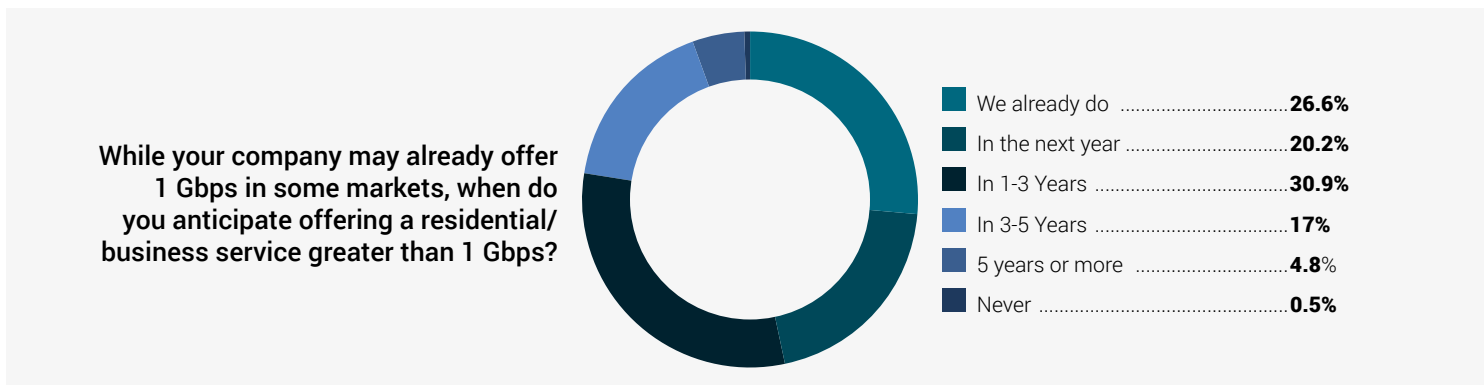


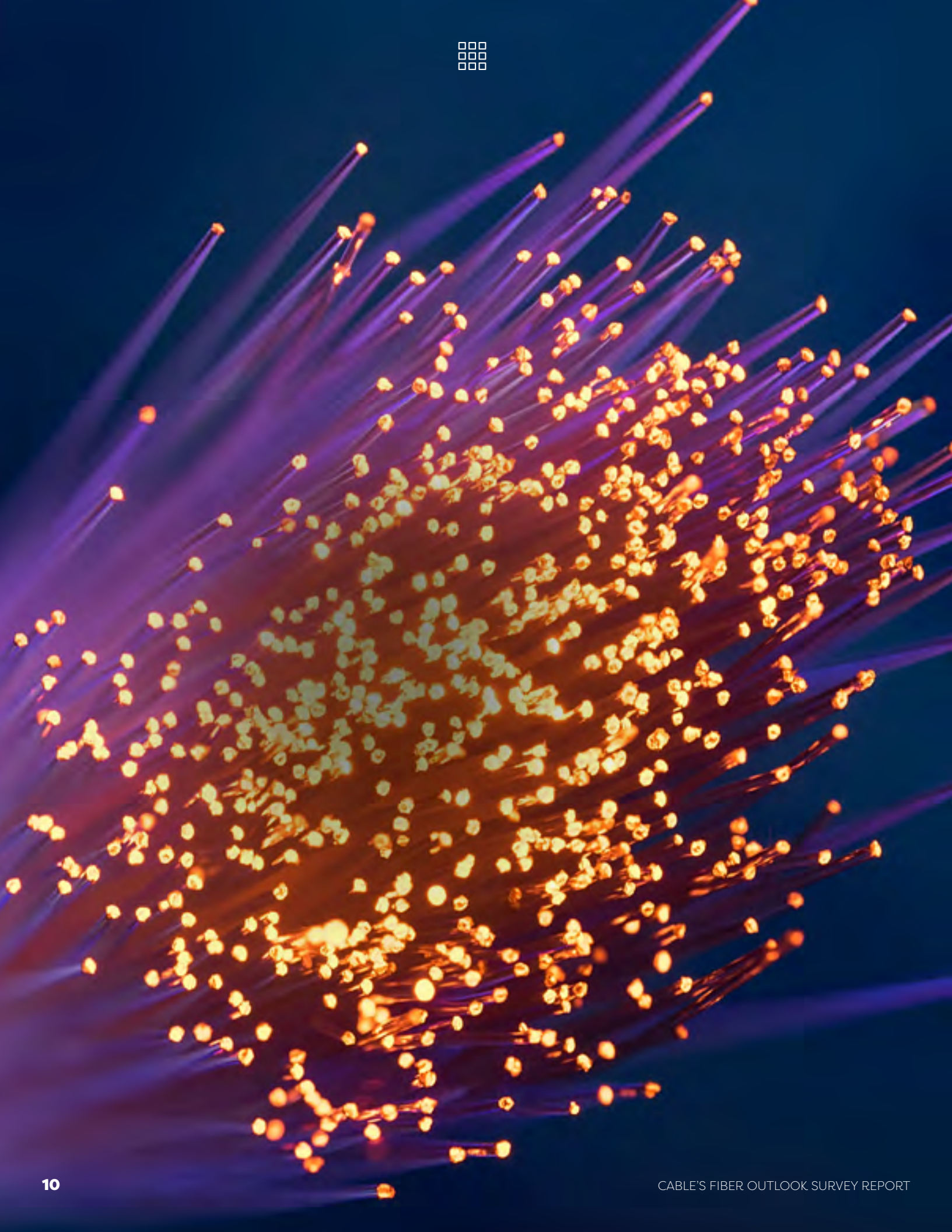
Building out fiber can be challenging. When rating how challenging various factors are to their company's ability to build out additional fiber capacity, 81% said the cost of fiber and related technologies is a significant or moderate challenge and 81% cited construction and labor costs. Other challenges loom, but most are perceived as being moderate or minor challenges as opposed to significant challenges.



Many providers already offer 1 Gbit/s service in some markets. When do they anticipate offering residential or business service greater than 1 Gig? Among respondents, 27% said they already do and 20% said within the next year, suggesting a quick path for many to throttle up. About 31% anticipate they'll offer more than 1 Gig service in the next 1-3 years and 17% anticipate 3-5 years. Less than 5% said 5 years or more.

The industry's road to 10G will take many twists and turns, and individual companies will take different routes to arrive at their destination. But the survey results suggest that most cable providers are ready and willing to put new technologies in place and ramp up to multi-gigabit speeds, driven by the increasing demands of a connected world.







At ADTRAN, Inc., we believe amazing things happen when people connect. From the cloud edge to the subscriber edge, we help communications service providers around the world manage and scale services that connect people, places, and things to advance human progress. Whether rural or urban, domestic or international, telco or cable, enterprise or residential—ADTRAN solutions optimize existing technology infrastructures and create new, multi-gigabit platforms that leverage cloud economics, data analytics, machine learning, and open ecosystems.

ADTRAN offers more than three decades of experience in helping service providers of all types in all regions build their best network. More than 2,000 employees strong, ADTRAN is a global leader in telecommunications solutions with customers in more than 68 countries. With products for both carrier and enterprise markets, ADTRAN is uniquely positioned to provide complete end-to-end solutions that produce the greatest network efficiency and at the lowest possible cost. Service providers depend on our equipment to connect central offices or remote terminals directly to subscriber equipment. This enables the delivery of voice, video, and Internet services, all while supporting business customers with a full line of business-class networking solutions.

Cable/MSOs are presented with their own unique challenges as they work to meet the ever-growing need to deliver more bandwidth with greater resiliency. ADTRAN has a complete portfolio of solutions tailored to the specific needs of cable/MSOs. These solutions are designed to:

- Accelerate DAA deployments combining 10G fiber access, virtualization, and hardened outside plant nodes.
- Speed Gigabit service expansion with mesh fixed wireless and CBRS solutions,
- Deliver a better connected-home experience with mesh Wi-Fi and advanced analytics, and.
- Capture business customers with right-sized managed SD-WAN solutions.

To learn more, visit www.adtran.com/mso



CABLE FTTH/PON PLANS

Although most leading cable technologists insist that the industry's basic hybrid fiber-coax (HFC) architecture still has plenty of juice left, cable operators are increasingly, albeit quietly, investing in fiber-to-the-premises (FTTP) network builds to meet their ever expanding bandwidth capacity needs. At the same time, cablecos are increasingly deploying various flavors of passive optical networking (PON) technology – in addition to or instead of the industry's homegrown DOCSIS technology – to deliver voice, video, data, and other services over their fiber-rich networks. As a result, operators are relying on a wider range of networks and technologies than ever before, mixing and matching HFC and FTTH networks as well as DOCSIS and PON technologies.

In this section, we look at the different types of fiber-related network upgrades that cable operators are carrying out and planning, the move toward more all-fiber deployments, and the reasons for this move. We also look at the new fiber-based services that operators are seeking to deliver and the challenges they are confronting as they make this historic shift.



KEY TAKEAWAYS:



Close to one-half of survey respondents (46%) said their company will carry out FTTP network upgrades with 10G-EPON over the next 2 years, making that the lead choice. Yet, at the same time, nearly as many respondents (41%) said their company will carry out DAA/fiber deep upgrades of their HFC networks in tandem with rolling out the proposed Extended Spectrum version of DOCSIS technology.



Cable executives rated reducing aging infrastructure as the greatest incentive for their company to install an all-fiber network rather than HFC, followed closely by matching or staying ahead of their competitors.



Fiber cable availability and expense emerged as the biggest challenge in migrating toward an all-fiber network. Providing the same services over FTTP as currently delivered over HFC came in a close second.



More than two-thirds of survey respondents (68%) said their company will offer 5G mobile backhaul over its fiber lines. Over half reported their company will also offer symmetrical multi-gigabit speeds, IoT, and/or streaming video.





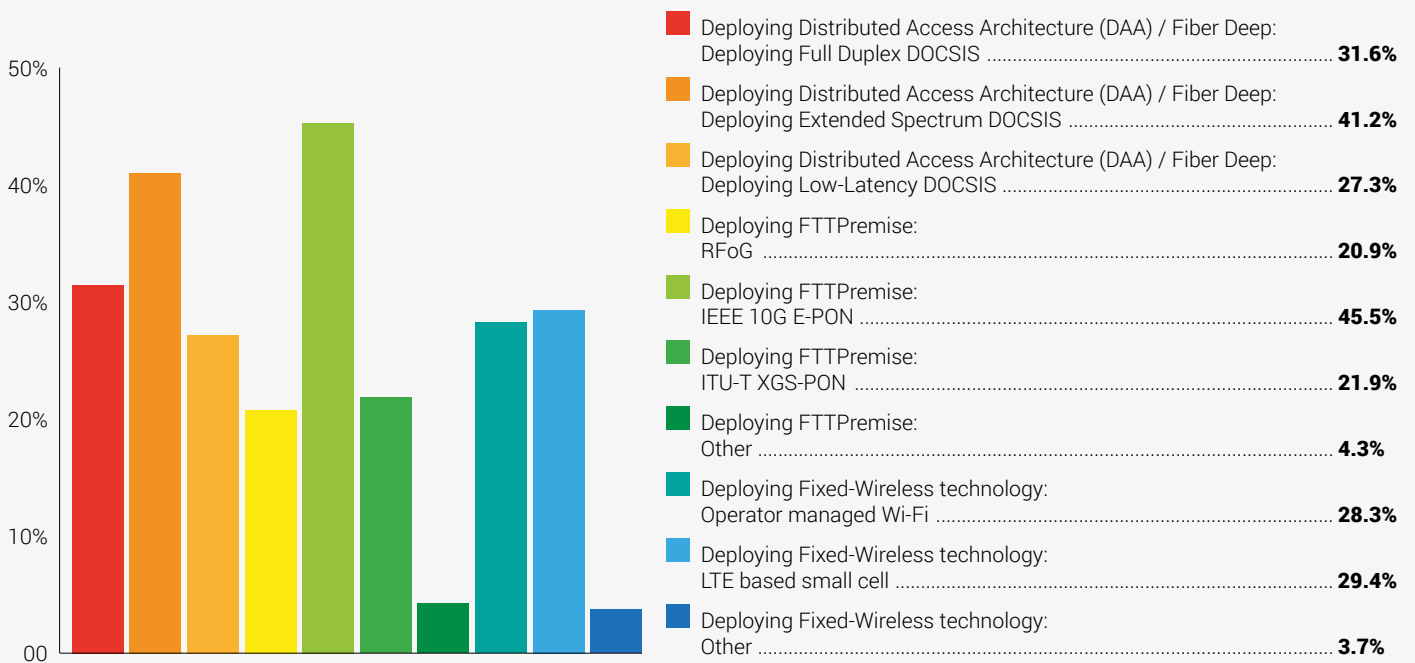
Playing with Fiber

Cable operators plan to carry out a growing number of network upgrades and new builds over the next 5 years, including FTTP-oriented, DAA-oriented, PON-oriented, DOCSIS-oriented, and fixed wireless-oriented deployments.

One thing that all these various architectural and technological strategies have in common is that they will rely on a greater use of fiber. Thus, it seems clear that fiber will play an ever-increasing role in the industry's future and that operators will use that fiber in a multitude of ways.

How do these fiber deployment plans break down by types of network architecture and delivery technology? The results are all over the board. Close to one-half of cable respondents (46%) said their company will carry out FTTP network upgrades with 10G-EPON over the next 2 years, making that the lead choice. Yet, at the same time, almost as many respondents (41%) said their company will carry out DAA/fiber deep upgrades of their HFC networks in tandem with rolling out the proposed Extended Spectrum DOCSIS spec.

Which type of network upgrades is your company planning to carry out over the next five years (by fall 2024)?

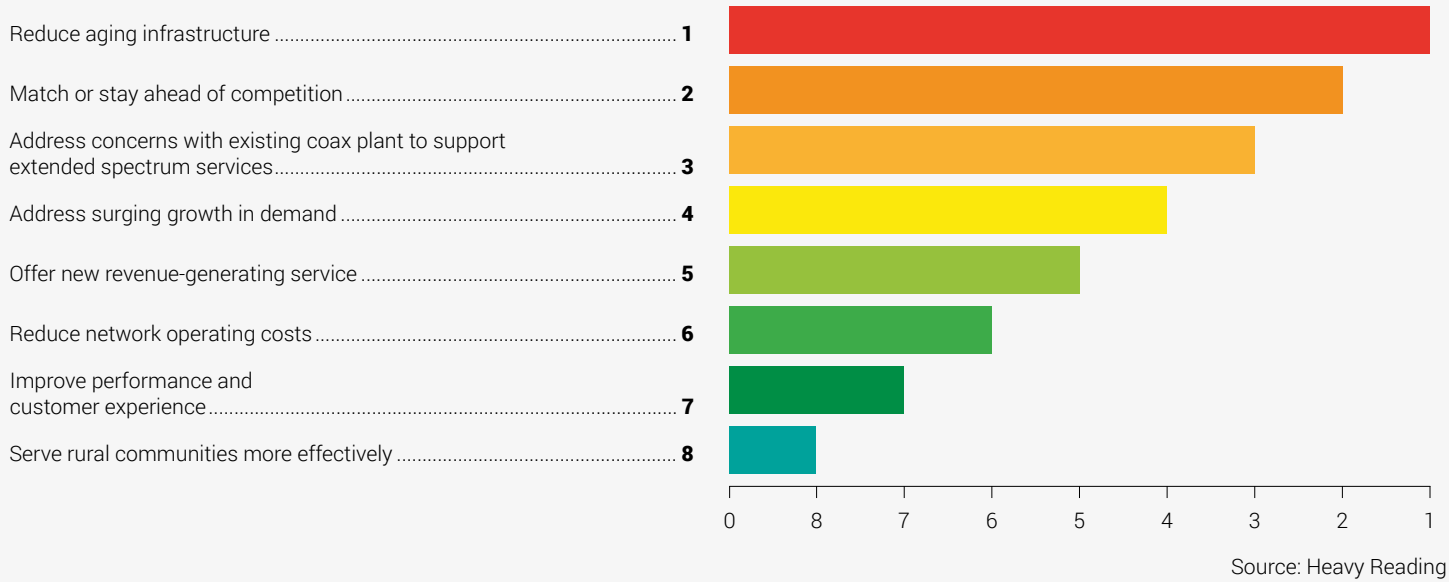


Source: Heavy Reading



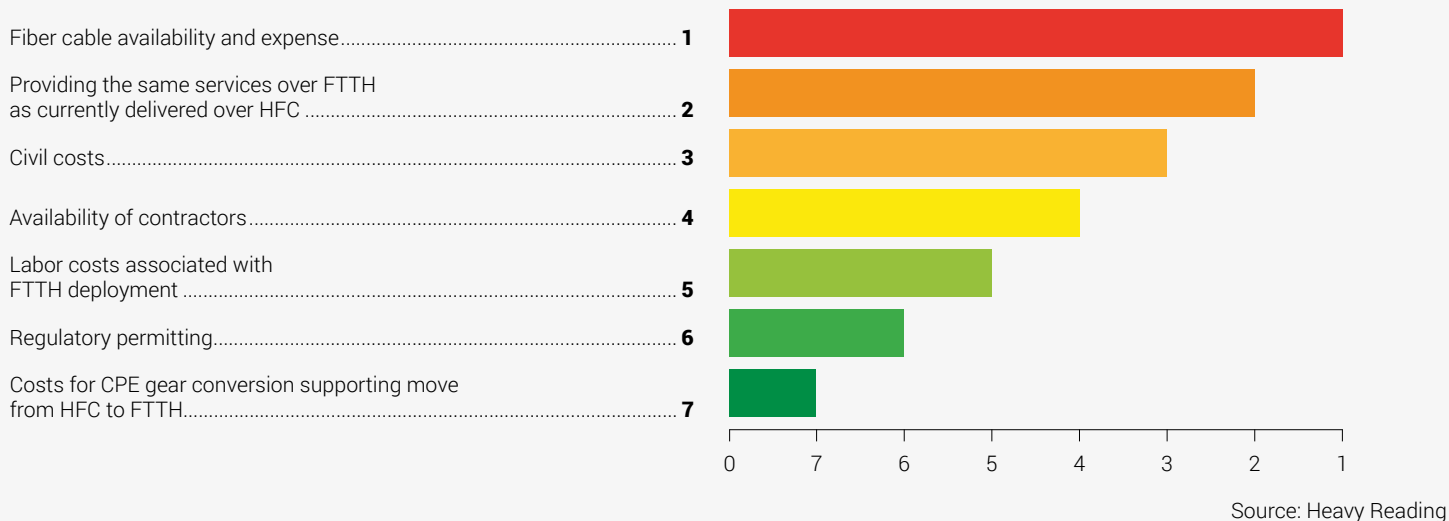
Why are cable operators increasingly turning to FTTP network builds instead of HFC network upgrades? Survey respondents rated reducing aging infrastructure as the greatest incentive for their company to install an all-fiber network. Matching or staying ahead of the competition came in a close second, followed by handling surging growth in customer demand, offering new revenue-generating services, and addressing concerns with existing coax plant to support extended spectrum services.

Please rank the following incentives for your company to install an all-fiber network rather than HFC. (1 = highest and 8 = lowest)



As they look to migrate toward all-fiber networks, though, cable operators know they face a number of major challenges. In the Heavy Reading survey, fiber cable availability and expense clearly emerged as the biggest challenge in making that shift. Providing the same services over FTTP as currently delivered over HFC ranked as the second biggest hurdle, followed by the civil permitting costs of installing fiber and the availability of fiber contractors.

Please rank the following challenges your company faces in migrating to an all-fiber network. (1 = most challenging and 7 = least challenging)

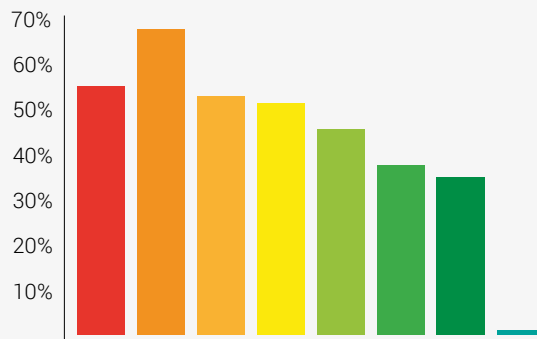




Which new services are cablecos seeking to deliver over their new fiber lines? More than two-thirds of respondents (68%) said their company will offer 5G mobile backhaul over its FTTP lines, making that easily the top choice. But symmetrical multi-gigabit speeds, IoT, and streaming video all scored highly on the survey as well, with each one generating checks from more than half of the respondents.

Which type of network upgrades is your company planning to carry out over the next five years (by fall 2024)?

Multi-gigabit symmetrical high-speed data services	55.3%
5G mobile backhaul	68.1%
IoT	53.2%
Streaming video	51.6%
IPTV	45.7%
4K/8K video	37.8%
Expanded commercial B2B service offerings	35.1%
Other (please specify)	1.1%

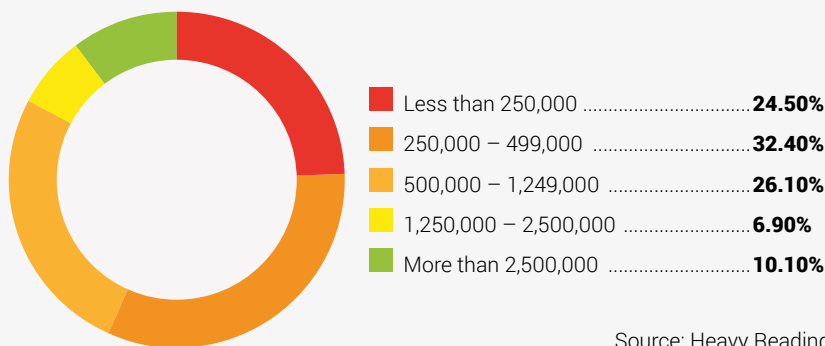


Source: Heavy Reading

Not surprisingly, then, cable operators are planning to run lots more fiber lines directly to their subscribers as the new decade looms – despite the prime challenges they face. About three-quarters of cable respondents (75%) reported their company expects to pass at least 250,000 more homes in its footprint with FTTP networks within the next 3 years. Over two-fifths of respondents (43%) said their company expects to pass at least 500,000 more homes with all-fiber lines. That’s pretty remarkable considering that a sizable subset of the executives work for smaller cablecos with 1 million or fewer homes passed.

Further, 17% of respondents said their company expects to pass at least 1.25 million more households with fiber by fall 2022. Some 10% plan to pass more than 2.5 million additional households.

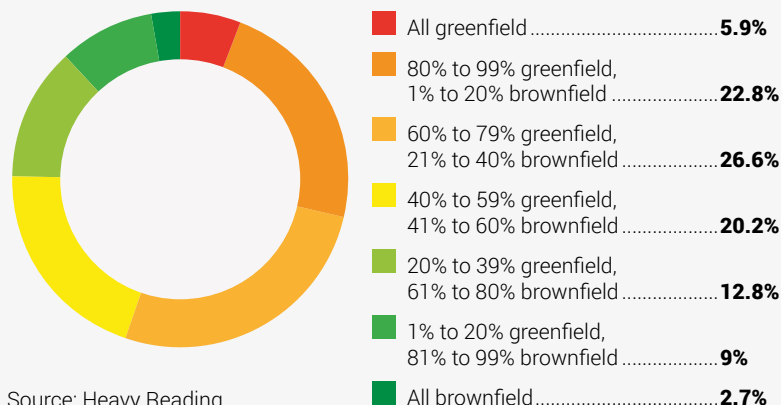
How many more incremental homes in your company's footprint do you expect to pass with FTTH over the next three years (by fall 2022)?



Source: Heavy Reading

As cable operators step up the FTTP installation pace, are they focusing mainly on building in their existing coverage areas or unserved parts of their regions? So far, as might be expected, they have concentrated their all-fiber push on the new, or “greenfield,” areas. More than one-half of respondents (56%) said their company has primarily or exclusively installed FTTP in greenfield areas so far. One-quarter (25%) reported they’ve concentrated mainly or exclusively on older “brownfield” areas where they already had plant. The remaining 20% have roughly split their fiber activity between greenfield and brownfield areas.

What is the current split between greenfield and brownfield installations in your company's FTTH builds (assume “greenfield” refers to new home construction)?

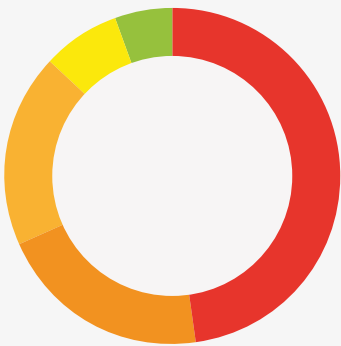


Source: Heavy Reading



Turning to cable's 5G ambitions, how much are operators intending to rely on fiber to carry the day? A great deal, it seems. In line with the earlier results, close to one-half (48%) of survey respondents said their company is planning to use fiber as THE transport medium for 5G services, while another 19% are considering the idea. In contrast, slightly over one-quarter (21%) indicated they think coax will be sufficient for 5G.

Are you considering 5G services in your network upgrades, and if so, what transport medium would be deployed?

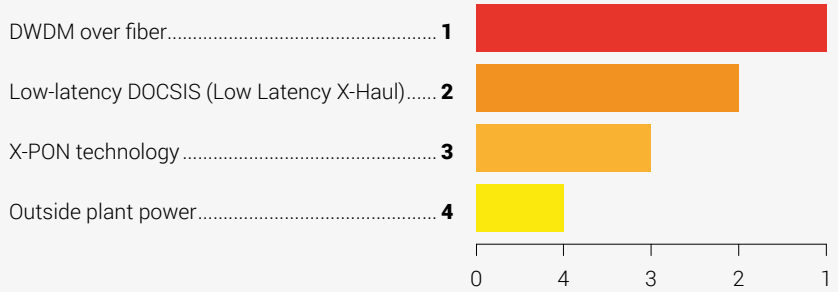


- Yes, we are planning for 5G, with fiber as medium **47.8%**
- Yes, we are planning for 5G, but coax is sufficient **20.7%**
- Maybe, we are considering 5G, with fiber as the medium **18.5%**
- Maybe, but our plans to support 5G are currently not defined **7.6%**
- No, we are not planning for 5G in our network upgrades **5.4%**

Source: Heavy Reading

With the prospect of 5G weighing heavily on their minds, cable operators are exploring how best to support next-gen mobile services with small cells. In the Heavy Reading survey, running Dense Wavelength Division Multiplexing (DWDM) over fiber scored as the technology upgrade most essential for supporting wireless small cells, handsily topping all other choices. Low latency DOCSIS came in a strong second, followed by X-PON technology.

Please rank the following technology upgrades in relation to their importance to support wireless small cells (1 = most important and 4 = least important)



Source: Heavy Reading



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Corning is one of the world's leading innovators in materials science, with a 166-year track record of life-changing inventions. We apply unparalleled expertise in glass science, ceramic science, and optical physics, along with our deep manufacturing and engineering capabilities, to develop category-defining products that transform industries and enhance people's lives. Our Optical Communications segment delivers connectivity to every edge of the CATV network, from the headend to subscribers, and includes optical fiber, cable, hardware and equipment, as well as RF connectivity and fully-optimized solutions for high-speed communications networks.

Just as we did with the invention of the world's first low-loss optical fiber more than four decades ago, we continue to transform the way the world connects. Our products and services enable CATV networks, from the headend to the subscriber, supporting today's architectures from HFC and fiber deep to fiber-to-the-home. We're constantly working to help MSOs increase the velocity and speed of deployments, as well as enable the full capabilities of their networks, while also reducing the total cost of ownership for our customers. This in turn increases MSO's ability to monetize their network across all platforms, including RF, ISP and the coming wave of 5G and 10G.

FIBER FOR 5G BACKHAUL

Cable operators are already providers of cell tower backhaul services for 4G, typically through their business services divisions. With 5G on the horizon, cablecos are eyeing new revenue growth opportunities, primarily offering 5G backhaul, midhaul, and fronthaul services to mobile network operators. To a lesser degree, cable providers are also offering some 5G services themselves.

One major challenge they face, however, is that 5G support will require a significant network overhaul – particularly in extending fiber connectivity out to 5G macro sites and new small cells. This section covers the coming 5G opportunity for cable MSOs, with a focus on the backhaul, midhaul, and fronthaul decisions that must be made.



KEY TAKEAWAYS



Just 15% of cable operators have upgraded their networks to support 5G, but the clock is ticking, as an additional 47% expect to upgrade their networks within the next 2 years.



More than one-half of MSO respondents (53%) reported that they plan to converge their fronthaul and backhaul segments in a single physical network, while 44% reported they plan to converge their legacy and next-gen fronthaul protocols (Common Public Radio Interface [CPRI] and evolved CPRI [eCPRI], respectively) over a single physical network.



For 5G midhaul and backhaul networks, cable operators expect to deploy active wavelength-division multiplexing [WDM] wavelength and PON technologies in nearly equal measure, with WDM selected by 31% of the group and PON chosen by 29%.





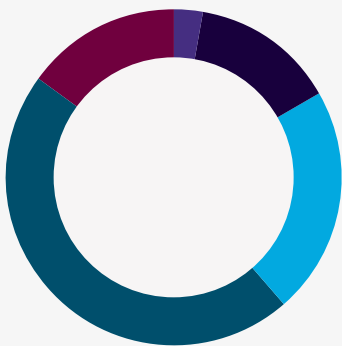
Meeting 5G Transport Requirements with Fiber

At just 15%, few cable operators have upgraded their networks to support 5G, but the clock is ticking. An additional 47% expect to upgrade their networks within the next 2 years. Only 22% of cable operators surveyed have a longer-term backhaul network upgrade horizon of 2-4 years, with 3% expecting no upgrades will be needed.

The relatively tight 2-year window for upgrading backhaul networks maps closely to overall industry expectations for 5G advanced use case roll-outs of massive machine-type communication (mMTC) and ultra-reliable low-latency communication (URLLC) services, both of which will likely require significant backhaul upgrades to handle stringent performance requirements. Cable operators – like their telecom counterparts – appear to be planning their networks with these advanced 5G use cases in mind.

Convergence is important for cable operators, as it promises lower costs and simplified operations. In Heavy Reading's Fiber Outlook Survey, more than one-half of MSO respondents (53%) reported that they plan to converge their fronthaul and backhaul segments in a single physical network, while 44% reported they plan to converge their legacy and next-gen fronthaul protocols (CPRI and eCPRI, respectively) over a single physical network. At 28%, a minority of respondents expect to keep their CPRI and eCPRI fronthaul networks separate, and fewer still (just 18%) expect to maintain separate 4G and 5G backhaul networks.

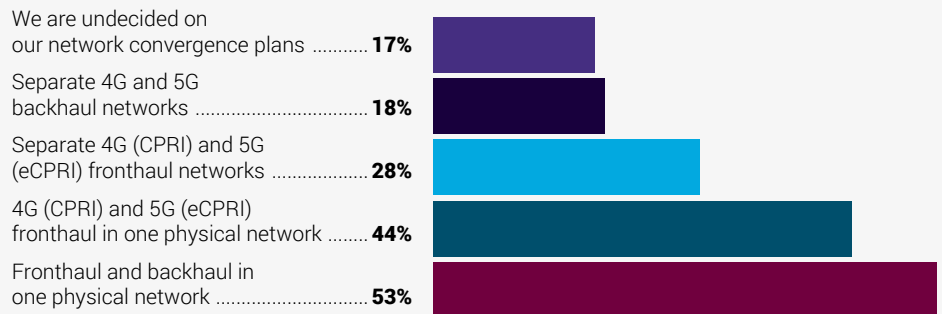
When will your company upgrade its backhaul network to support 5G?



Upgrade not needed for 5G	3%
Unknown	14%
2-4 years	22%
Less than 2 years	47%
Already completed	15%

Source: Heavy Reading

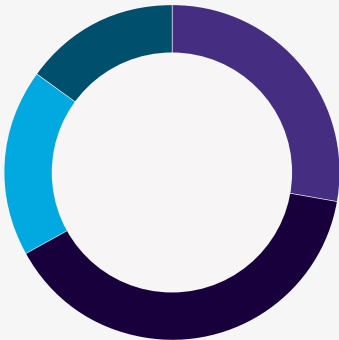
Please Describe Your Company's Convergence Strategy for the Fronthaul and Backhaul Networks.



Source: Heavy Reading

Network slicing creates multiple logical networks within a single physical network, each with different quality-of-service (QoS) and performance attributes. Cable MSOs view network slicing as an important technology enabler to deliver multiple types of 5G services without needing multiple physical networks to do so. More than two-thirds of cable operators surveyed (67%) reported that they plan to deploy network slicing in their transport networks. For 39% of respondents, network slicing will be used to deliver on the full suite of 5G use cases: enhanced mobile broadband (eMBB), URLLC, and mMTC. For 28% of the group, network slicing will partition transport networks to address eMBB and URLLC applications (excluding Internet of Things [IoT]-centric mMTC). Just 18% have no plans for network slicing, and an additional 15% are still deciding on their strategies.

Is your company planning to deploy network slicing in the transport network?



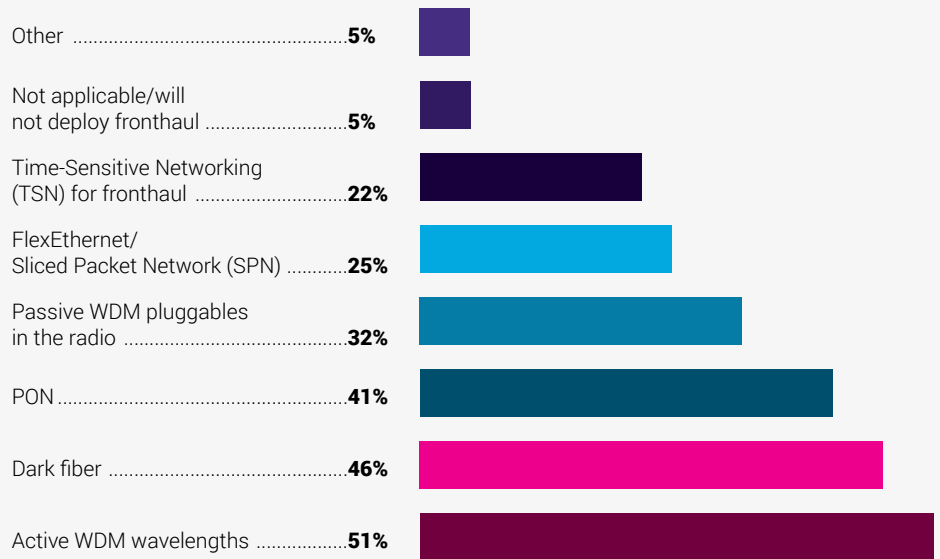
- Yes, we are planning to have enhanced mobile broadband services (eMBB) and ultra-reliable low latency communications (URLLC) **28%**
- Yes, we are planning to have eMBB, URLLC, and massive machine-type communication (mMTC) **39%**
- No plans for network slicing in transport network **18%**
- We are undecided on network slicing plans **15%**

Source: Heavy Reading

Fronthaul protocols connecting radio unit (RU) and centralized baseband unit (BBU) processing are characterized by high bandwidth requirements. Multiple 10 Gbit/s and 25 Gbit/s per RU are expected for 5G, even with the bandwidth efficiency of eCPRI considered. Fiber is the clear choice for physical connectivity, though multiple fiber options exist. The majority of cable executives surveyed (51%) expect to use active WDM wavelengths for fronthaul connectivity while 46% plan to use dark fiber. At 41%, next-gen PON is also an important option, based on the survey results.

When comparing these results to recent survey results from telecom network operators (i.e., non-cable), we note that the cable respondents here show a higher preference for WDM and a lower preference for dark fiber. Dark fiber is a choice for fiber-rich service providers, while WDM is preferred when fiber is scarce, which could explain the differing views.

Which fronthaul technologies will your company deploy in its network to support 5G?



Source: Heavy Reading

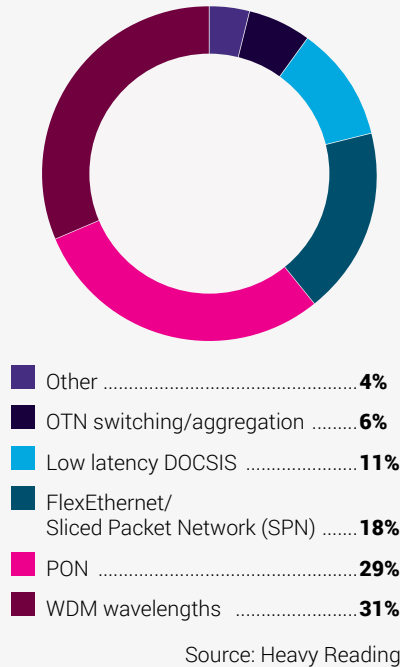




While latency and bandwidth requirements in backhaul (and midhaul) segments are more relaxed than in fronthaul segments, 5G imposes greater demands than 4G. Therefore, upgrades will be required in midhaul/backhaul as well. Cable operators surveyed expect to deploy active WDM wavelength and PON technologies in nearly equal measure, with WDM selected by 31% of the group and PON chosen by 29%. Surprisingly, low latency DOCSIS garnered low support among cable MSOs and was selected by just 11%.

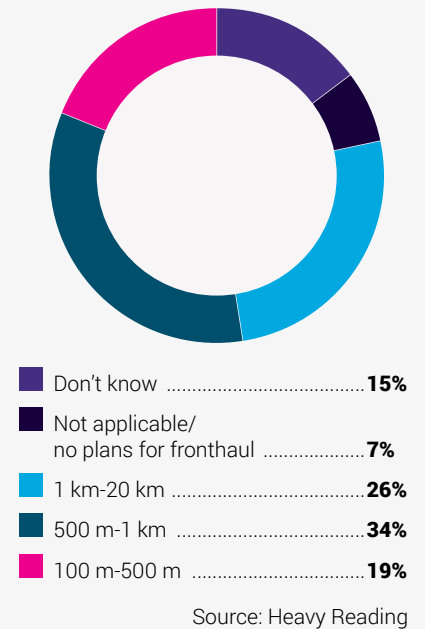
Interest in preserving the existing HFC network is to be expected, and CableLabs has been working on and promoting efforts to upgrade coax to support 5G requirements. But the findings here suggest that sentiment is shifting firmly in favor of fiber-based 5G transport.

Which midhaul/backhaul technologies will your company deploy in its network to support 5G?



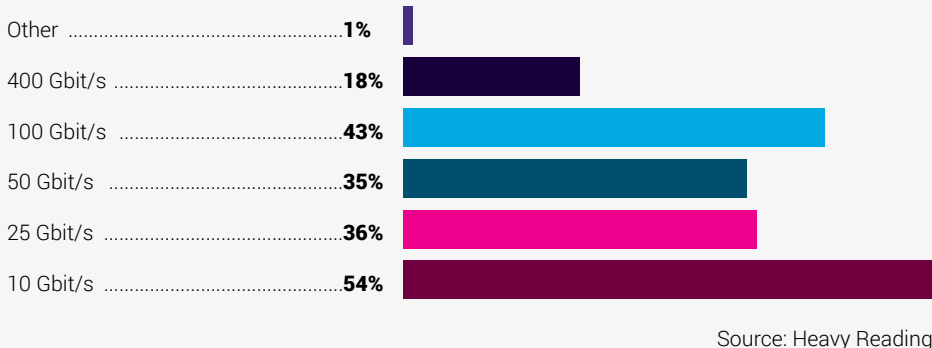
Distance is a crucial consideration in fronthaul architectures, as the timing requirements between the RUs and the BBUs also place hard limits on how far these elements can be physically separated. Timing requirements cap maximum fronthaul distances at 20 km, but cable operators surveyed anticipate their fronthaul distance requirements might be significantly less. While just over a quarter of respondents (26%) expect distances from 1 km to 20 km, a plurality (at 34% of the group) expect fronthaul distances of 500 meters to 1 km. A further 19% expect minimal fronthaul distance requirements of 100 to 500 meters.

What is the expected length of fiber in your company's 5G fronthaul network?



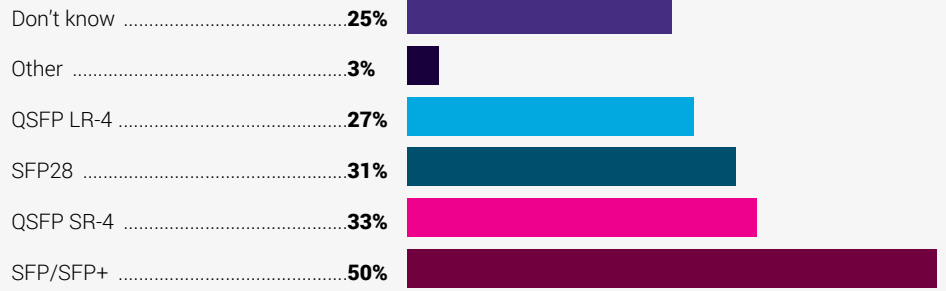
While the majority of cablecos expect 10 Gbit/s line rates will be sufficient for their midhaul/backhaul networks, several higher data rate options are also in play. Following relatively closely behind 10 Gbit/s line rates (selected by 54% of respondents), 100 Gbit/s was selected by 43% of the group. The typical line rate for 4G backhaul today is 1 Gbit/s, so many operators are expecting a 100x increase in available capacity as they move to 5G. Cable operators also showed interest in new Ethernet data rates of 25 Gbit/s and 50 Gbit/s, which were selected by 36% and 35% of respondents, respectively.

Which optical line rates does your company expect to deploy in its 5G midhaul/backhaul networks?



The final 5G backhaul question in the survey dealt with transceiver technologies and was aimed at understanding which transceiver form factors will be most important in 5G New Radio (NR). At 50%, cable operators expressed a clear preference for SFP/SFP+. All other technologies formed a second tier of interest – including QSFP SR-4 (selected by 33%), SFP28 (31%), and QSFP LR-4 (27%).

Which optical transceiver technologies will your company's 5G NR deploy?



Source: Heavy Reading





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DAA/CIN PLANS

Although few cablecos have actually deployed the next-gen technology en masse yet, distributed access architecture (DAA) is viewed by many cable technologists as crucial to the industry's future. That's because DAA – an approach that shifts key electronics and functions out of the cable headend and toward the edge of the HFC access network – promises to bring a wide array of benefits, including greater network capacity, better signal quality, more efficient use of space and power, and easier plant maintenance.

But while DAA clearly has strong appeal to the industry, many questions remain about how the overall technology can be implemented effectively. In particular, there are questions about how cablecos can leverage one of DAA's critical components, the Converged Interconnect Network (CIN), which is a digital fiber link between the cable headend and the network fiber-optic nodes in a distributed HFC architecture. There are also questions about other related technologies, such as coherent optics, field aggregation, and automation. This section of our report tackles these types of questions, examining how cable operators intend to bring both DAA and CIN to life.

KEY TAKEAWAYS:



More than one-half of survey respondents (52%) said their company is working on its DAA strategy. Another 35% said their company already has a DAA strategy in place and is now evaluating either the digital endpoints or the digital network aspects of it.



Coherent optical solutions to maximize capacity and fiber utilization in the access and metro networks ranked as the top technology that CIN will require, closely followed by high density packet aggregation with integrated optics to reduce space, power, and complexity.



Almost three-quarters of cable executives (72%) said their company is planning to use its CIN infrastructure for at least two different services, with 15% intending to use the CIN for four or more services.



Nearly three-fifths of respondents (58%) said their company plans to use remote OLT/PON services in the outside plant as part of its DAA strategy. Slightly more than one-half (51%) intend to leverage remote aggregation of R-PHY and/or R-MAC/PHY traffic.

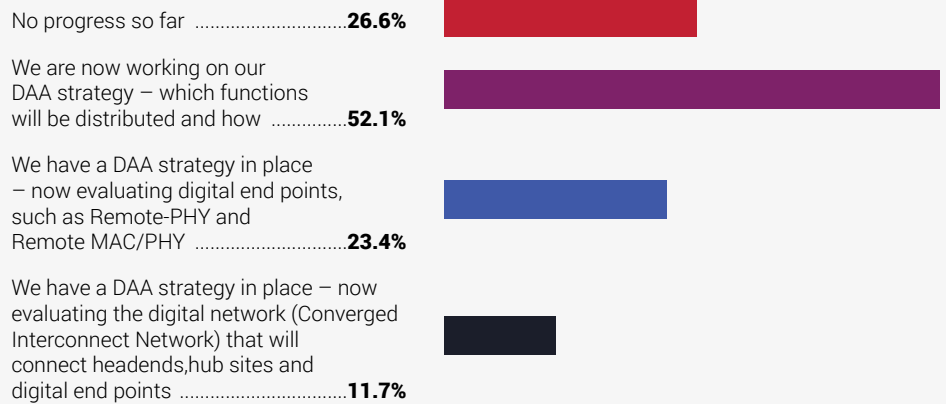


Converging on DAA

Despite the strong appeal of the technology, most cablecos have not gone ahead with their expected deployments of remote PHY, remote MAC/PHY, and other DAA options just yet. A couple of major MSOs are moving forward with DAA roll-outs, but most operators are still holding back and cautiously pondering their next-gen network options.

Both the keen appeal of DAA and the caution surrounding it are evident in the results of the Heavy Reading survey. More than one-half of survey respondents (52%) said their company is working on its DAA strategy but has not finished formulating it yet. Another 35% said their company does have a DAA strategy in place but is now evaluating either the digital endpoints or the digital network before executing its plan. More than one-quarter (27%) said their company has made no progress so far.

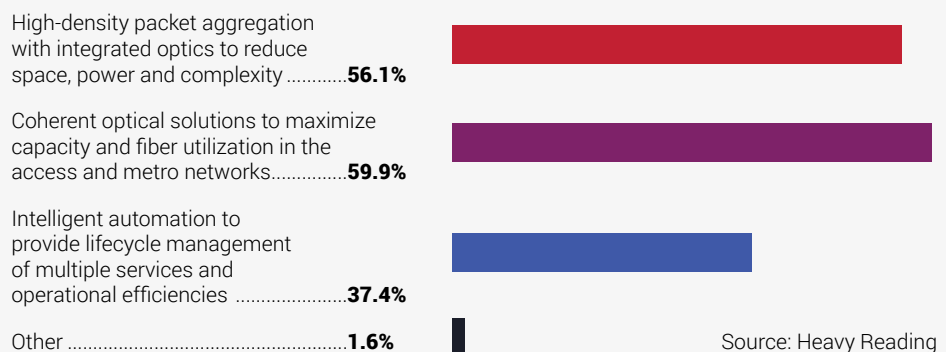
How much progress has your company made in defining a Distributed Access Architectures (DAA) strategy and evaluating related technologies?



Source: Heavy Reading

As mentioned earlier, a key element of that DAA plan involves the CIN. As part of their DAA implementation, cable operators are looking at how best to leverage the CIN and what will be needed to do so. In the Heavy Reading survey, coherent optical solutions to maximize capacity and fiber utilization in the access and metro networks ranked as the top technology that the CIN will require. That choice was closely followed by high density packet aggregation with integrated optics to reduce space, power, and complexity.

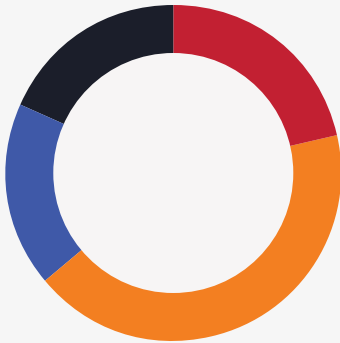
Which of the following technologies will the Converged Interconnect Network (CIN) require?



Source: Heavy Reading

We then asked how much cablecos intend to leverage their CIN links to support various service offerings. In the survey, more than three-quarters of cable executives (79%) said their company is planning to use its CIN infrastructure to converge at least two different types of residential and commercial services. Further, 15% intend to use CIN to converge four or more services.

Is your company planning to converge multiple services over a common Converged Interconnect Network (CIN) infrastructure?

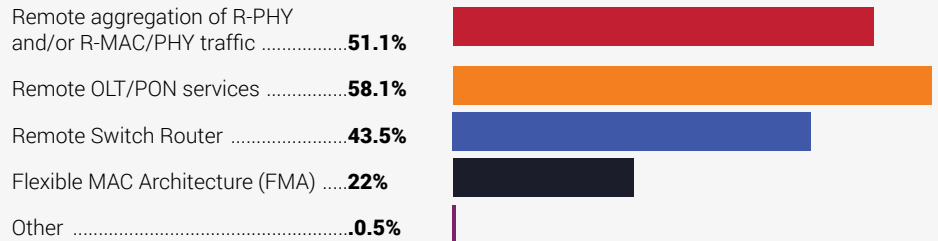


- No – we are planning to use CIN for just one type of service (e.g. residential services or business services) **28%**
- Yes – we are planning to use the CIN infrastructure for two services (e.g. residential services and business services) **39%**
- Yes – we are planning to use the CIN infrastructure for three services (e.g. residential services, business services, fiber-to-the-premise/PON) **18%**
- Yes – we are planning to use the CIN infrastructure for four or more services (e.g. residential services, business services, fiber-to-the-premise/PON, mobile backhaul).... **15%**

Source: Heavy Reading

Which DAA options are operators exploring to use in their outside plant? Surprisingly, nearly three-fifths of respondents (58%) said their company plans to use remote OLT/PON services in the outside plant as part of its DAA strategy, much higher than might be expected given cable's relatively recent embrace of PON technology. More in line with our expectations, slightly more than one-half (51%) intend to leverage remote aggregation of R-PHY and/or R-MAC/PHY traffic.

Which options is your company planning to use in the outside plant as part of your DAA strategy and plans?

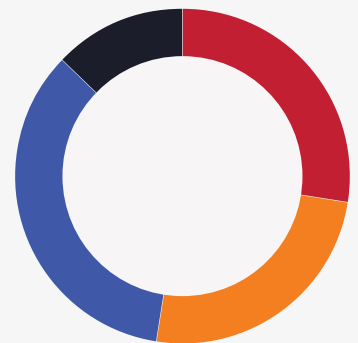


Source: Heavy Reading

Maintaining the focus on the outside plant, Heavy Reading inquired about operators' field aggregation strategies. More than one-third of cable executives (35%) said their company is planning to carry out field aggregation in both its street cabinets and secure pole-mounted enclosures. Some 28% plan to do field aggregation just in their street cabinets, while 25% plan to do it only in their pole-mounted enclosures.

Which field aggregation strategy (i.e. aggregation in the outside plant) best fits your network goals?

- We are planning to do some field aggregation in street cabinets. **27.7%**
- We are planning to do some field aggregation in secure pole-mounted enclosures **25%**
- We are planning to do some field aggregation in both street cabinets and secure pole-mounted enclosures **34.6%**
- Not planning field aggregation; we are planning to do all aggregation in hub sites and headends **12.8%**



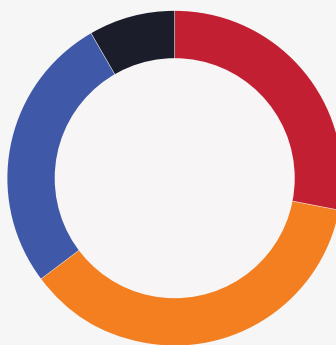
Source: Heavy Reading



We then sought to shed light on cablecos' strategies for coherent optics, another key technology for the fiber end of the HFC plant. Nearly two-fifths of survey respondents (37%) indicated they think coherent optics will mainly be used in their access networks (e.g., backhaul R-PHY/R-MAC/PHY traffic aggregated in the access network). More than one-quarter (28%) said the technology will mainly be used in their metro networks (e.g., between headends and hub sites), while nearly as many (27%) said it will be used in both their metro and access networks.

Where will coherent optics (100G and higher DWDM rates) be used in the Converged Interconnect Network (CIN)?

- Coherent optics will mainly be used in metro networks (e.g. between headends and hub sites) **28.1%**
- Coherent optics will mainly be used in access networks (e.g. backhaul R-PHY/R-MAC/PHY traffic aggregated in the access network) **36.8%**
- Coherent optics will be used in both metro and access networks **27%**
- Capacity requirements are not likely to warrant coherent optics for the CIN **8.1%**

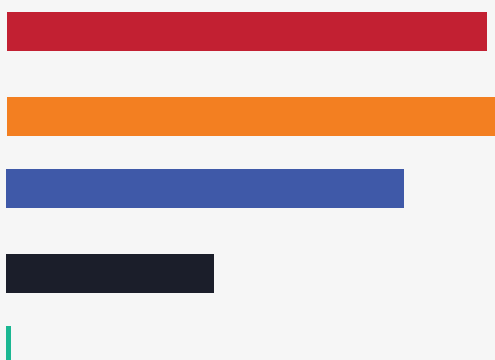


Source: Heavy Reading

Turning back to the CIN, Heavy Reading wondered how operators viewed the packet aggregation switch/platform for it. In the survey, advanced timing, low latency, and high capacity ranked as the most important features in the packet aggregation switch/platform. This choice was followed closely by high availability, extended temperature range, and remote cabinet deployment.

Which features in the packet aggregation switch/platform are the most important for the Converged Interconnect Network (CIN)?

- High availability, extended temperature range, and remote cabinet deployment **59.4%**
- Advanced timing, low latency, and high capacity **61.5%**
- Flexible aggregation interface configuration of 1/10/25 GbE **49.2%**
- Deployable in remote cabinets and flexible coherent interface configuration of 100/200 Gb/s **25.7%**
- Other **0.5%**

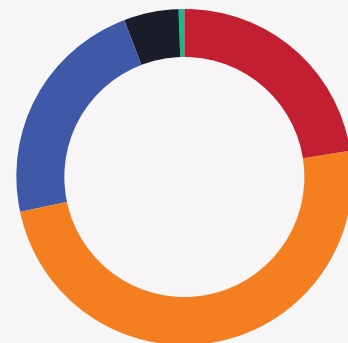


Source: Heavy Reading

Finally, cablecos were asked about the role of automation in the CIN. Regarding that technology, survey respondents said the greatest need in their company's DAA strategy and CIN rollout is to automate the delivery of services across physical and virtual infrastructures. Two other needs for automation tied for second: federating inventory (single view) for DAA, CIN, and existing network resources; and gaining real-time visibility of IP routing and service delivery impact in the CIN.

Where is the greatest need for more automation in your company's DAA strategy and Converged Interconnect Network (CIN) rollout?

- Federated inventory (single view) for DAA, CIN and existing network resources **22.5%**
- Automate delivery of services across physical and virtual infrastructures **49.2%**
- Real-time visibility of IP routing and service delivery impact in the CIN **22.5%**
- Lifecycle management of services across packet-optical CIN **5.3%**
- Other **0.5%**



Source: Heavy Reading



Ciena is a networking systems, services and software company. We provide solutions that help our clients create the Adaptive Network™ in response to the constantly changing demands of their users. By delivering best-in-class networking technology through high-touch consultative relationships, we build the world's most agile networks with automation, openness and scale.

The cable industry announced its vision for delivering 10 Gigabit networks, or 10G – enabling new services, enhancing the customer experience, and achieving operational efficiencies. MSOs will achieve 10G with a collection of architectures and technologies, including Distributed Access Architectures (DAA), Converged Interconnect Networks (CIN), and extending fiber deep.

Ciena builds the Adaptive Network™ for MSOs by modernizing network infrastructures, supporting DAA strategies and the CIN, and enabling innovative solutions for their enterprise customers. The Ciena Fiber Deep solution is a unique combination of packet, optical and automation technologies for the Converged Interconnect Network, comprised of: (1) high-density packet aggregation with integrated optics—reducing space and power, and providing architectural flexibility, (2) industry-leading coherent optical solutions—maximizing capacity and fiber utilization in the access and metro networks, and, (3) intelligent automation—providing lifecycle management of multiple services over a common infrastructure with operational efficiencies.

Learn more about the Ciena Fiber Deep solution for the Converged Interconnect Network at ciena.com/distributed-access-architecture/#fiber-deep-solution



FIBER SERVICE ORCHESTRATION

There's a lot more to adding more fiber to the cable plant than first meets the eye. Beyond digging up the streets and installing new fiber lines in the ground or stringing them from utility pole to pole, cablecos must protect the new lines from harm, add new devices to support them, and thread them into their existing HFC plant. They also must activate the new fiber-based services, integrate them with their existing services over HFC, and manage both sets of services on both the front and back ends.

In this section of the report, Heavy Reading looks at the challenges of operating and provisioning these new fiber services and the methods that operators are using or exploring to overcome those challenges. We also look at what cablecos will require as they continue to adapt to the new fiber era.



KEY TAKEAWAYS:



Service activation, configuration, and decreasing fallout is the leading area where cablecos are focusing for greater operational efficiency over the next 12 to 18 months, followed closely by customer premises equipment (CPE) roll-out and management (CPE plug and play, zero-touch provisioning).



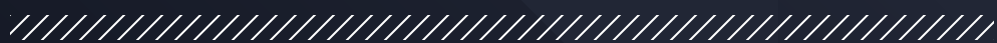
Just over one-third of cable executives (35%) have already converged residential and business service provisioning and operation into a single operations support system (OSS) stack. Nearly one-half of cable executives (49%) said their company has partially extended its residential services OSS stack to support business-to-business (B2B) service delivery by converging internet services.



Cable executives view network virtualization (e.g. VOLTHA, vCPE, vCMTS, vCCAP, vDAA) as the leading fiber catalyst that will drive an inventory upgrade or replacement, with new product introduction (e.g., managed services, GPON/EPON, etc.) coming in a strong second.



More than three-fifths of survey respondents (61%) said their company seeks to address network vendor neutrality and open APIs with its provisioning approach when rolling out DAA, making that the lead choice. More than one-half of respondents said their company is also seeking to address hands-off automation (or zero-touch), device scaling, and/or future-proofing for going fiber deep.





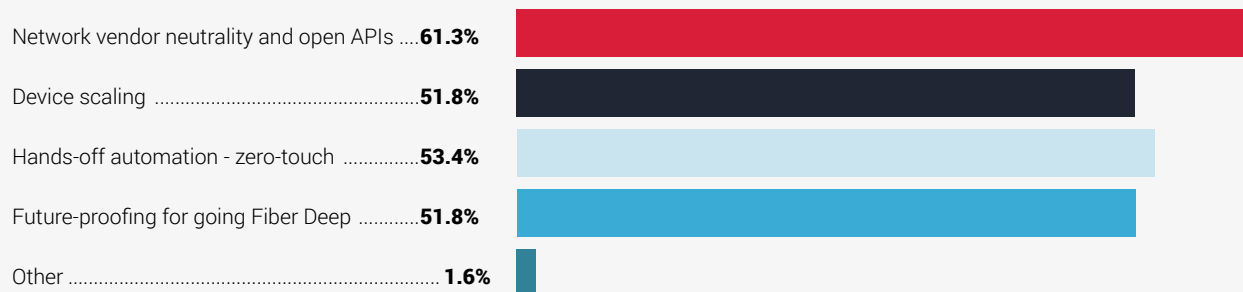
Tuning Up the Fiber Band

Cable operators have been managing service delivery to their customers for more than 7 decades. But for most of that time, the services have been delivered primarily over the coaxial part of the industry’s HFC plant.

Now that cablecos are increasingly delivering their voice, video, data, and other offerings over fiber lines while continuing to also deliver them over coax, a new, more complex level of service orchestration is required – especially as they move to a distributed access architecture (DAA) framework.

In the Heavy Reading survey, more than three-fifths of survey respondents (61%) said their company seeks to address network vendor neutrality and open APIs with its provisioning approach when rolling out DAA, making that the lead choice. More than half of respondents said their company is also looking to address other critical areas, such as hands-off automation or zero-touch (53%), device scaling (52%), and future-proofing for going fiber deep (52%).

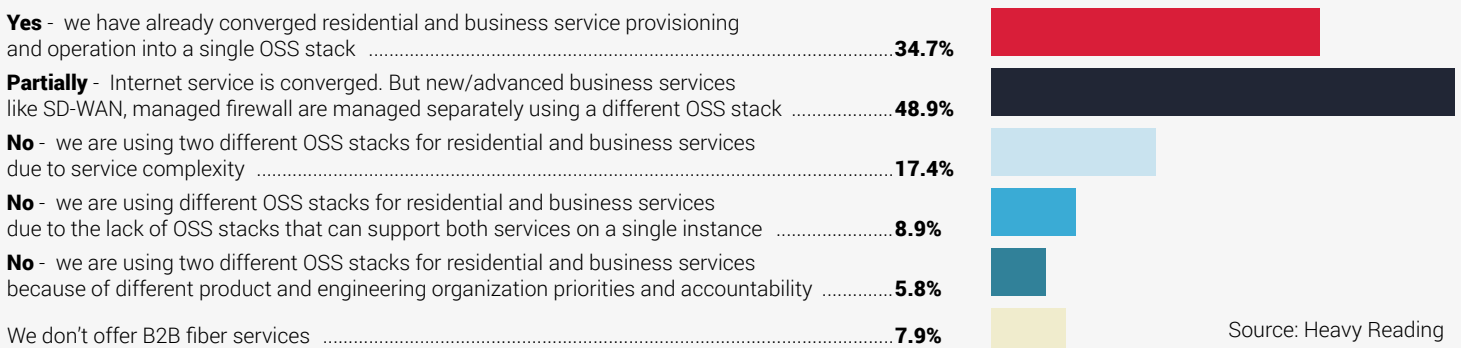
When rolling out DAA (Remote PHY, Remote MAC/PHY), what is your company seeking to address with its provisioning approach?



Source: Heavy Reading

What progress are cable operators making with their back-office support of fiber-based services? Just over one-third of cable executives (35%) have already converged residential and business service provisioning and operations into a single OSS stack. Nearly one-half of cable executives (49%) said their company has partially extended its residential services OSS stack to support B2B service delivery by converging internet service. But the latter are still using a different OSS stack to manage new/advanced business services, such as SD-WAN, managed firewall, Metro Ethernet, and L2/L3 VPN services.

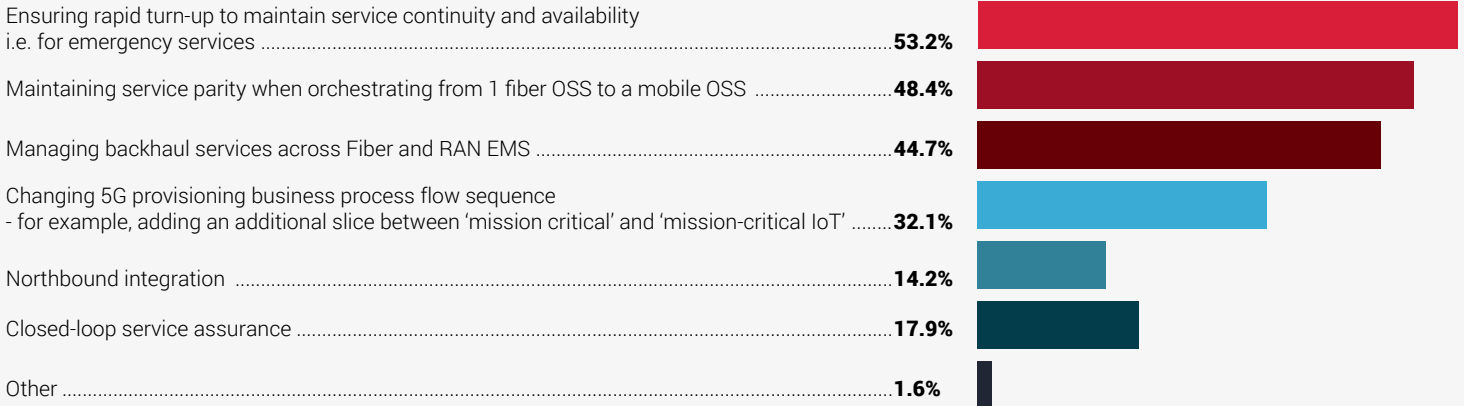
Has your company extended its residential services OSS stack to support B2B service delivery?



Source: Heavy Reading

Heavy Reading then turned to what would happen to 5G backhaul service if there were a fiber cut. Ensuring rapid turn-up to maintain service continuity and availability (i.e., for emergency services) ranked as the top fulfillment challenge with 5G redundant backup connectivity, with more than one-half of survey respondents (53%) choosing it. Maintaining service parity when orchestrating from one fiber OSS to a mobile OSS came in second with 48% and managing backhaul services across fiber and RAN EMS followed in third with 45%.

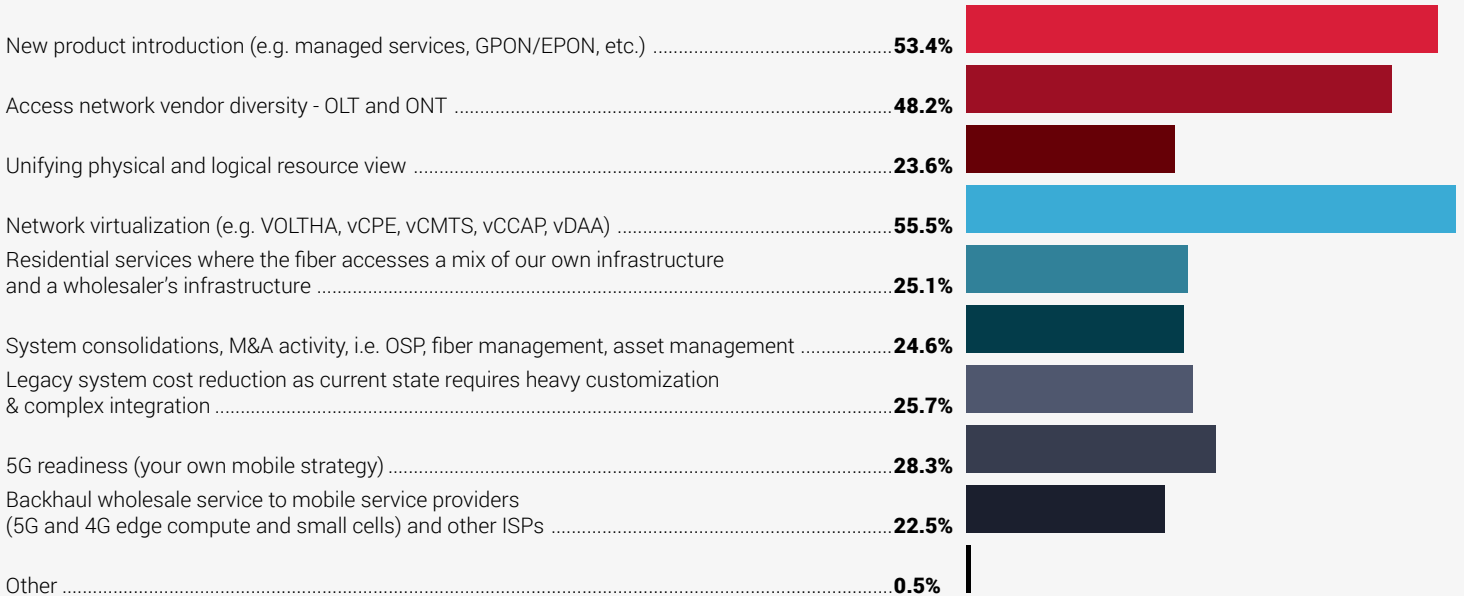
In the event of a backhaul fiber cut, what fulfillment challenges do you anticipate with 5G redundant backup connectivity?



Source: Heavy Reading

What will prompt cable operators to upgrade or replace their inventory? Cable executives view network virtualization (e.g. VOLTHA, vCPE, vCMTS, vCCAP, vDAA) as the leading fiber catalyst that will drive an inventory upgrade or replacement.. More than one-half of respondents (56%) chose it in the survey. New product introduction (e.g., managed services, GPON/EPON, etc.) came in a strong second, also earning checks from more than one-half (53%) of the respondents.

Which fiber catalysts will drive an inventory upgrade or replacement?



Source: Heavy Reading



With each architectural advance they make, cable operators are looking to gain greater operational efficiency. So where do they see the potential for greater operational efficiency with fiber? Service activation, configuration, and decreasing fallout is the leading area where cablecos are focusing for greater operational efficiency over the next 12 to 18 months, with more than one-half of survey respondents (55%) selecting that choice. CPE rollout and management (CPE plug and play, zero-touch provisioning), followed closely behind, with 52% choosing it. Also scoring relatively highly were device discovery and diagnostics (45%) and improving service quality and churn management (44%).

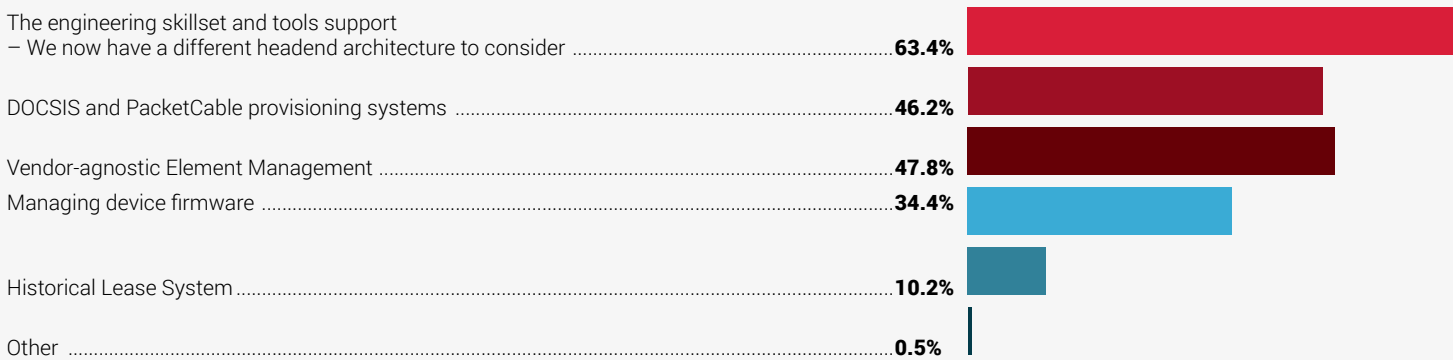
Where is your company focusing for greater operational efficiency over the next 12-18 months?



Source: Heavy Reading

As cable operators make the shift to a DAA framework, they must make corresponding changes to their operational processes. Given that necessity, which areas do they see as the most likely for change? Nearly two-thirds of survey respondents (63%) view engineering skillset and tools support as the area where they anticipate making changes as their company adapts its operational process to a virtualized Converged Cable Access Platform (CCAP) core, making that easily the lead choice. Vendor-agnostic element management came in second, drawing votes from 48% of respondents. DOCSIS and PacketCable provisioning systems followed right behind, earning selection by 46% of respondents.

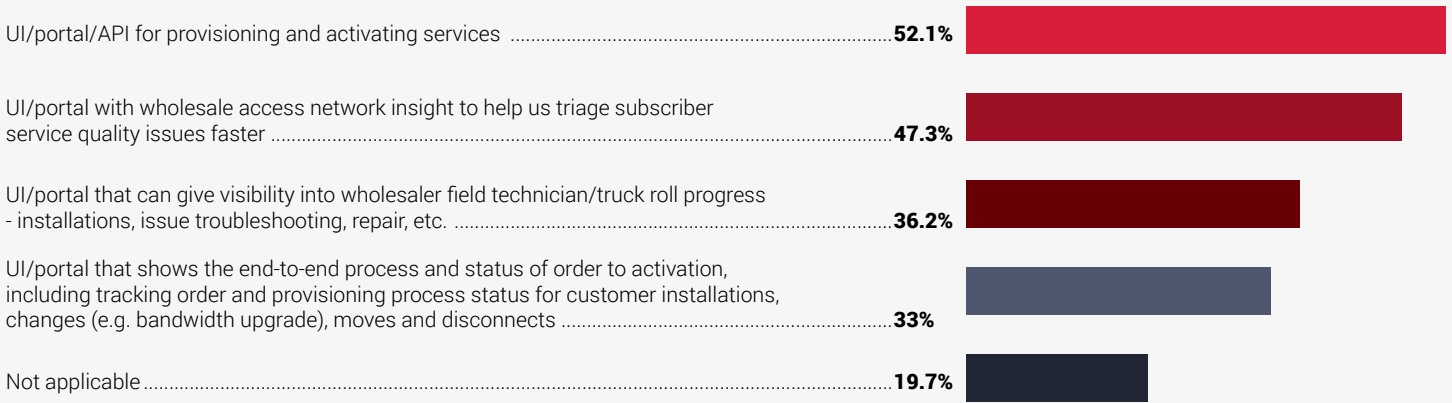
As your company adapts its operational process to a virtualized CCAP core, where are you anticipating changes?



Source: Heavy Reading

Finally, as cablecos make this historic shift to fiber-based service, they could undoubtedly use some help from wholesale fiber providers. So we asked operators exactly what they need. User interface (UI)/portal/API for provisioning and activating services ranked as the top thing that they would like to see from their wholesale fiber provider, with more than one-half (52%) of survey respondents choosing that option. UI/portal with wholesale access network insight to help them triage subscriber service quality issues faster came in second, with nearly one-half of respondents (47%) picking it.

If you are a retail ISP, what would you like to see from your wholesale fiber provider?



Source: Heavy Reading



Incognito Software Systems Inc. provides service orchestration software and services solutions that help fixed providers operate, manage, and scale next-generation in-home broadband services.

Our productized service orchestration platforms allow cable, fiber, and fixed wireless broadband service providers to manage devices and services, and bring extensive automation and analytics to reduce operational costs and improve the home-user experience. Incognito solutions are proven in communications service provider networks globally, delivering tangible operational efficiencies and service agility. With over 20 years' experience, we've helped global providers like Globe, Orange and Digicel accelerate and innovate in-home broadband services with our modular, productized suite of software platforms.

The Incognito Fiber Service Orchestration Solution accelerates service activation and device lifecycle management for next-generation fiber-based IP services. With Incognito, service providers gain a unique operational competitive advantage with an accelerated deployment model in weeks, coupled with extensive process automation and the capability to easily integrate and co-exist with legacy OSS and BSS systems. Incognito's turn-key, pre-integrated fiber solution not only provides multi-play bundled services, such as hybrid video (IPTV, OTT), Internet, and VoIP, but lays the foundation to fulfill new business models such as smart home, IoT, and mobile backhaul.

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FIBER TEST

It is clear that fiber expansion will play a crucial role in the plans and strategies that cable MSOs are developing to support next-generation consumer video, broadband, business services, and 5G. A successful fiber expansion strategy, however, requires proper fiber testing – and cable operators may not have the fiber testing expertise they need. Technicians experienced in coax will increasingly have to learn how to work with fibers. Even those trained in fibers will migrate from lower speeds to 100 Gbit/s coherent optics and beyond. This section covers testing issues related to fiber expansion, including installation, service turn-up, and troubleshooting. It looks at both technical and operational issues associated with fiber testing.

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KEY TAKEAWAYS:



Nearly one-half of cable respondents (49%) rated the importance of fiber testing to their fiber expansion as a 1 – the highest rating on the scale.



Just 24% of those surveyed had the highest level of confidence in their technicians' abilities to handle fiber (a 1 rating).



Although still a key factor, cost ranked a mere fourth on a list of six important factors for fiber test equipment in Heavy Reading's survey. Reliability topped the list by a strong margin, followed by durability and ease of operation.



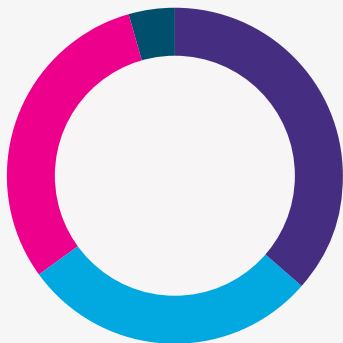


Proper Installation and Testing Will Underpin Fiber Success

Fiber installations for cable operators are performed by a somewhat uneven mix of in-house technicians and outside contractors.

In our survey, 37% of respondents reported that the majority of installations are performed by in-house staff, while 29% reported that outside contractors do most of the installation work. Nearly one-third (31%) stated that the mix is equal.

Who performs the majority of fiber installations at your company?

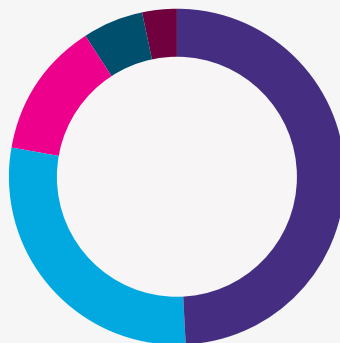


	In-house technicians	36.6%
	Outside contractors	28.5%
	An equal mix of in-house technicians and outside contractors are used	30.6%
	Don't know/Not applicable	4.3%

Source: Heavy Reading

Whether those fiber installations are done in-house or by outside contractors, it is clear that cable MSOs highly value proper testing of those fibers. When Heavy Reading asked cable executives to rate the importance of fiber testing to the success of their company's fiber expansion, just under half (49%) rated it a 1 in importance – the highest rating on the scale from 1 to 5. An additional 29% rated fiber testing a 2, and just 3% gave fiber testing the lowest rating of 5.

Please rate the importance of proper fiber testing to the success of your company's fiber expansion strategy.

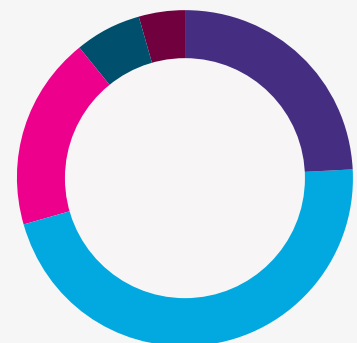


	1	49.2%
	2	28.6%
	3	13%
	4	5.9%
	5	3.2%

Source: Heavy Reading

While cablecos overwhelmingly view fiber testing as critical to their business success, they are less confident in their own technicians' abilities to do the work. Using a scale of 1-5, with 1 the highest, we asked cablecos to rate how confident they are that their technicians are properly trained to install, turn up, and troubleshoot fiber networks. While 49% of respondents rated fiber testing as critical to their fiber expansion strategies (a 1 rating), just 24% of them had the highest level of confidence in their technicians' abilities to handle fiber (a 1 rating). The findings indicate a gap between the criticality of fiber testing and the abilities of cable technicians to properly install and test fiber.

How confident are you that your technicians are properly trained to handle install, turn-turn, and troubleshooting of fiber networks?

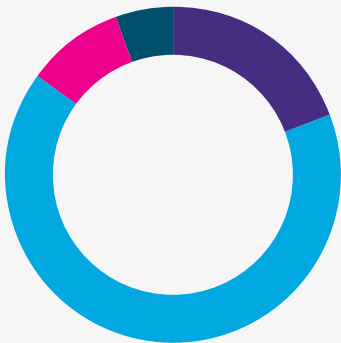


	1	24.3%
	2	46.5%
	3	18.4%
	4	6.5%
	5	4.3%

Source: Heavy Reading

Ease of setup and analysis of Optical Time Domain Reflectometer (OTDR) fiber test results is at least important to almost all cable operators and a critical function for some. In Heavy Reading's survey, 85% rated ease of setup and analysis as at least important, with 19% of the group reporting the functions are critical. The main driver for ease of use is lack of OTDR expertise among technicians.

How important is ease of setup and analysis of OTDR fiber test results?

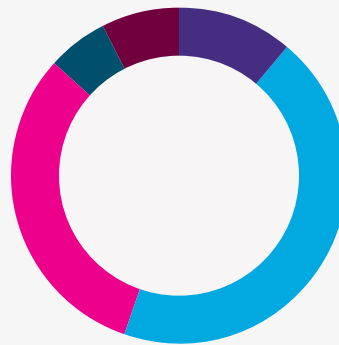


- Critical – our technicians do not have OTDR expertise **19.3%**
- Important – most technicians are proficient, but it still has significant benefits **65.8%**
- Marginal – Only minor benefits will result **9.6%**
- Not a factor – our technicians are full experts at OTDR **5.3%**

Source: Heavy Reading

As fiber connectivity increasingly moves from direct detection (using on-off keying) to coherent detection, a plurality of cable operators expect that fiber testing requirements will remain the same. In our survey, 44% of respondents reported that coherent optics will require the same amount of testing as direct detect optics. Nearly one-third (31%) of respondents expect coherent optics will require more fiber testing compared to direct detect, while just 11% expect less testing will be required. Coherent links are more tolerant of polarization mode dispersion (PMD) and chromatic dispersion (CD). However, operators must keep in mind that 100 Gbit/s coherent systems may run next to 10 Gbit/s direct detect systems on the same fibers; thus, PMD and CD testing will still be required.

As more of your company's networks move to coherent optics, what is the expected impact on fiber testing in your company?

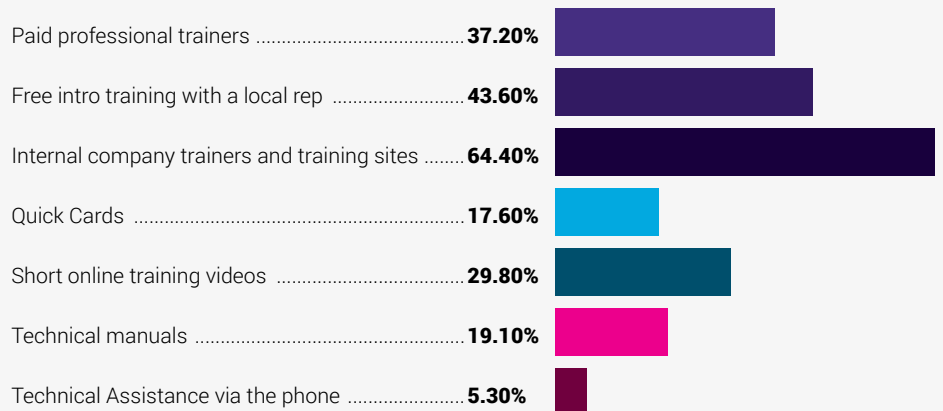


- Less fiber testing needed as coherent systems are more tolerant of chromatic dispersion (CD) and polarization mode dispersion (PMD) **11.2%**
- Roughly same amount of fiber testing will be required **44.1%**
- More fiber testing needed to address coherent optics **31.4%**
- Company is still evaluating the impacts of coherent optics on fiber testing needs **5.9%**
- Don't know/not applicable **7.4%**

Source: Heavy Reading

When it comes to training technicians on new fiber test equipment, cable operators have a strong preference for direct, face-to-face instruction. Nearly two-thirds (64% of respondents) listed internal company trainers as the preferred method, but free intro training with local reps (selected by 44% of respondents) and paid professional trainers (37%) are also strongly preferred. All non-personal training options received low marks, including online training courses, technical manuals, quick cards, and phone assistance.

What is your preferred way to train technicians on new fiber test equipment?



Source: Heavy Reading



Although important, cost is not king when it comes to selecting fiber test equipment. In fact, cost ranked fourth on a list of six important factors for fiber test equipment in Heavy Reading's survey. Topping the list, by a strong margin, was reliability, followed by durability and ease of operation. Coming in below costs were multipurpose testing solutions (ranked 5th) and automated workflow and reporting (ranked last).

Please rank the importance of the following factors in selecting fiber test equipment.

Factor	Overall Rank	Score
Reliability	1	995
Durability	2	924
Ease of operation (no training required)	3	904
Costs	4	883
Multipurpose testing solutions	5	639
Automated workflow and reporting	6	541



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