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Society of Cable Telecommunications Engineers
International Society of Broadband Experts

CABLE'S FIBER OUTLOOK SURVEY REPORT



FIBER LINK/ DAA PLANS

For the past few years, cable operators have increasingly been exploring the concept of Distributed Access Architecture (DAA), which calls for pushing some key electronics closer to the edge of the access network. The idea behind this is to lay the groundwork for the virtualization of some key network functions and services, while also supporting the rollout of such new, multi-gigabit-enabling technologies as DOCSIS 3.1, Full Duplex DOCSIS and Extended Spectrum DOCSIS. Operators are also counting on DAA to boost overall network capacity, improve signal quality and make plant maintenance easier, among other things.

But, while cable's commitment to carrying out DAA seems firm, many questions remain about the industry's implementation plans. Chief among them are which DAA approach will be the preferred one, how much time the rollout will take, which new services will be offered and what major hurdles will need to be overcome. This section of our report tackles these and related questions, looking at how cable operators intend to make DAA a reality.

KEY TAKEAWAYS:

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More than three-fifths of respondents (62%) say their company has started converting its cable systems to DAA or plans to start doing so by the end of this year.
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Nearly three-fifths of respondents (57%) say their company is pursuing a Remote PHY node approach, while more than two-fifths (43%) say their company is pursuing a Remote MAC/PHY node scheme.
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More than half of survey respondents (53%) say their company expects to roll out DAA to most of its cable systems by the end of 2020, a little more than two years from now.
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More than one-fifth of respondents (almost 22%) see upgrading fiber-optic nodes as the greatest challenge in implementing DAA, making it the lead choice over dealing with legacy network equipment (16%), working out signal timing issues (13%) and upgrading headend equipment (13%).
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DAA on Arrival

After hearing about the potential benefits of DAA for several years, cable operators are now pretty sold on the concept, and most of them are embracing it. In fact, more than three-fifths of survey respondents (62%) say their company has either started converting its cable systems to DAA already (51%) or plans to start doing so by the end of the year (11%). Another 17% intend to begin the conversion process by the end of 2019, while 5% more aim to begin in 2020. As a result, fewer than one-seventh of respondents (13%) don't have any plans to go the DAA route.

As other independent surveys have indicated, Remote PHY has emerged as the early favorite among the industry's DAA options. Nearly three-fifths of respondents (57%) say their company is now pursuing a Remote PHY node approach, while more than two-fifths (43%) say their company is pursuing a Remote MAC/PHY node

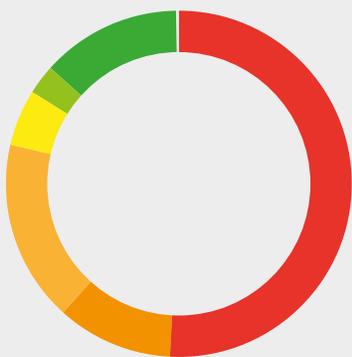
scheme. The Virtualized CCAP core approach ranks third with a 29% score, and EPON OLT comes in a close fourth with 26%, as cable operators explore more than one distributed option at the same time. These results are consistent with the findings from a similar question in another part of the survey.

Now that many cable operators have begun to deploy DAA, a big question is how fast they intend to roll it out to their entire footprint. More than half of survey respondents (53%) say their company expects to roll out DAA to most of its cable systems by the end of 2020, with over 23% aiming to do so by the end of 2019 and another 29% intending to hit that mark by the close of 2020. Just 15% don't plan to reach that milestone by the end of 2022.

While they seem committed to shifting to a distributed approach, cable operators recognize that they must overcome many challenges to fulfill that commitment. More than one-fifth of respondents (almost 22%) see upgrading fiber-optic nodes as the greatest challenge in implementing DAA, making it the lead choice. Other key hurdles cited as the biggest challenge include dealing with legacy network equipment (16%), working out signal timing issues (13%) and upgrading headend equipment (13%).

Another big question with DAA is which new or more advanced services it will enable. >

When does your company plan to begin converting its cable systems to DAA (Distributed Access Architecture)?



- We are already doing this **51.0%**
- We will start by the end of this year.. **11.0%**
- We will start in 2019 **16.8%**
- We will start in 2020 **5.2%**
- We will start in 2021 or later **2.9%**
- We have no plan to convert to DAA.. **13.2%**

There are many reasons why cable operators feel compelled to deploy DAA. But by far and away the biggest reason appears to be the promise of greater network capacity. In our survey, more than four-fifths of respondents (82%) cited that as one of the most important factors leading them to deploy DAA. Better end-of-line signal quality ranked second at 50%, and simpler outside plant maintenance came in third at 42%. No other factor claimed more than 40% of the total votes.



When asked that question, nearly two-thirds of respondents (65%) said their company expects to offer 4K/8K video service with the help of a distributed architecture, making it the most popular choice. 5G mobile backhaul came in second, garnering votes from 59% of operators. IPTV ranked a surprisingly strong third, capturing 54% of the votes, and IoT came in fourth with 45%. As before, these results were consistent with the findings from a similar question in another part of the survey except for IPTV, which wasn't a choice in the earlier survey.

Turning to the types of network upgrades that cable operators are carrying out or planning along with implementing DAA, survey respondents ticked off numerous current industry initiatives. Not too surprisingly, DOCSIS 3.1 led the way, with about two-thirds of respondents (67%) choosing the next-gen DOCSIS standard that operators are now rolling out throughout North America and other parts of the world. Nearly three-fifths of respondents (58%) selected Fiber Deep, and nearly one-half chose Full Duplex DOCSIS (48%) and node splits (48%). Thus, as might be expected, operators are now coordinating several different network upgrades and architectural shifts at the same time.

“NOW THAT MANY CABLE OPERATORS HAVE BEGUN TO DEPLOY DAA, A BIG QUESTION IS HOW FAST THEY INTEND TO ROLL IT OUT TO THEIR ENTIRE FOOTPRINT. MORE THAN HALF OF SURVEY RESPONDENTS (53%) SAY THEIR COMPANY EXPECTS TO ROLL OUT DAA TO MOST OF ITS CABLE SYSTEMS BY THE END OF 2020.”

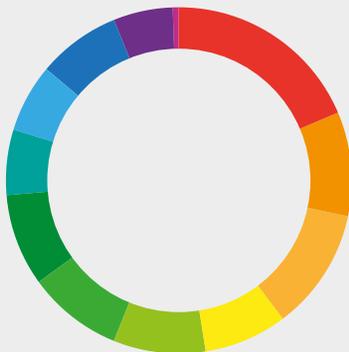
We then asked cable operators which virtualization solutions their company plans to deploy as part of its DAA initiatives. OpenStack or other networking operating systems clearly carried the day, with 60% of respondents checking it off. Management of DAA components also scored highly, ranking second at 46%. Docker/Kubernetes or other management orchestration solutions took third place, with 27% of respondents choosing it.

As for which solution for Converged Interconnect Network their company plans to use as part of its DAA initiative, cable operators are almost evenly split between their own solution developed in-house and one developed by a vendor. Slightly more than one-third of our survey respondents (36%) say their company intends to use an in-house solution, while nearly one-third (32%) say their

company intends to rely on a vendor-specific solution. Plus, slightly more than one-quarter (26%) say their company will leverage a multi-vendor solution. Thus, operators appear to be all over the map on this question right now.

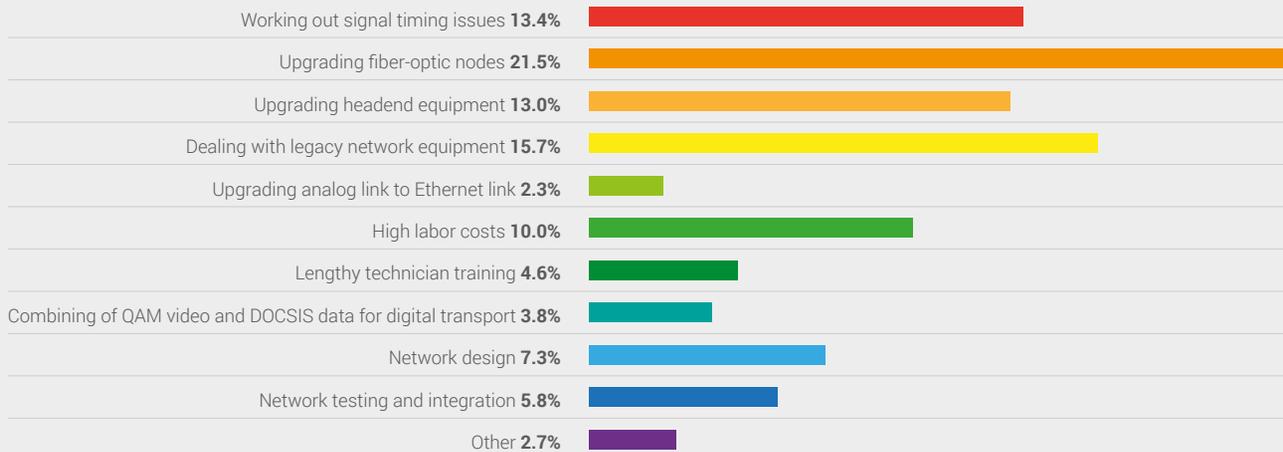
With most cable operators extending fiber deeper in their networks and adopting a distributed network approach, it makes sense that the service groups served by each fiber-optic node might shrink. Indeed, that appears to be the case. Three-fifths of respondents (60%) say their company aims to reduce the size of its service groups to just 200 homes or fewer, down from the industry standard of 500 homes or more now. Further, slightly more than one-third (34%) say their company is looking to cut the size of its service groups down to no more than 100 homes. ■

What are the most important factors leading your company to deploy DAA? (choose all that apply)



● Increased network capacity	81.7%
● Simpler outside plant maintenance	42.4%
● Better end-of-line signal quality	50.0%
● Headend consolidation	34.0%
● Higher modulation and bit-rates	37.4%
● Greater spectral efficiency, more wavelengths per fiber	39.3%
● Lower operational and capital expenditures	37.0%
● Reduced headend power, space and coding requirements	27.1%
● Ability to add QAMs without changing the RF combining network	27.5%
● Extend IP network to the node	34.4%
● Optical fiber capacity constraints	23.7%
● Other	2.7%

What is the biggest challenge in converting your systems over to DAA?



“THE SURVEY BRINGS ATTENTION TO THE FACT THAT BY 2019, MOST OF THE MSOS WILL BE READY TO BEGIN THE CONVERSION OF THEIR CURRENT CABLE SYSTEMS TO DAA, AND THEY PLAN TO COMPLETE THE ROLLOUT TO A MAJORITY OF THEIR CABLE SYSTEMS BY THE END OF 2020.”

ARRIS is leading the evolution of cable systems with the introduction of Distributed Access Architecture (DAA). This survey report provides an analysis of the imperative questions about the challenges and opportunities associated with the advent of DAA in the cable industry. The survey also analyzes the services being offered with DAA and acceptance of the forward-looking technologies, such as Full Duplex DOCSIS, and others.

The survey brings attention to the fact that by 2019, most of the MSOs will be ready to begin the conversion of their current cable systems to DAA, and they plan to complete the rollout to a majority of their cable systems by the end of 2020. Further analysis reveals that a slim majority of the MSOs are moving toward Remote PHY node solutions. The survey determines that the motivation for many MSOs to choose DAA is because it offers increased network

capacity and better end-of-line signal quality. The report finds that some of the main challenges of DAA evolution are upgrading the fiber-optic nodes and dealing with the legacy equipment.

The survey report also reveals that the MSOs are already upgrading or planning to upgrade their networks to DOCSIS 3.1 and introduce Full Duplex DOCSIS to offer more bandwidth capacity and better quality of service.

ARRIS offers high-performance Remote PHY solutions in the form of the E6000® CCAP Core with Gen 2 hardware and the E6000n™ Remote PHY Device in different form factors: NC2000, NC4000 nodes, and OM6000 fiber deep node, and E6000r™ Remote PHY Shelf. ARRIS is also leading the Remote MACPHY CableLabs committee to bring the cutting-edge technology to MSOs that choose the Remote MACPHY solution.



FIBER CHARACTERIZATION/INSTALLATION

Now that cable operators are pouring so many resources into putting more fiber in their plant, it seems a good time to take a close look at what they've accomplished so far. So, in this section of our survey report, we are examining the progress that cablecos have made with installing fiber in their transport and backbone networks up to this point, the pace they plan to maintain in installing more and the factors driving their fiber momentum.

It also seems a good opportunity to delve into the nitty-gritty of the fiber installation process, focusing on the technical, operational, financial and other challenges of deploying more fiber. Along with that, we'll look at how MSOs are handling the planning, maintenance and repair of their burgeoning fiber transport networks.



KEY TAKEAWAYS:

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More than one-third of survey respondents (35%) say their company is "very aggressively" deploying new fiber capacity in its transport networks right now, while slightly more than half (51%) say their company is "somewhat aggressively" deploying fiber now.
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Nearly three-quarters of respondents (72%) say their company is expanding fiber capacity to support business services growth, while nearly as many (71%) cite residential services growth as a driving factor.
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Fiber availability and cost easily ranks as the top challenge for cable operators seeking to boost fiber capacity in their transport networks, followed by network design and coordination of multiple fiber providers.
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Cablecos view fiber quality as the top network technical challenge they're facing with the medium, followed by latency issues and power failures.



Where the Fiber Meets the Road

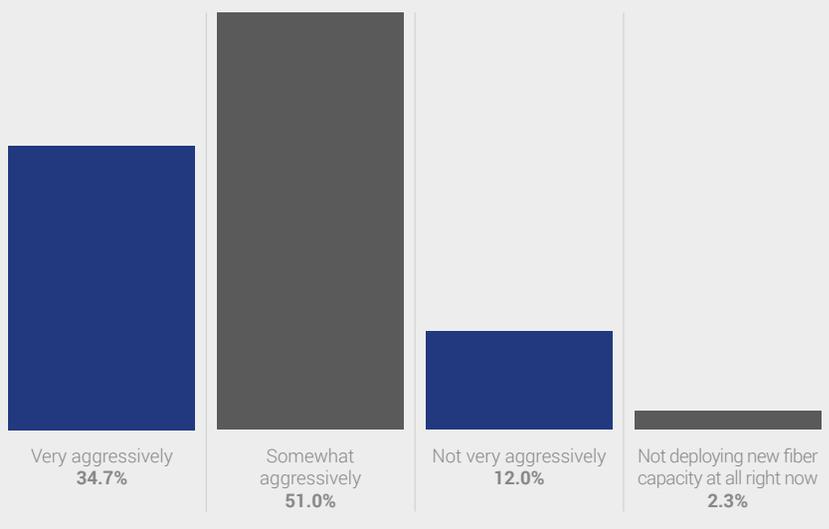
Cable operators are not exactly newcomers to fiber. After all, the "F" in cable's HFC networks does stand for fiber. Although the industry's focus now is on putting more fiber in the access network, cablecos have been building up both their transport and backbone networks with fiber for years, if not decades.

In fact, about two-fifths of survey respondents (40%) say their company now has more than 100,000 fiber miles in their transport and backbone networks, while another 13% say their company now has between 50,000 and 100,000 fiber miles and yet another 10% report having 30,000 to 50,000 fiber miles. These findings at least partly reflect the fact that executives from the two largest U.S. MSOs, Comcast and Charter, made up more than one-third of the survey respondents. But they also reflect the fact that cable operators of all sizes

have been bulking up their long-haul networks with fiber for a long time.

If anything, that bulking-up effort is accelerating now. More than one-third of survey respondents (35%) say their company is "very aggressively" deploying new fiber capacity in its transport networks right now, while slightly more than half (51%) say their company is "somewhat aggressively" deploying fiber now. Taking those totals together, nearly seven-eighths of respondents (86%) say their company is now deploying fiber in its transport networks at least somewhat aggressively. Just 2% say their company is not deploying new fiber capacity at all.

How aggressively is your company deploying new fiber capacity in its transport networks right now?



There are several key factors driving cablecos to add more fiber to their transport networks. Nearly three-quarters of survey respondents (72%) say their company is expanding fiber capacity to support business services growth, while nearly as many (71%) cite residential services growth as a driver. Moving their combined traffic onto higher-capacity fibers also ranks as a top driving factor for cablecos, with slightly more than one-half of respondents (51%) choosing it.

Of course, cable operators face some major hurdles in expanding their fiber diets, as they well know. In our survey, fiber availability and cost ranked as the top challenge for cablecos seeking to boost fiber capacity in their transport networks, easily beating out network design, coordination of multiple fiber providers and labor costs. >

No other challenge came close to those four on the scale.

Staying on the subject of hurdles, we also asked survey participants about the three biggest fiber network technical challenges their company is facing. Respondents replied that they view fiber quality as the top technical challenge, thereby sending a strong, sobering message to fiber suppliers. Latency issues and power failures also scored highly on the scale, followed by faulty lasers and inadequate testing.

Cable operators have ambitious plans to leverage the additional fiber in their transport networks for the delivery of new and more advanced services to customers. Nearly two-thirds of respondents (65%) say their company plans to use the additional fiber to offer

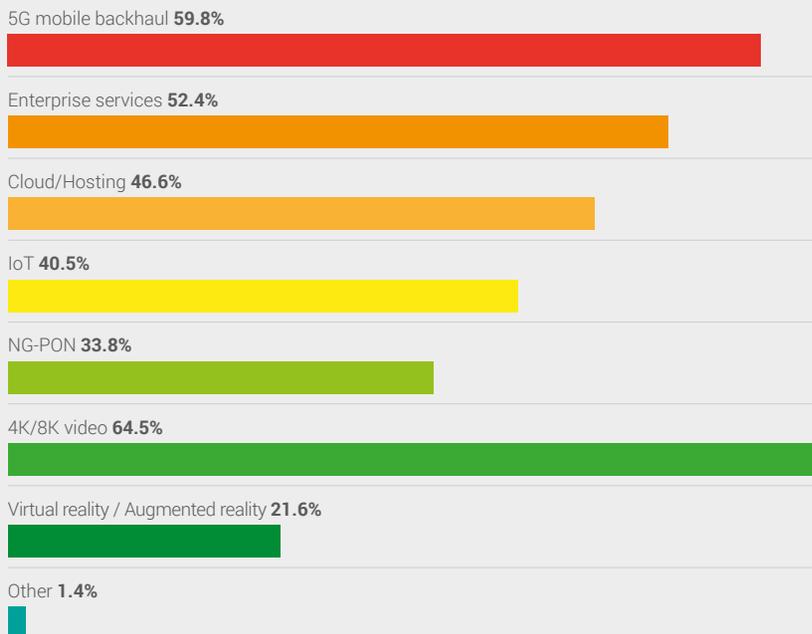
4K/8K video services, making that the lead choice. Three-fifths of respondents intend to offer 5G mobile backhaul service over the fiber, more than one-half (52%) aim to offer enterprise services and close to half (47%) plan to offer cloud and hosting services. These findings are largely consistent with the results from similar questions in other parts of our survey.

Given these new and more advanced services, cable operators see the bandwidth requirements of their transport networks continuing to climb steadily. Nearly one-half of survey respondents (46%) said their transport networks need 100 Gbit/s of bandwidth now, making that the most popular choice. Further, about two-fifths of respondents (40%) see the bandwidth requirements surging to 400 Gbit/s in the near future.

Moving on to the more nitty-gritty issues of fiber network planning, maintenance and repair, we asked cable executives how their company handles capacity planning on its key fiber routes. Just about one-half of respondents (50%) said their company relies on predictive analysis based on historical fiber specifications and outage and performance data, making that the leading selection. Close behind came forecasting based on DWDM equipment capacity, which generated support from 49% of respondents. Another popular method is forecasting based on linear bandwidth growth, which drew votes from 43% of survey participants. So clearly many cable operators are making use of several techniques to meet their fiber capacity planning needs.

Next, we asked how cablecos build out, deliver and maintain their critical

Which new services does your company plan to offer when it has more fiber capacity in its transport network? (choose all that apply)



“THERE ARE SEVERAL KEY FACTORS DRIVING CABLECOS TO ADD MORE FIBER TO THEIR TRANSPORT NETWORKS. NEARLY THREE-QUARTERS OF SURVEY RESPONDENTS (72%) SAY THEIR COMPANY IS EXPANDING FIBER CAPACITY TO SUPPORT BUSINESS SERVICES GROWTH.”



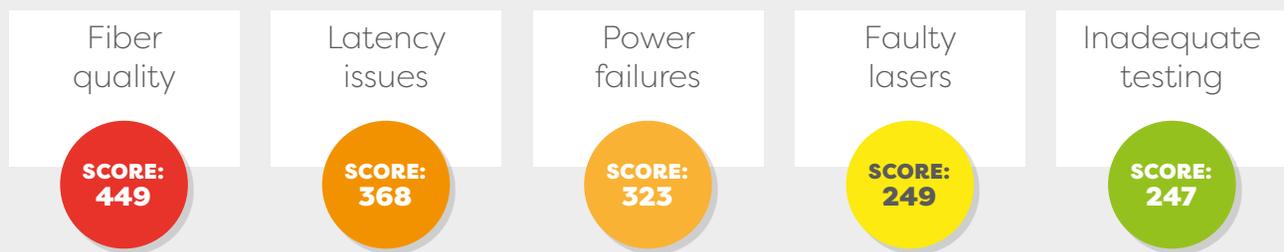
fiber infrastructure. In a sign that cable operators are doing much of the work themselves, three-fifths of respondents (60%) said their company draws completely on its internal resources for both inside and outside plant work. But many cablecos also lean heavily on consultants and vendors for test, measurement and remediation post-construction and deployment phase

services, with 54% of respondents picking this option. Plus, a good number of cablecos rely on leased or dark fiber providers to perform all services, with more than one-quarter of respondents (26%) selecting this option.

Finally, we asked survey participants how long it takes their company to fix

a problem on their company's fiber network when the problem is NOT related to a fiber cut. More than three-fifths of respondents (63%) said their company's MTTR (mean time to repair) is less than 24 hours, while about one-quarter (25%) said their company's MTTR is 24 to 48 hours. Just 12% of respondents said it typically takes longer than two days to make repairs. ■

What are the three biggest fiber network technical challenges your company is facing? (please list the biggest challenge first)



ARRIS: Force Multiplier for Fiber Expansion

As cable operators expand fiber in their plant, finding a partner to help becomes critical. The right partner becomes a "force multiplier" to help the operator ramp up new capacity quickly and with quality. ARRIS has been working with global Internet and Cloud companies for years – managing dark fiber and leased wave partners, route design and data center expansion and remediating fiber issues before adding them to the operators' networks. We've made over 1,000 data centers,

carrier hotel or COLO sites ready for operation, tested and made ready over 300,000 kilometers of fiber and designed and documented over 550 backbone, metro and peering fiber routes. This experience, combined with ARRIS's decades of support for cable and Cloud operator network expansion, makes ARRIS the ideal partner to support fiber expansion.

Our fiber characterization teams at ARRIS make the task of bringing new fiber routes online seamless, while ensuring facilities meet precise

requirements. Using industry-leading test gear and analysis tools, we document all the physical and logical attributes of each fiber span, measure the quality and continuity of fiber routes from end to end and coordinate with internal resources and external vendors to ensure remediation of any issues found. We also create and maintain documented route and span drawings to help improve efficiency and future serviceability.

For more information visit: www.arris.com/services/data-center-services/



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