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HEAVY READING
WHITE PAPER

Heavy Reading's 2020 Open RAN Operator Survey

A Heavy Reading white paper produced for Cisco, Ericsson, Fujitsu, and Radisys

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INTRODUCTION AND KEY FINDINGS

This report presents the results of the **Heavy Reading Open RAN Operator Survey** conducted in the summer of 2020 on the outlook for open radio access networks (open RANs). Heavy Reading defines "open RAN" as *the ability to integrate, deploy, and operate radio access networks using components, subsystems, and software sourced from multiple suppliers.* The survey was open to employees of communications service providers only.

This report follows an earlier Heavy Reading Open RAN Operator Survey conducted in autumn of 2018. The almost two-year gap between the surveys allows for an analysis that identifies changes in operator sentiment and intent over the intervening period.

Key findings: Open RAN is making real progress

The most important business justification for open RAN, according to 49% of respondents, is to "increase vendor diversity / reduce lock-in." This focus on vendor diversity is consistent with Heavy Reading's 2018 survey and with operator commentary over the intervening period. The market for RAN equipment is highly concentrated and, in some countries, operators now only have a choice of two or three vendors. This situation has been exacerbated over the past two years by geopolitical issues. The focus on vendor diversity is therefore expected and readily explainable. "To improve coverage in new and/or marginal geographies" is the second most important reason to pursue open RAN, followed closely by "new service and monetization opportunities" in third.

"Optimize network opex" scores toward the bottom of the range of reasons to pursue open RAN, with just 15% selecting it as one of the top two business justifications for investment. This is somewhat of a surprise but is consistent with operator commentary that while they would like lower opex and see a path toward it with open RAN automation, they have not yet been able to show these benefits in practice. "Government mandate" scores lowest, at just 3% of respondents. This indicates that although the policy environment can help open RAN, the large majority of operators prefer to retain the market-based approach to network deployment and operation that, broadly speaking, prevails in the sector today.

A relatively small 13% of respondents believe open RAN technology is now "mature for large-scale deployment." A more significant 28% believe it is "mature for certain use cases." Probably the most interesting aspect of the result is to consider this 28% in combination with the 27% that say open RAN is "close" to being ready for commercial deployment. It is worth keeping in mind that close to one-third of respondents (29% and 3%) think the technology is still some way from ready.

A small lead group of respondents (16%) say their company has already deployed multi-vendor digital unit (DU) and radio unit (RU) equipment in their networks. This is consistent with public comments from operators in the US and Japan that they now have multi-vendor DU-RU operational at small scale. A much larger 45% say they will deploy multi-vendor DU-RU in the next one to three years.

Operators are interested in the idea of "O-RAN-compliant" networks sourced from a single vendor, but they are also cautious about it. Nearly a quarter (23%) say this is "very interesting." The dominant response, however, is the 49% that believe this "might be useful," which indicates this idea is being seriously considered. Which way that 49% breaks as operators continue their analysis and gain more information on what "O-RAN compliant" really means will probably determine if this model takes off in a meaningful way.

5G is now driving open RAN technology development and network planning. The preferred deployment scenario, with 65% of the response, is for 5G New Radio (NR) to be deployed into existing brownfield network environments. This appears to signal an important turning point because until recently, it was reasonable to argue that open RAN was better suited to LTE, which is a better understood, "easier" technology. In contrast, 5G had advanced capabilities that were not widely (if at all) supported by open RAN vendors. US respondents have a greater interest in open RAN for 5G (75%) than the Rest of World (RoW) respondents (57%). An important caveat is that 5G is nearly always deployed with or alongside LTE.

"Systems integration and multi-vendor interoperability" and the "stability and maturity of standards" are the major barriers to open RAN, with 63% and 53% of respondents citing these as their top two concerns. This is very much in line with the 2018 survey and not unexpected. The major difference from 2018, however, is that specifications from the O-RAN Alliance have since been released and provide a baseline against which to create and measure interoperability. The challenge in 2021 is for vendors to create products that support these interfaces and to demonstrate multi-vendor interoperability through plugfests and real-world deployments.

A large majority (77%) of respondents would prefer to work with two or three lead vendors to minimize the commercial risk of open RAN. Only 8% of operator respondents say their company wants to integrate many vendor components in-house. This preference for working with a smaller number of lead vendors is one of the clearest results of the survey.

A full 43% of respondents expect to use an "existing RAN vendor" as the prime network integrator for open RAN. A further 29% expect to use a "new RAN vendor"—but still a RAN vendor. Only 11% expect to use a "third-party systems integrator," which is something of a surprise because systems integrators have been widely heralded as likely to take a key role in open RAN. "In-house integration and verification" scores a decent, but not game-changing, 17%. Overall, this result indicates that while open RAN could be a disruptive force in the vendor landscape, it will be within the bounds of regular business practice. In other words, open RAN will be disruptive, but it will not entirely upend the existing industry structure.

The biggest question regarding open RAN in late 2020 is how soon the technology will be ready for deployment at scale. It is difficult to determine the likely extent of open RAN deployments at this stage of the market. A majority of respondents expect to deploy open RAN clusters of less than 200 sites through the end of 2023; 25% expect to deploy clusters of less than 50 sites and 27% expect to deploy between 50 and 199 sites. Operators may, of course, deploy multiple non-overlapping open RAN clusters in their networks. If this is the case, then the number of commercial sites could climb quite significantly, and quite quickly, on a per-network and industrywide basis.

Another way to get a sense of how large open RAN deployments might be is to ask about the percentage of sites that will use, or be compatible with, open fronthaul. By the end of 2023, most respondents expect less than 25% of their 4G and 5G footprints will be O-RAN 7-2x compliant. However, a large majority also think more than 10% of their RAN footprint will be compliant, and almost one-third (31%) expect more than 25% of their sites will be 7-2x compatible. This level of penetration of open fronthaul into the mobile network footprint would represent great progress if it were to come to pass in real-world deployments.

A healthy 41% expect open RAN and integrated RAN systems to offer comparable performance within a three-year timeframe. This is an encouraging signal. The same number (also 41%) expect open RAN performance to be "slightly lower than integrated RAN"—and this concern should not be ignored. It is plausible that even at the expense of a "slight" performance impact, open RAN could still be an attractive deployment option if other aspects stack up (e.g., cost and vendor diversity). Only 16% expect open RAN performance to be "much lower" than integrated, proprietary system performance within the next three years.

There is broad-based market demand for a wide range of RU product variants. Respondents have no strong preference for single-carrier or multi-carrier RUs. There is a preference for 4x4 systems, with single-band, single-carrier 4x4 RUs (45%) just ahead of 4x4 multi-band, multi-carrier RUs (41%). However, 2x2 multi-carrier variants also score reasonably well with scores of 31% (2x2 multi-band) and 27% (2x2 single-band).

Only 17% of respondents think massive multiple input, multiple output (MIMO) will not be mature enough for open RAN deployment over the next three years. The majority, therefore, expect massive MIMO to be technically and economically viable to deploy. This appears to reflect the ongoing work on massive MIMO RU product development, fronthaul standards, and DU software to handle the increased processing requirement. The equal split of respondents with a preference for 64T64R (30%) and 32T32R (31%) aligns well with today's massive MIMO market, with both configurations widely deployed.

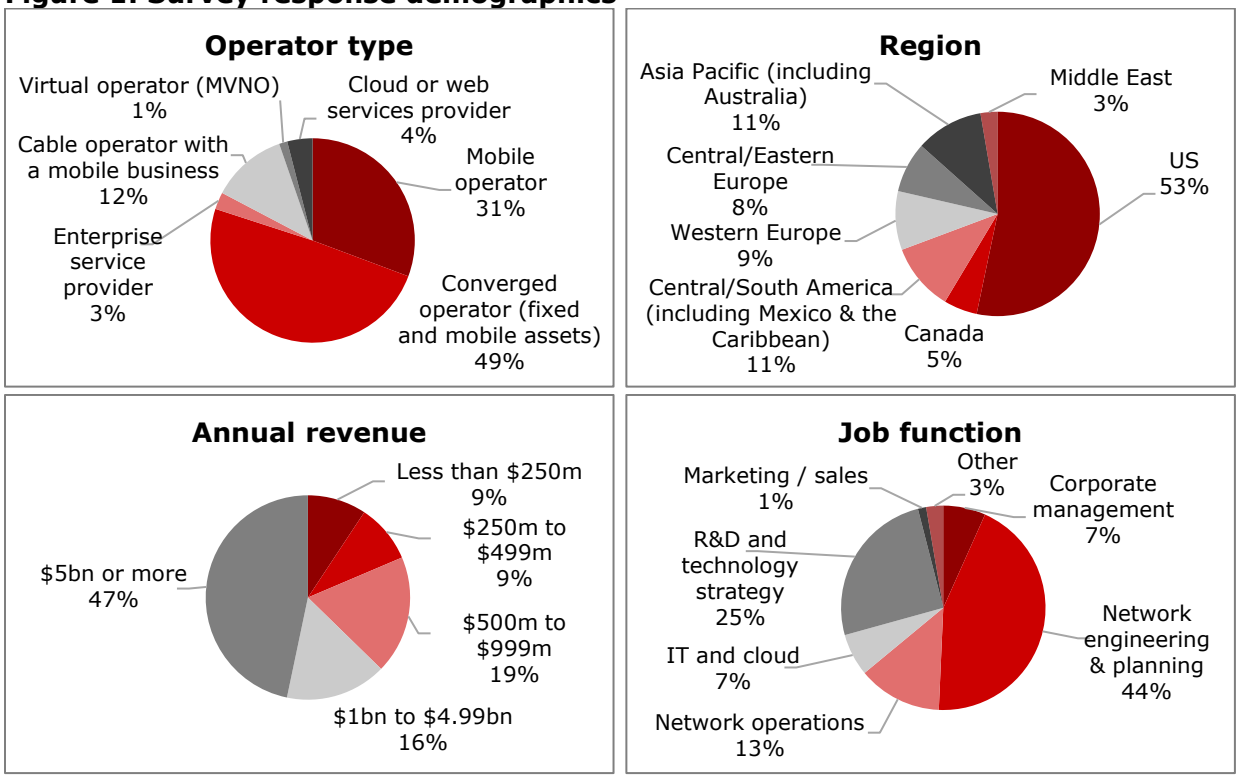
A quarter of respondents expect to have open "service management and orchestration" (SMO) deployed in their RAN within two years; after three years, a majority expect to be using this technology. This appears a reasonable timeframe given that operators already have some experience with multi-vendor RAN analytics and self-organizing network (SON) tools. The real task will be to take advantage of open interfaces and standardized data formats made available in open SMO to gain a more granular level of observability and control of RAN resources.

Survey response demographics

The questionnaire used in this study was written by Heavy Reading, with input from Cisco, Ericsson, Fujitsu, and Radisys as sponsors of our 2020 Open RAN Market Leadership Initiative. The online survey was promoted by email to Heavy Reading's service provider databases. It garnered 75 responses from individuals working at communications service providers after non-qualified responses were deleted from the survey. Respondents were asked to self-assess their knowledge about mobile RAN strategy; those that reported "no direct knowledge" or only "a little knowledge" of their company's RAN strategy were also excluded from the survey and their responses are not considered in this analysis.

Respondent demographics are shown in **Figure 1**. The response is led by mobile operators and converged or cable operators with mobile businesses. Respondents are generally from developed economies, with the majority working for operators reporting more than $1bn in annual revenue. Network engineering & planning and R&D/technical strategy are the main job roles represented, accounting for a combined 69% of respondents. The US is the largest region by a distance; however, there is a good representation from RoW, enabling this analysis to reasonably compare US and RoW responses.

Figure 1: Survey response demographics



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Source: Heavy Reading

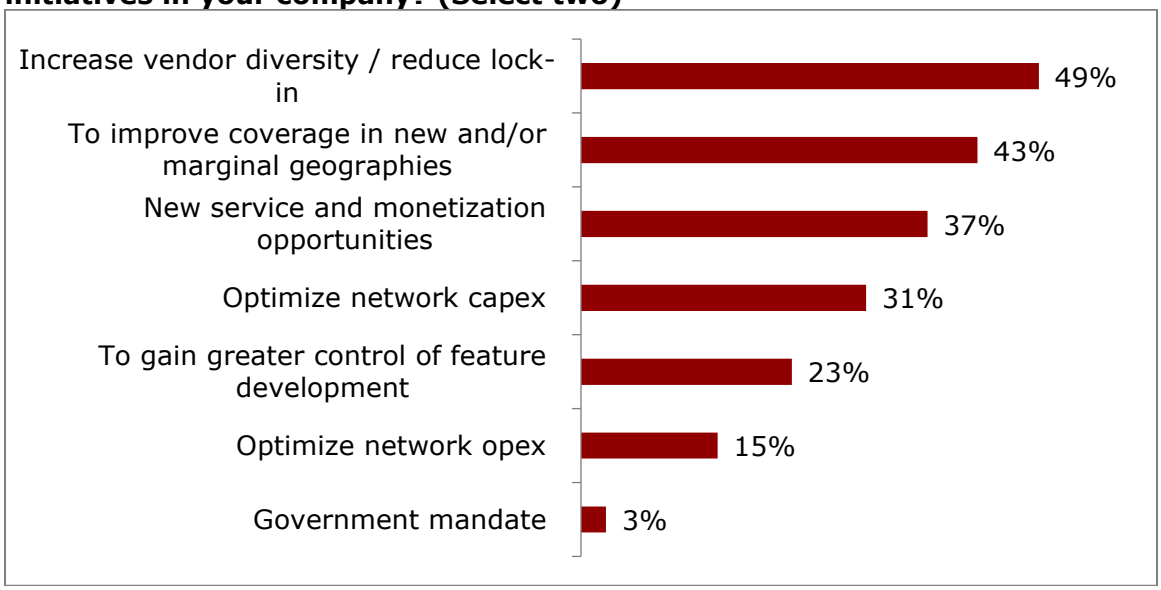
OPERATOR DEMAND FOR OPEN RAN

At the start of the survey, respondents were presented with the following definition to guide their answers: *"Open RAN" refers to the ability to integrate, deploy, and operate radio access networks using components, subsystems, and software sourced from multiple suppliers.*

This section of the report discusses operator demand for open RAN, including their motivations, expected deployment timelines, and how they might scale open RAN.

Figure 2 shows that the most important business justification for open RAN is to "increase vendor diversity" (49% of respondents place this in their top two reasons). This is consistent with Heavy Reading's 2018 Open RAN Operator Survey and with anecdotal operator commentary over the intervening period. The market for RAN equipment is highly concentrated (the top three vendors account for approximately 80% of global sales), and in some markets, operators now only have a choice of two or three vendors. This situation has been exacerbated over the past two years by geopolitical issues, especially in markets where limits on the use of equipment from Chinese suppliers have reduced competition and supply chain diversity. The focus on vendor diversity is therefore expected and readily explainable.

Figure 2: What are the two most important business justifications for open RAN initiatives in your company? (Select two)



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Source: Heavy Reading

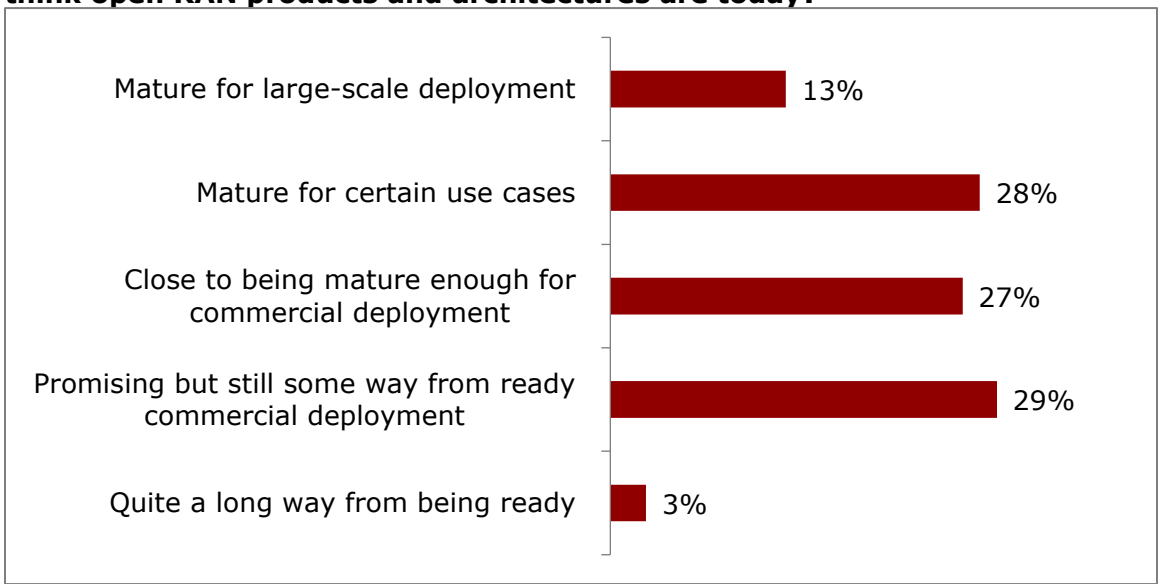
To see what else is driving operator interest in open RAN, this question allowed for two responses to give a total of 150 responses from the 75 respondents. In second place, with 43%, was "to improve coverage in new and/or marginal geographies." This perhaps aligns with operators' public commentary that they will likely first deploy open RAN in rural and low density suburban markets or in low density emerging markets where low cost coverage is essential. These are the types of scenarios for which open RAN technology is currently best-suited.

In third, at 37%, are "new service and monetization opportunities." This result is puzzling in the sense that it is not obvious how open RAN enables monetization or services that cannot be addressed with classic RAN. Perhaps one explanation might be that the push into new geographies expands revenue opportunities. Another might be the push into new services such as fixed wireless access, which clearly does have new monetization opportunities associated with it. However, this result may also simply be a case of over-enthusiasm. Operator respondents, working in technical roles, generally like the idea of greater monetization due to network investment and tend to be optimistic about the directness and speed of the link between new technology and customer revenue.

It is notable that "optimize network opex" scores toward the bottom of the range (15%). This is consistent with operator commentary that while they would like lower opex and see a path toward that with open RAN automation, they have not yet been able to show these benefits in practice. "Government mandate" is lowest at just 3% of respondents and perhaps indicates that while the policy environment can help open RAN, most operators do not want network deployment to be directed by the government. Instead, they prefer to retain the market-based approach that, broadly speaking, prevails in the sector today.

A relatively small 13% of respondents believe open RAN technology is now "mature for large-scale deployment" (**Figure 3**). A more significant 28% believe it is "mature for certain use cases." Probably the most interesting aspect of the result is to consider this 28% in combination with the 27% that say open RAN is "close" to being ready for commercial deployment. One way to interpret this is that, while open RAN is not yet ready for commercial deployment at scale, many respondents think the industry is close to that point. It is worth keeping in mind that nearly one-third of respondents (29% and 3%) think the technology is still some way from ready; clearly, there are still concerns in the market about technical readiness.

Figure 3: In terms of readiness for commercial deployment, how mature do you think open RAN products and architectures are today?



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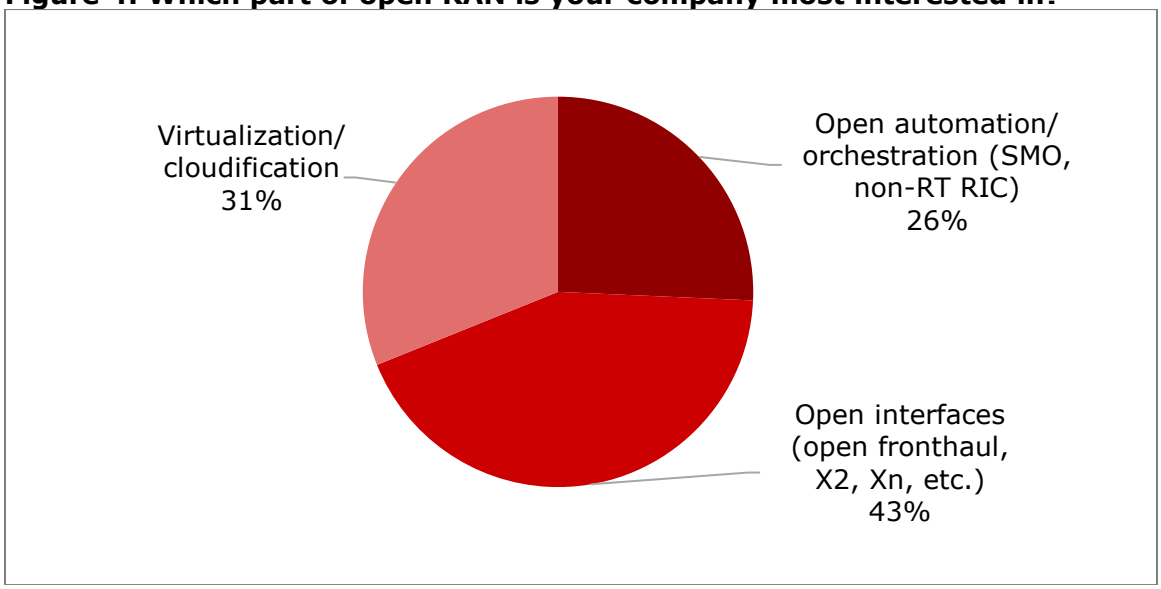
Source: Heavy Reading

Open RAN is a broad term that covers different forms of "openness." **Figure 4** reveals that open interfaces (43%) are of most interest to operators, ahead of cloudification (31%) and open orchestration (26%). These results are expected because open interfaces are the bedrock of open RAN and the focus of the O-RAN Alliance specifications. But it is also clear that operators are interested in all aspects of "openness" in the RAN to varying degrees. More details on each of these aspects of openness in the RAN are covered in later questions.

Figure 4: Which part of open RAN is your company most interested in?



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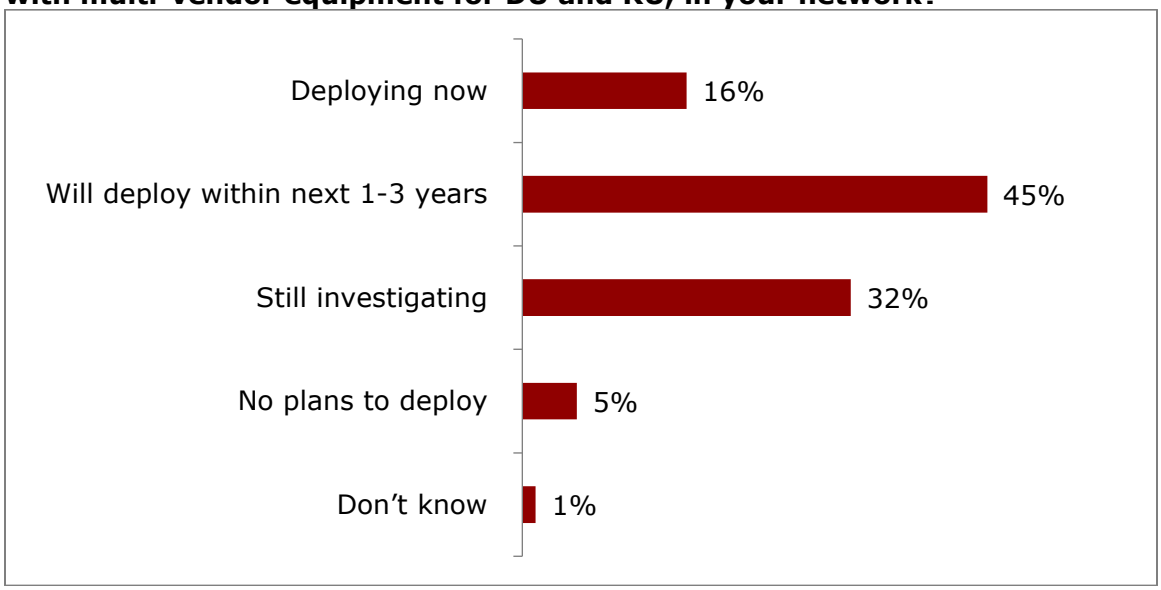
Source: Heavy Reading

Figure 5 below shows that a small lead group (16%) is already deploying multi-vendor DU and RU equipment in their networks. This is consistent with public comments from several operators in the US and Japan that they now have multi-vendor DU-RU operational at small scale. A much larger 45% say they will deploy multi-vendor DU-RU in the next one to three years. This is consistent with the view, established previously, that open RAN is close to mature enough for commercial deployment. Again, around a third (32%) still have reservations and will continue to investigate. Only 5% say they have no plans to deploy multi-vendor RU-DU.

Figure 5: Which best reflects the deployment status of an open RAN architecture, with multi-vendor equipment for DU and RU, in your network?



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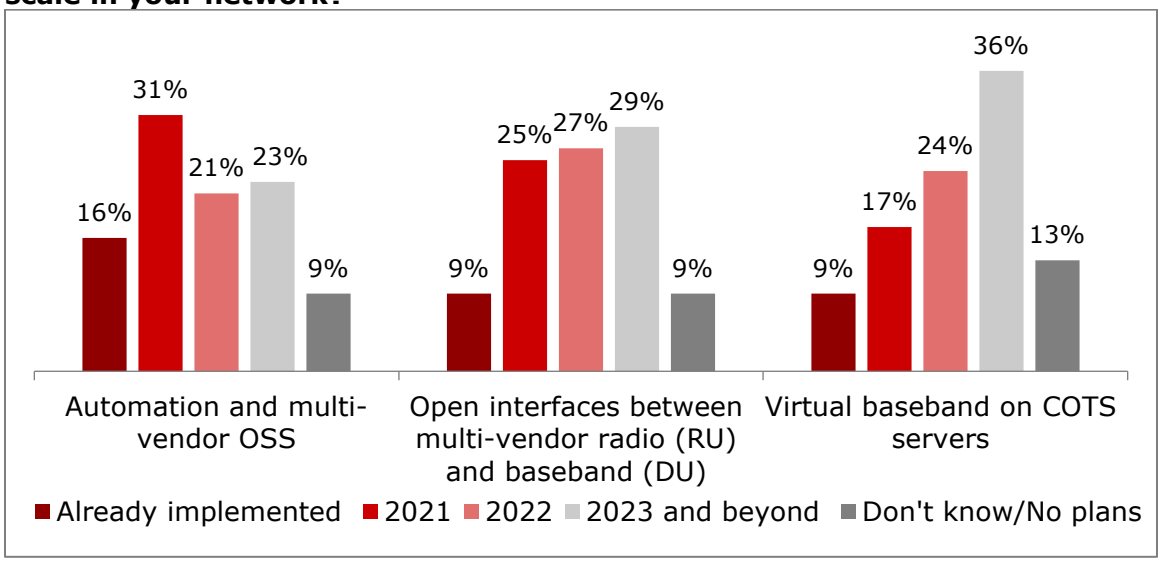
Source: Heavy Reading

Digging into slightly more detail on deployment schedules, the next question asked respondents about their timeline expectations for multi-vendor automation, open RU-DU, and virtualization. The primary finding from the responses (**Figure 6** below) is that the timelines are broadly similar across the three categories, with a small cohort of bullish respondents "already implemented," a set of advanced operators looking to deploy in 2021, and the majority deploying from 2022 onwards. Automation and multi-vendor operations support systems (OSS) score a little ahead of the other categories, with 16% "already implemented" and 31% planning to implement next year. This perhaps accords with the fact that multi-vendor RAN planning, optimization, and SON tools are already routinely used by operators. It may also suggest that operators are preparing the automation and management tools they will need to run virtualized, cloud RANs at a later date.

Figure 6: When do you plan to implement the following aspects of open RAN at scale in your network?



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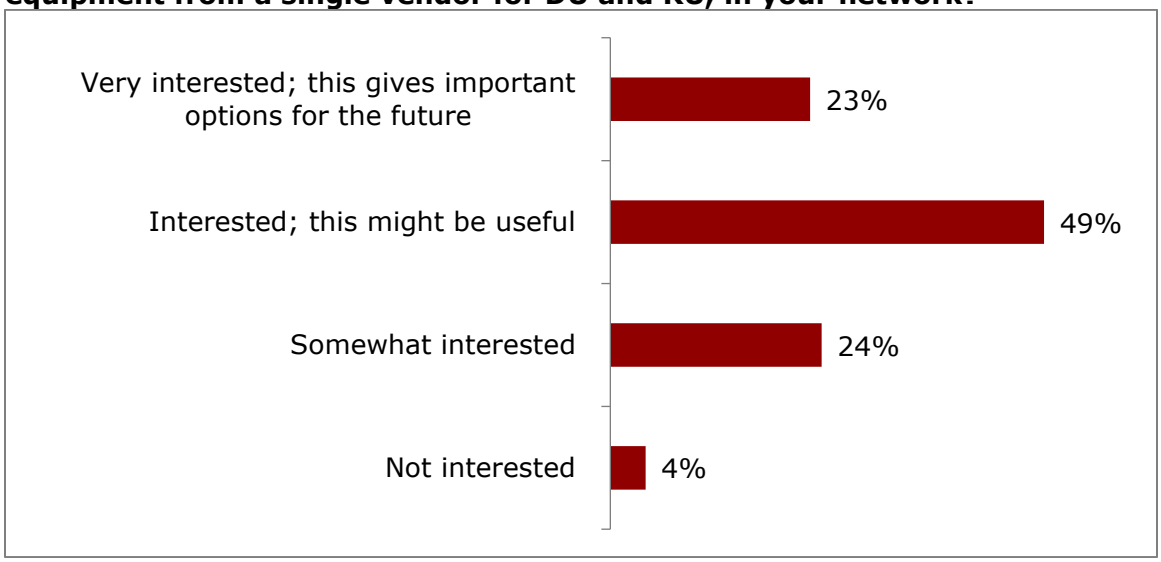
Source: Heavy Reading

One of the interesting discussions in open RAN over the past year or so is the idea of "O-RAN-compliant" networks sourced from a single vendor. The thinking is that this allows for a ready-made integrator (the vendor) that can develop and support an integrated RAN system. Because this vendor also supports the O-RAN interfaces, the operator, in theory, retains the option to bring in alternative suppliers at later date. If the interface specifications are genuinely supported and are genuinely open, the logic is that operators may be able to deploy O-RAN-compliant systems with some confidence that they will not be as locked-in to a single supplier over the long term.

Figure 7: How interested are you in deploying an open RAN architecture, but using equipment from a single vendor for DU and RU, in your network?



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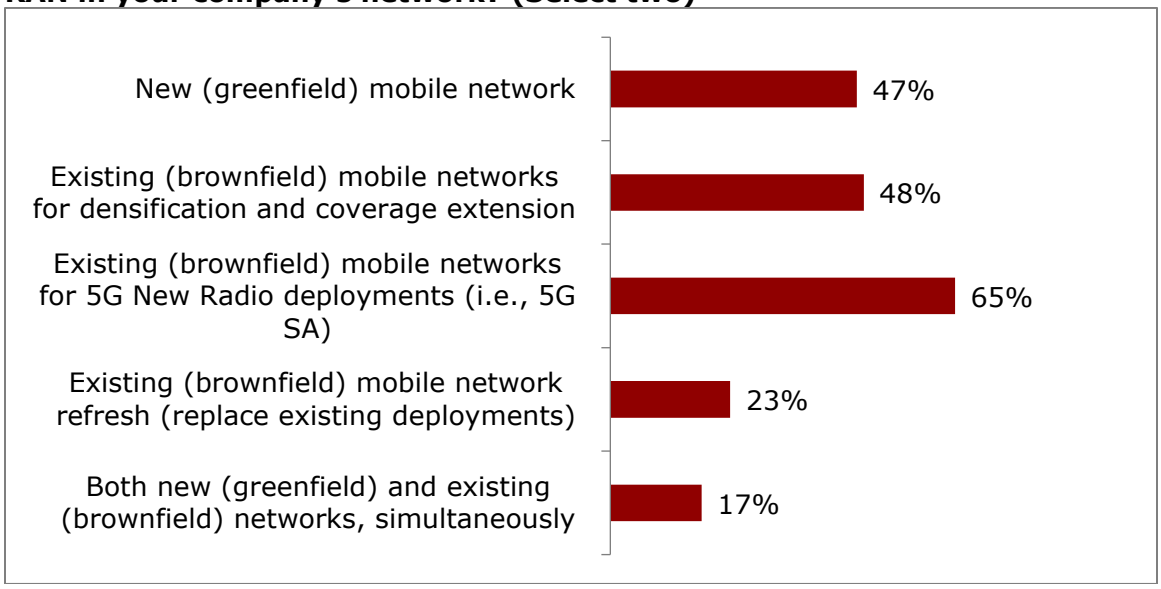
Source: Heavy Reading

Figure 7 above shows operators quite like this idea, but that they are also cautious about it. Nearly a quarter (23%) say they are "very interested." The most useful response, however, is the 49% that believe this "might be useful" because it indicates the idea is being seriously considered. Which way that 49% breaks, as operators continue their analysis and gain more information on what "O-RAN compliant" really means will probably determine if this model takes off in a meaningful way.

Whether operators initially use open RAN in brownfield (existing) or greenfield (new) networks is a critical consideration. The highest profile and largest virtual RAN (vRAN) deployment to date by Rakuten in Japan is a greenfield network (vRAN is close to, but not identical to, open RAN). However, there are relatively few of those opportunities because the mobile services sector is a mature and established industry.

Figure 8: What do you think will be the first two deployment scenarios for open RAN in your company's network? (Select two)



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Source: Heavy Reading

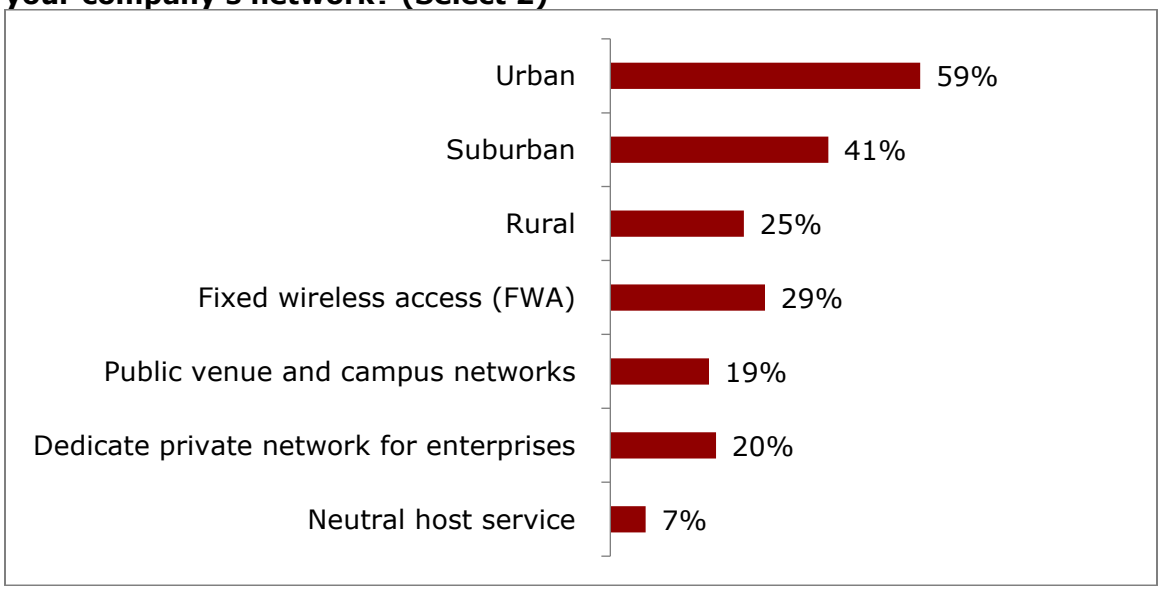
VRAN, and arguably open RAN more generally, has tended to focus on 4G. It is interesting then that the preferred deployment scenario is for 5G, with 65% of the respondents selecting open RAN for 5G in existing, brownfield network footprints (**Figure 8** above). US respondents have a greater interest in open RAN for 5G (75%) than RoW respondents (57%). Nevertheless, in all regions, 5G SA is the lead response.

This indicates the market is now at a threshold at which 5G becomes the driving force for open RAN. Until recently, it was reasonable to argue that open RAN was better suited to LTE because this was better understood technology. In contrast, 5G had advanced capabilities that were not widely (if at all) supported by open RAN vendors. An important caveat, however, is that 5G is nearly always deployed with or alongside LTE.

According to this response, operators are less interested in open RAN for refreshes where they need to rip and replace existing equipment. The 23% that selected this option show that it is not off the table and should not be ignored. However, the wider picture is that operators will seek to maximize the lifespan of deployed equipment.

In terms of where operators will deploy open RAN, **Figure 9** shows urban settings came out at the top with 59% of responses. This is logical in that urban areas are where most subscribers live and work and these markets give the best return on investment. However, it is also a change from Heavy Reading's 2018 survey, when "dense urban" came in third behind private networks and public venue deployments and "general urban" came in fifth place.

Figure 9: What are the two most important deployment classes for open RAN in your company's network? (Select 2)



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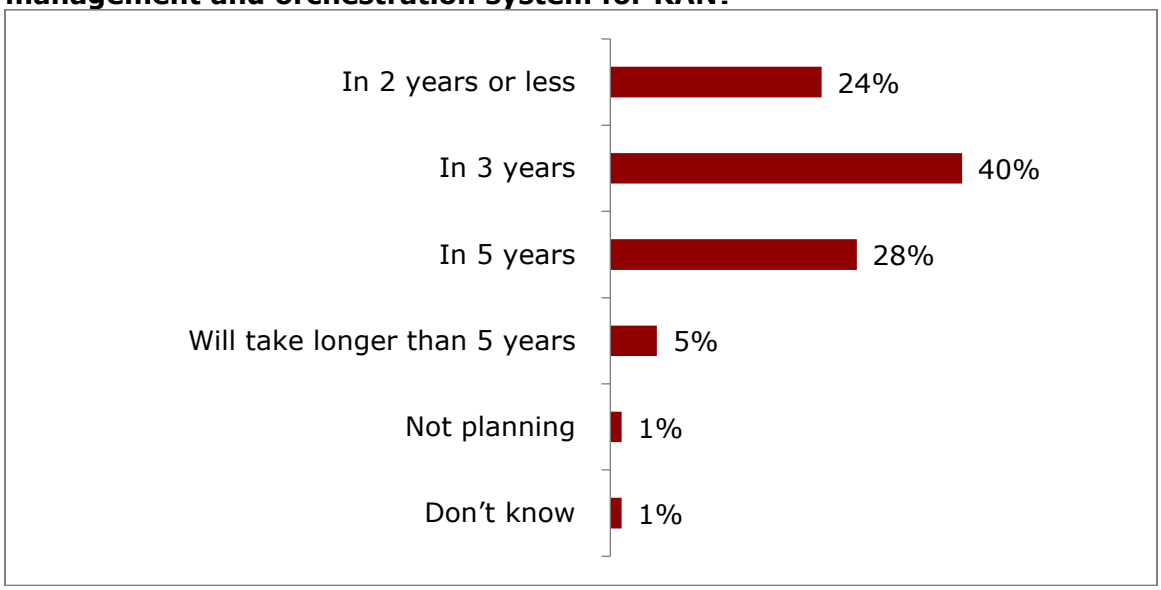
Source: Heavy Reading

In the 2020 survey, public venues and private network drop down in the rankings. Two plausible explanations for this shift in sentiment over the two-year period are:

- Open RAN technology is now more mature and therefore more viable for urban deployments.
- Private networks were once considered less technically demanding than urban macro and therefore were a more likely starting point for open RAN.

A major focus of open RAN—as seen throughout this report—is on the RU-DU interface and open fronthaul. This, however, is only a part of what makes a RAN "open." As seen in other domains, notably cloud and data center networking, control of network behavior and the ability to configure the network, according to the operator's intent, over standardized interfaces and open APIs are fundamental to "openness." In O-RAN Alliance terms, this is called "service management and orchestration" (SMO) and refers to the ability to programmatically control the RAN using higher layer controllers and orchestrators.

Figure 10: When is your company planning to move to an open service management and orchestration system for RAN?



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Source: Heavy Reading

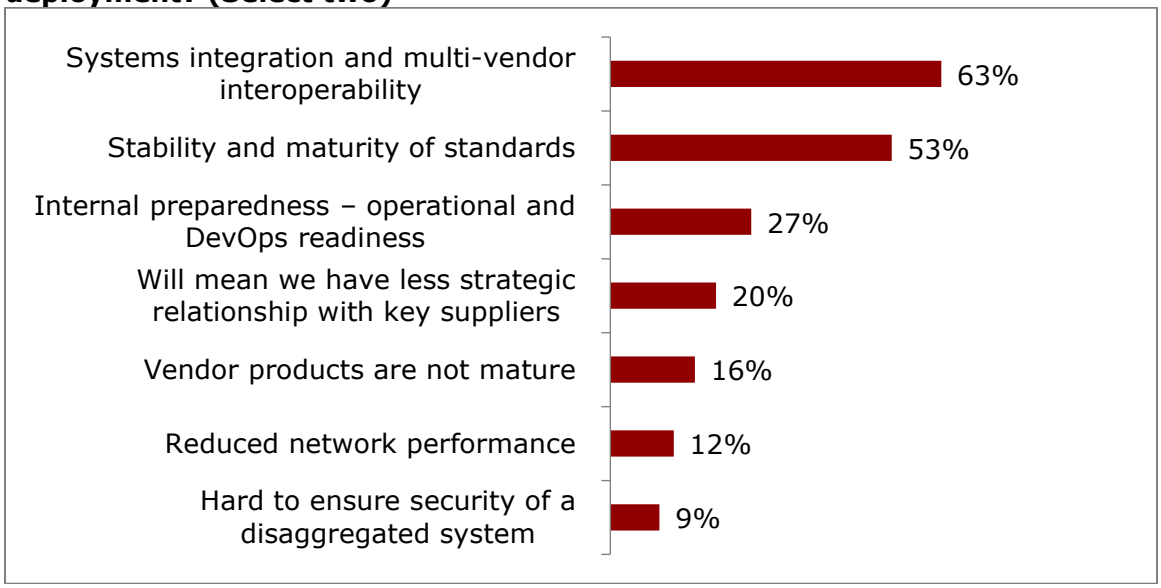
Figure 10 above shows a quarter of respondents expect to have open SMO deployed in their RAN within two years; after three years, a majority (24% + 40%) expect to be using this technology. This appears a reasonable timeframe given that operators already have experience with multi-vendor RAN analytics and SON tools. The real task will be to take advantage of open interfaces and standardized data formats made available in open SMO to gain a much more granular level of observability into RAN behavior and then control of RAN resources.

OPEN RAN SYSTEMS INTEGRATION

This section covers questions related to open RAN system design, integration, and operation. It includes discussion of "openness," standards, and the respective roles of operators and their vendors.

In terms of barriers to open RAN deployment, **Figure 11** shows two clear results. "Systems integration and multi-vendor interoperability" is the biggest barrier with 63% of the response. This is very much in line with the 2018 survey and not a surprise. "Stability and maturity of standards," in second with 53%, makes a similar statement on the challenges of interoperability. The major change from 2018 is that interface specifications from the O-RAN Alliance have been released and provide a baseline against which to create and measure interoperability. The challenge for 2021 is for vendors to create products that really do support these interfaces and for the industry to demonstrate multi-vendor interoperability through plugfests and real-world deployments.

Figure 11: What are the top two barriers to open RAN implementation and deployment? (Select two)



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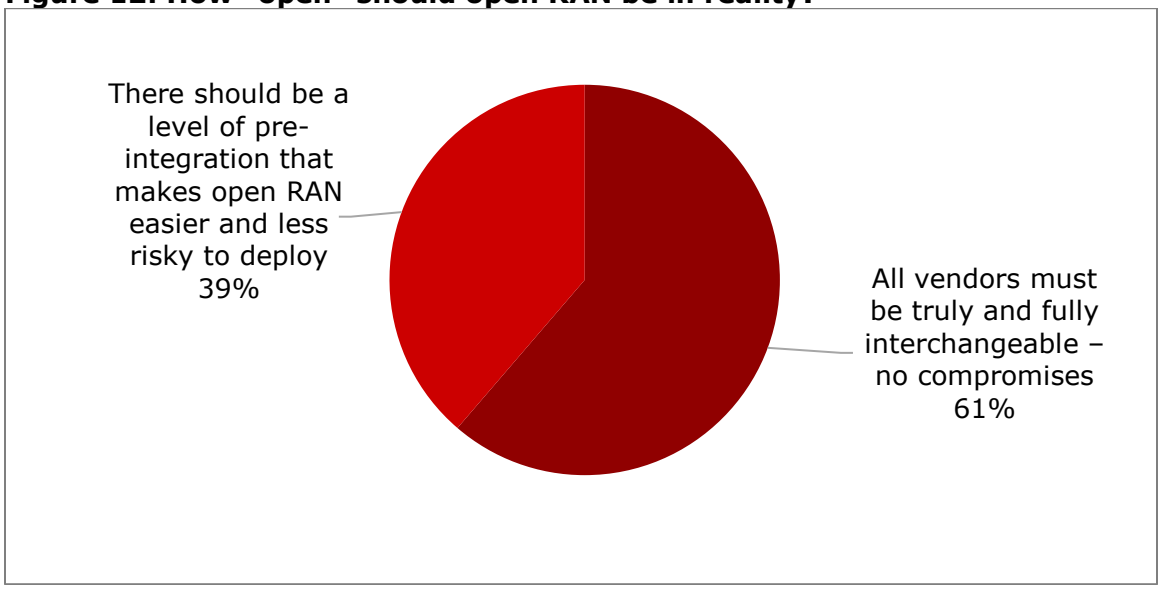
Source: Heavy Reading

Open networking disaggregates previously integrated functions and, by definition, introduces interfaces and APIs that either did not exist or were internal and proprietary. As already identified, this comes with integration and testing costs. An interesting decision then must be made on how "open" operators want to be and how much integration they want to take on in-house. The following survey question (**Figure 12** below) partly addresses that, with 61% saying "all vendors must be truly and fully interchangeable" and 39% saying "there should be a level of pre-integration that makes open RAN easier and less risky to deploy." This theme is covered in later questions.

Figure 12: How "open" should open RAN be in reality?



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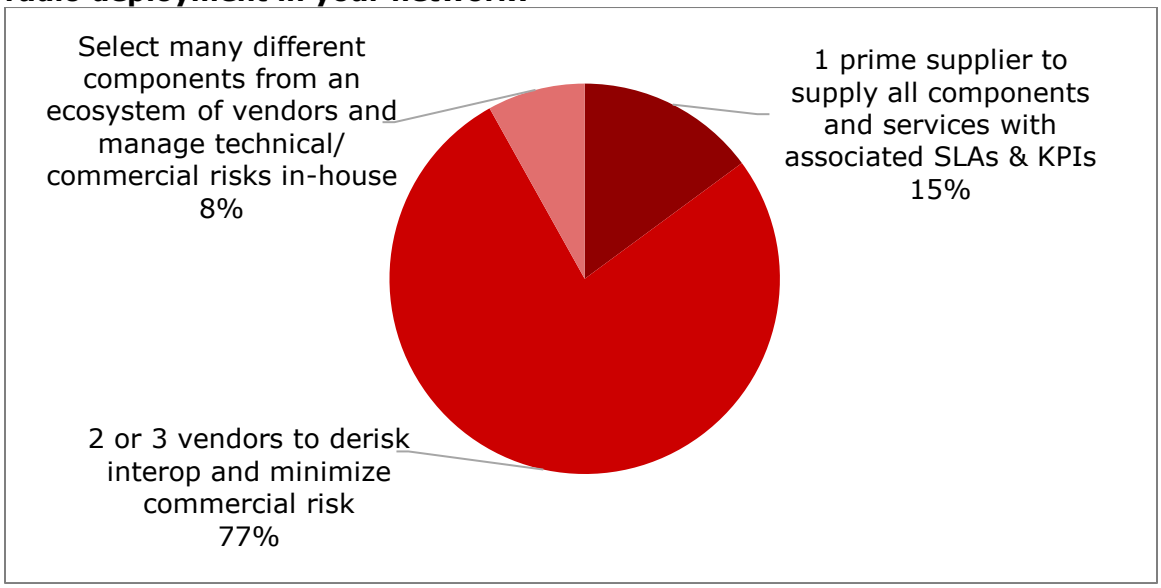
Source: Heavy Reading

Having "truly interchangeable" vendors does not necessarily mean the operator wants to integrate lots of individual vendor components in-house. **Figure 13** shows that a large majority (77%) would prefer a level of integration that involves working with two or three lead vendors to "minimize commercial risk." Only 8% want to integrate many vendor components in-house. This preference for working with a smaller number of lead vendors is one of the clearest results in the survey. This then begs the question: Who should that integrator be?

Figure 13: What level of turnkey solution do you expect for an open RAN or vRAN radio deployment in your network?



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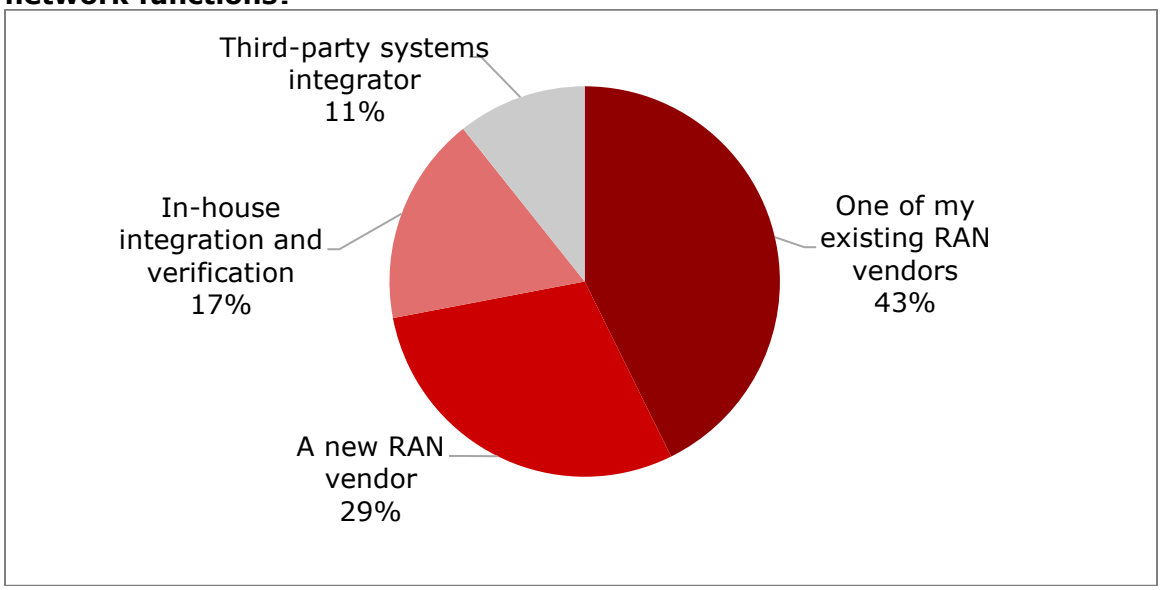
Source: Heavy Reading

The response to the following question, shown in **Figure 14**, generates an interesting result that shows open RAN could be a disruptive force in the vendor landscape. However, this disruption, although significant, will be within the bounds of regular business practice. The largest group (43%) expect to use an "existing RAN vendor" as the prime network integrator, which is closest to business as usual. A further 29% expect to use "a new RAN vendor"—but still a RAN vendor—which is analogous to selecting a new vendor and is something that happens routinely, if not frequently, in the industry.

Only 11%, the smallest group of respondents, expect to use a "third-party systems integrator." This is something of a surprise because these systems integrators have been widely touted as likely to take a key role in open RAN. "In-house integration and verification" scores a decent, but not game-changing, 17% of the response. The takeaway is that open RAN has the potential to be disruptive, but at this stage, it does not look like it will entirely upend the existing industry structure.

Figure 14: Who do you see as the prime network integrator for your open radio network functions?



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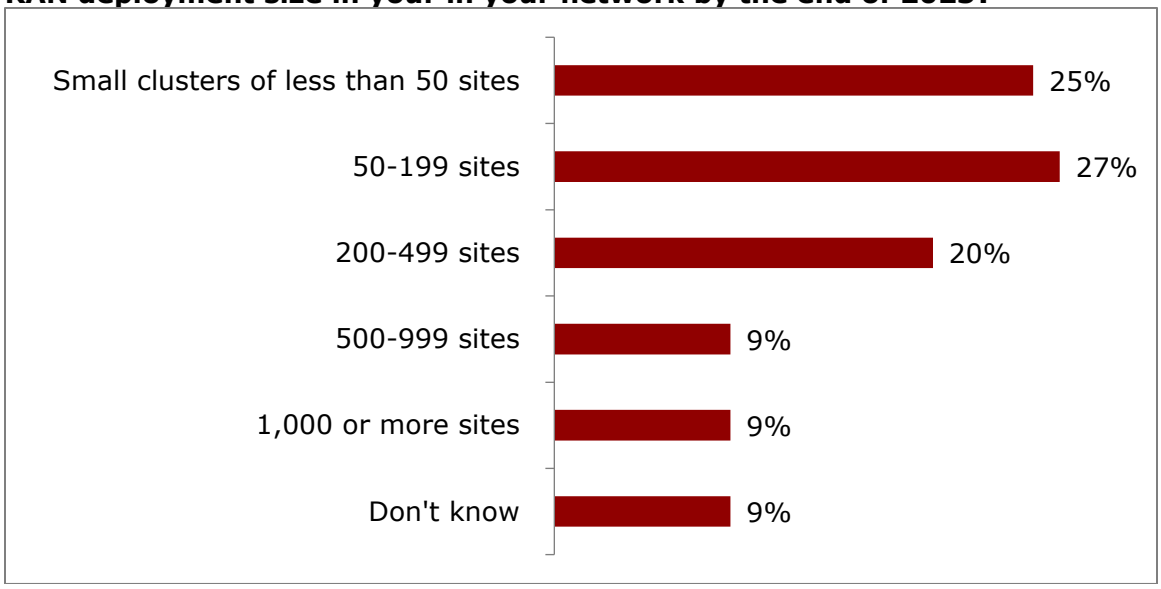
Source: Heavy Reading

OPEN RAN AT SCALE

The biggest question in open RAN in late 2020 is how soon the technology will be ready for commercial deployment at scale. With around 10 million logical macro cell sites deployed worldwide, mobile RAN is a large-scale infrastructure business. The opportunity for open RAN is therefore commensurately large, but with technical, operational, and business requirements that are correspondingly challenging.

A question that will provide insight into the likely extent of open RAN deployments is difficult to write and to answer. Nevertheless, **Figure 15** attempts to provide some guidance on the size of open RAN deployment clusters (i.e., locations with adjacent cell sites). The results show deployments are skewed to the lower end, with a majority of respondents expecting to deploy clusters of less than 200 sites by the end of 2023 (25% expect to deploy clusters of less than 50 sites and 27% expect to deploy between 50 and 199 sites). In broad terms, 200 sites would enough to cover a small city and its environs, and could, depending on frequency, cover a large rural area. By way of reference, an operator in one of the larger European markets would have upward of 20,000 outdoor macro cell sites deployed today.

Figure 15: In terms of outdoor macro sites, what will be the most common open RAN deployment size in your in your network by the end of 2023?



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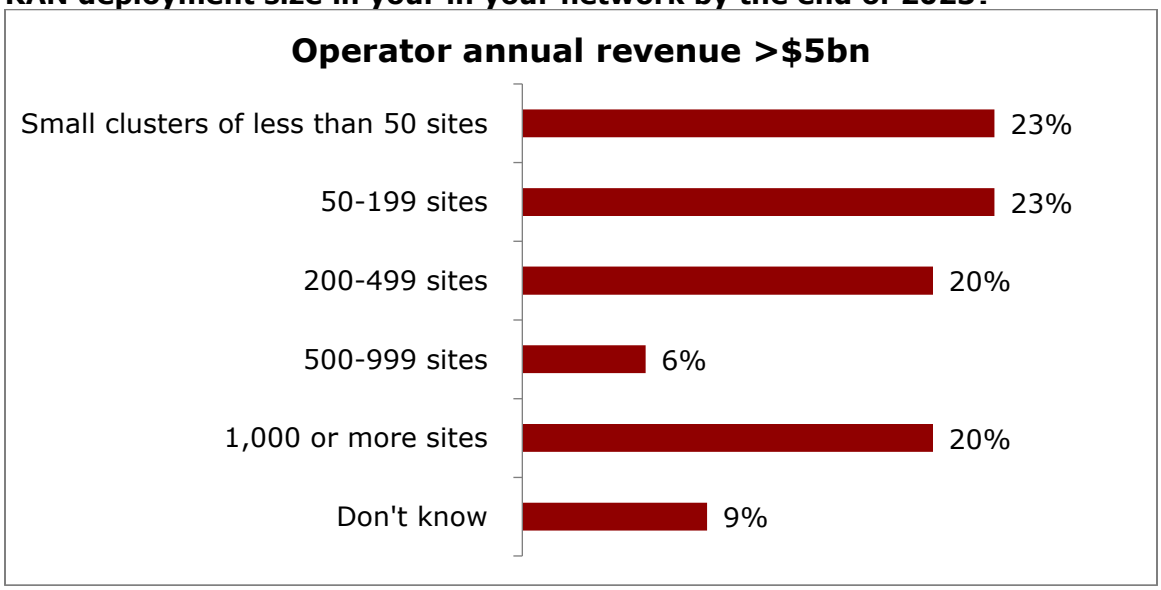
Source: Heavy Reading

Operators may also deploy multiple non-overlapping open RAN clusters in their networks. If this is the case, then the number of commercial sites could climb quite significantly on a per-network and industrywide basis. Nevertheless, even under optimistic assumptions, it would be unrealistic to expect large parts of a network to transition to open RAN by the end of 2023 judging by the response to this question.

Figure 16 shows how the average cluster size increases when the survey data is filtered to include only responses from larger operators (i.e., operators with more than $5bn in annual revenue). These are the very largest operators on the planet. In this group of respondents, 20% say clusters of 1,000 sites or more will be "most common" by 2023 versus 9% on average and 0% among operator respondents with revenue below $500m annually. This does not necessarily mean 20% of large operators will, or will not, deploy clusters of this size routinely. Rather, it shows that larger operators are more likely to deploy larger clusters.

Figure 16: In terms of outdoor macro sites, what will be the most common open RAN deployment size in your in your network by the end of 2023?



n=35
Source: Heavy Reading

Another way to get a sense of how large open RAN deployments might be is ask about the percentage of sites that will use or be compatible with open fronthaul. Perhaps the most interesting finding from this question (**Figure 17**) is that respondents do not make much of a distinction between 4G and 5G in the likely prevalence of open fronthaul in their networks.

Figure 17: In terms of active, logical cell sites, how much of your 4G and 5G RAN footprint will be O-RAN 7-2x compliant (i.e., with open fronthaul) by the end of 2023 and 2025?

By the end of 2023

	Not planning to use open RAN	5% or less	5-10%	10-25%	25-50%	>50%	Don't know
4G	17%	12%	11%	24%	23%	8%	5%
5G	5%	19%	21%	16%	19%	12%	8%

By the end of 2025

	Not planning to use open RAN	5% or less	5-10%	10-25%	25-50%	>50%	Don't know
4G	9%	4%	11%	15%	20%	35%	7%
5G	0%	1%	17%	15%	24%	33%	9%

n=75
Source: Heavy Reading

The 2023 estimates—which is over three years from when the survey was conducted—show that that most respondents expect less than 25% of their 4G and 5G footprints will be 7-2x compliant. However, a large majority also think more than 10% of their RAN footprint will be compliant, and almost one-third (31%) expect more than 25% of their sites will be 7-2x compliant. This would represent great progress for open RAN if it were to come to pass in real-world deployments and would qualify as a great success.

The 2025 estimates show an increase in the proportion of sites respondents expect to be compliant with open fronthaul, with a majority now expecting more than 25% of sites to be 7-2x compatible. Even so, only about a third (35% 4G and 33% 5G) expect more than 50% of their sites will be capable of running the 7-2x interface. It is probably worth noting that fronthaul interface specifications may evolve significantly over a five-year period; therefore, this question is more an indication of the direction of travel than specific to 7-2x.

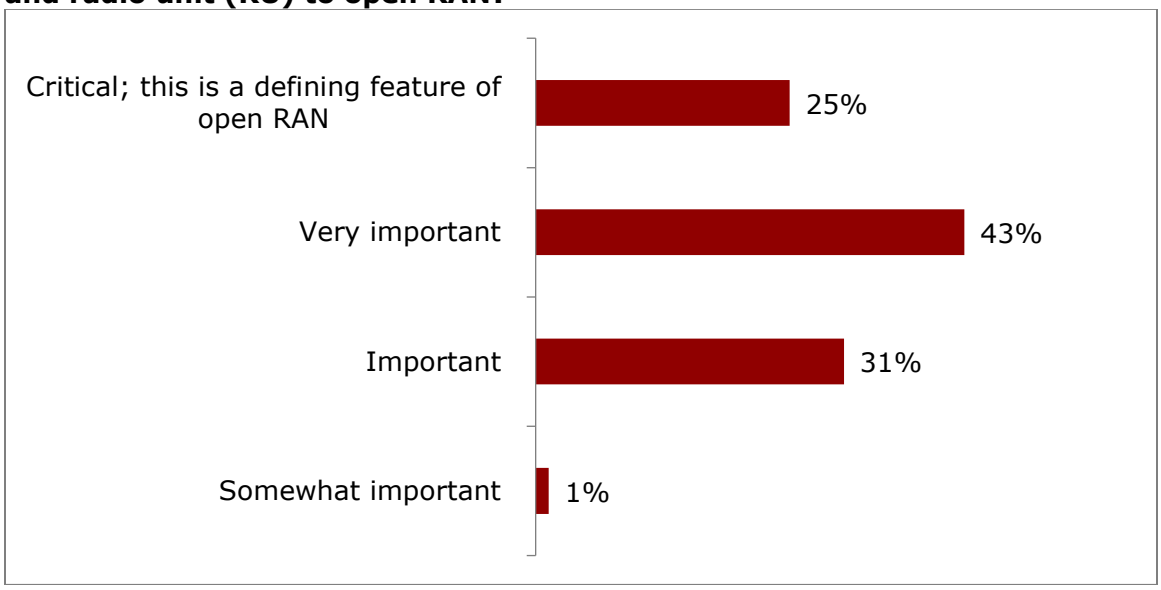
US respondents are more bullish on the penetration of open fronthaul than RoW respondents. This may reflect that US operators have been among the first in the world to adopt multi-vendor radio baseband deployments, but it may also reflect the culturally more bullish nature of US respondents to survey questions that Heavy Reading has observed over the years. To illustrate, by 2025, 48% of US respondents expect more than half their 5G sites to be open fronthaul compliant versus just 17% of RoW respondents.

TECHNOLOGY, OPEN INTERFACES, AND PERFORMANCE

This section addresses some of the key technology questions around open RAN and expectations for the performance of these systems.

A lot of attention is placed on open fronthaul. Earlier questions have already demonstrated that open interfaces are the most important aspect of open RAN to operator respondents. This question seeks to determine just how critical the open fronthaul interface is. The results, in **Figure 18**, are interesting in that only 25% say it is "critical; this is a defining feature of open RAN." This is lower than might have been expected. However, there is no real doubt that operators place great emphasis on fronthaul given that the larger group of 43% say it is "very important" and a further 31% say it is "important." Just 1% say it is only "somewhat important."

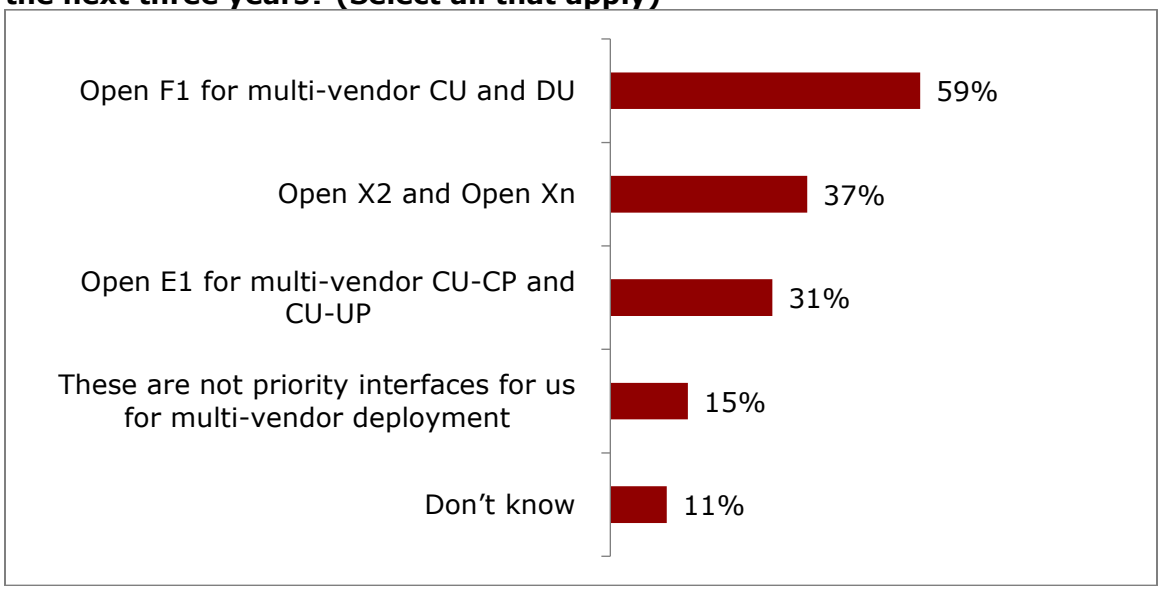
Figure 18: How important are open fronthaul interfaces between digital unit (DU) and radio unit (RU) to open RAN?



n=75
Source: Heavy Reading

Moving on from fronthaul, **Figure 19** below sought to understand which other interfaces are important to operators and likely to be deployed within the next three years. The clear leader is open F1 with 59% of the response. This is unsurprising, as F1 is already a 3GPP-standardized interface and operators are already starting to disaggregate the centralized unit (CU) from the DU in their commercial deployments (although in almost all cases so far, operators are using a single vendor for disaggregated CU and DU).

Figure 19: Which other open interfaces do you expect to deploy in your RAN within the next three years? (Select all that apply)



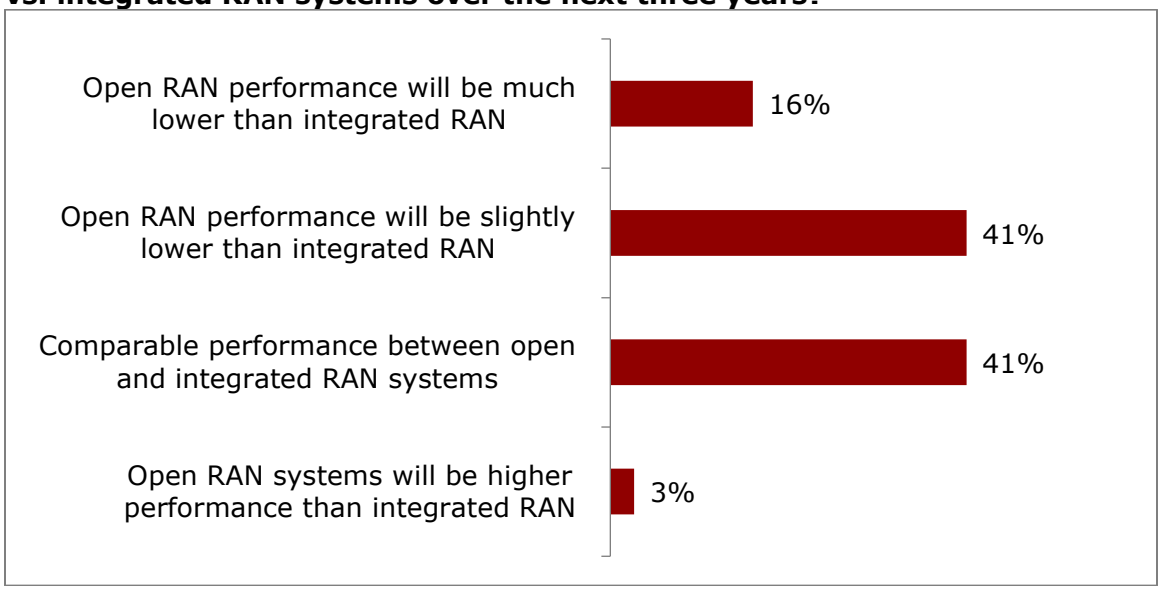
n=75
Source: Heavy Reading

In second place with 37% is open X2 and Xn. These are LTE interfaces, long specified in 3GPP, that are important for vendor-to-vendor interoperability. In particular, X2 can be used to overlay a new 5G vendor onto an existing LTE network from a different vendor. The challenge many operators have noted historically is that while X2 and Xn are already standards, they are often not open enough in practice to enable true interoperability. Operators have been making concerted efforts to encourage vendors to improve support for X2 and Xn interoperability for some years. It is possible they have made sufficient progress and this issue is starting to decline in importance.

One of the challenges for open RAN systems to date has been to match the performance, broadly defined, of state-of-the-art integrated RANs. The leading incumbent vendors have very large R&D divisions, hold essential intellectual property, have long-term experience with designing, deploying, and operating networks, are deeply involved in standards setting, have the budget to design and commission custom silicon, and so on.

By developing integrated products, incumbent vendors co-optimize adjacent modules to improve system performance (a source of lock-in). The challenge for open RAN is first to match the performance of single-vendor integrated systems and then, in time, surpass it.

Figure 20: What are your expectations for the performance of open RAN systems vs. integrated RAN systems over the next three years?



n=74
Source: Heavy Reading

Figure 20 above shows only 16% expect open RAN performance to be "much lower" than integrated, proprietary systems within the next three years. 41% expect performance to be "slightly lower than integrated RAN"; the word "slightly" is doing a lot of work in this statement. It is entirely plausible that even at the expense of a "slight" performance impact, open RAN could still be an attractive deployment option if other aspects stack up (e.g., cost and vendor diversity).

A healthy 41% expect open and integrated RAN systems to offer comparable performance in the three-year timeframe. This is an encouraging signal for open RAN and lends consistency to earlier findings that operators expect a fair chunk of their RAN estate to be open RAN compatible in the medium term.

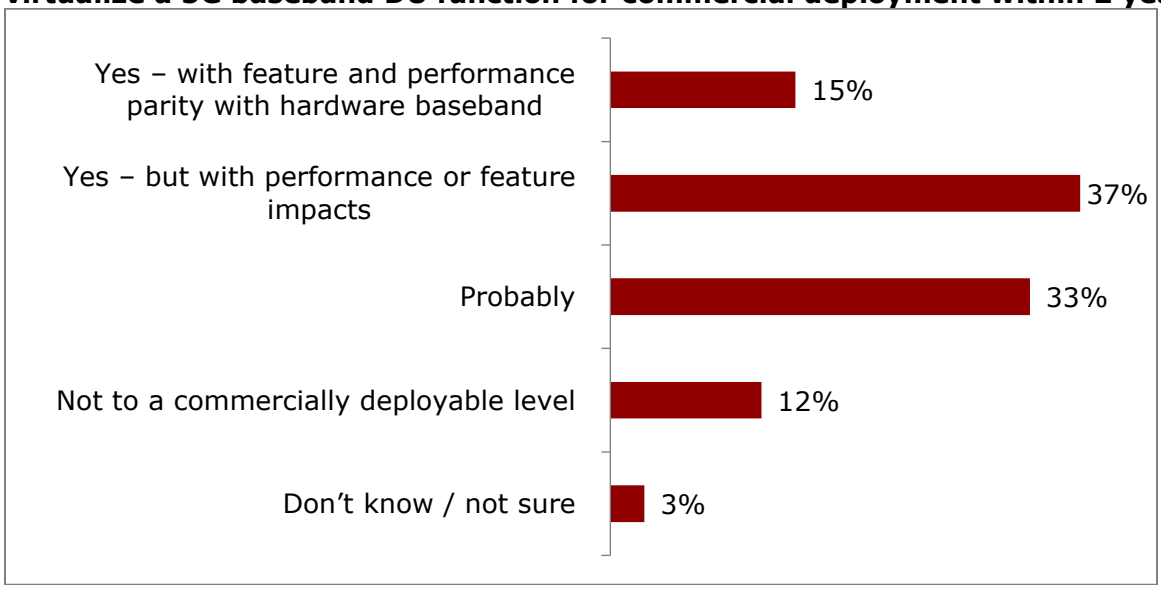
One area where open RAN faces a performance challenge is virtualized baseband. This is particularly the case where baseband software is deployed on commercial-off-the-shelf (COTS) server hardware. High performance 5G DUs today typically use dedicated system-on-chip processors optimized for L1 and L2 tasks in order, for example, to process very wide bandwidths, run multiple MIMO layers, and compute beamforming and beam-tracking algorithms.

COTS hardware can support these features but typically at greater expense in terms of hardware (number of servers/processors), power consumption, heat dissipation, and so on. Historically, this has made it economically and operationally challenging to use virtual DU for 5G. However, approaches to open RAN baseband are evolving in four important ways:

- Baseband software is increasingly optimized for COTS and specifically for multithreaded processors
- New COTS processors with libraries optimized for L1 processing are emerging
- Hardware accelerators to offload L1 processing from the CPU is now established best practice
- Incorporation of lower Layer 1 into RUs is gaining traction

With these changes, virtual 5G baseband is now viable. The question is now: Is it competitive?

Figure 21: In terms of baseband performance, do you think it is practical to virtualize a 5G baseband DU function for commercial deployment within 2 years?



n=75
Source: Heavy Reading

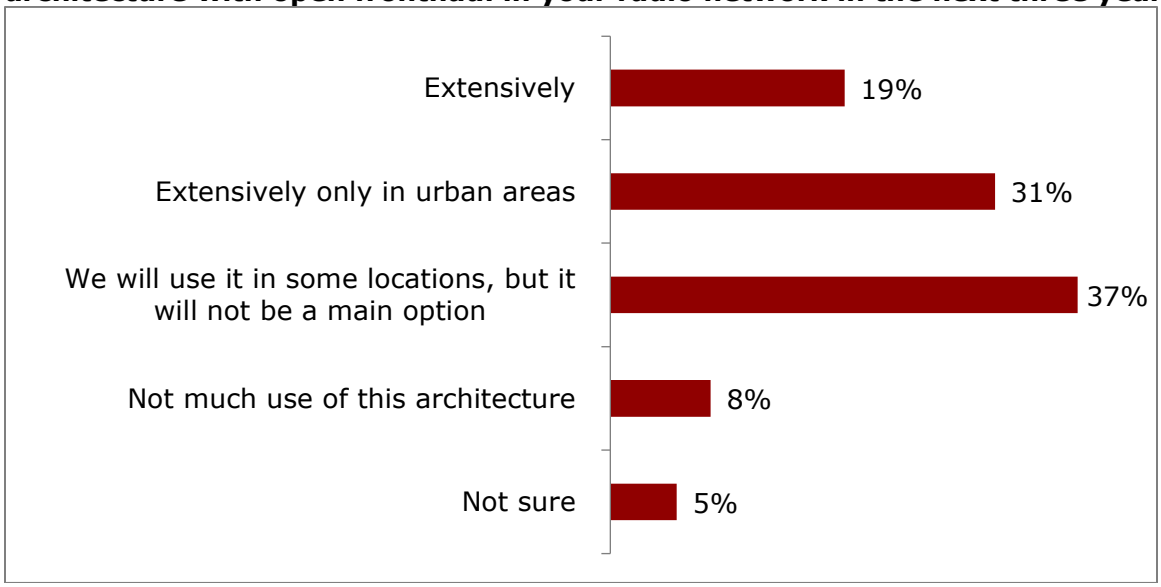
Figure 21 above shows that 15% of respondents believe it already is, or will be, within two years. A much larger 37% think virtual DU is practical "but with performance and feature impacts" relative to hardware-based DU. Only 12% think virtual DU will not be commercially deployable within two years. This is a positive, yet realistic, picture.

It is frequently speculated that open RAN will lead to a greater use of centralized RAN (C-RAN) architectures because

- Packet-based fronthaul enables new deployment options relative to point-to-point dark fiber connections.
- With virtualization, there is an opportunity to run baseband processing on edge cloud infrastructure.

The response to the next question (**Figure 22**) shows that 19% expect to use a C-RAN "extensively" over the next three years and 31% expect to use it "extensively only in urban areas." This is a bullish outlook for C-RAN given that the vast majority of LTE deployments today use a distributed architecture.

Figure 22: To what extent do you expect to use a centralized cloud RAN architecture with open fronthaul in your radio network in the next three years?



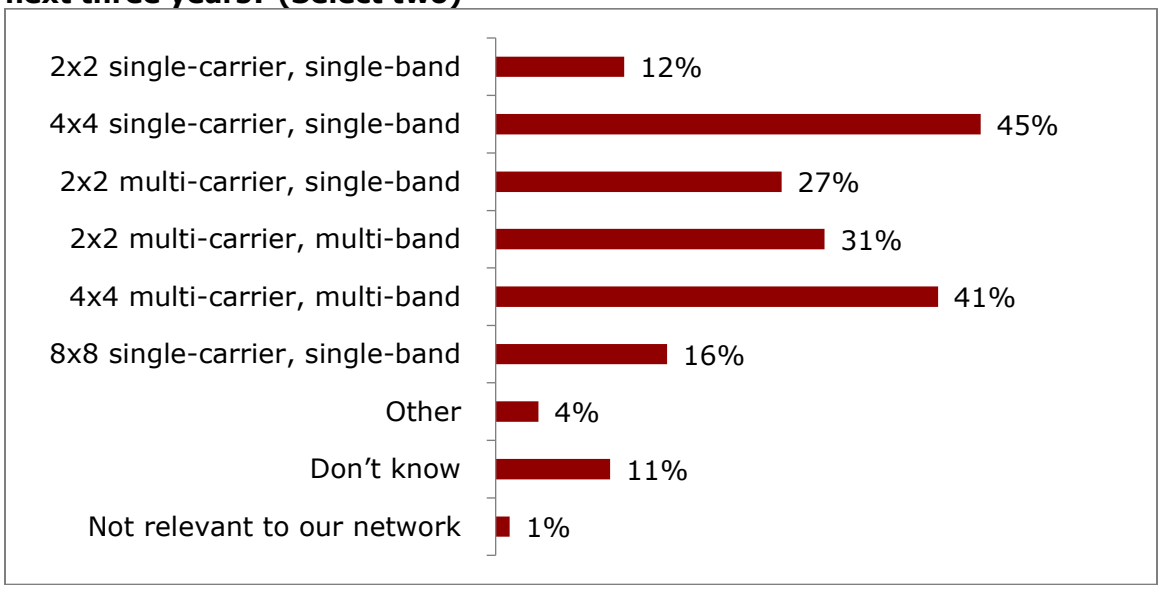
n=75
Source: Heavy Reading

Open fronthaul, greater use of virtualization, and synergies with edge computing are reasons to think this model will gain traction and support the survey finding. Nevertheless, widespread adoption of C-RAN would represent a major change in mobile RAN deployment architecture. The 37% "will not be a main option" and 8% "not much use" responses are a useful reminder that C-RAN has been on the verge a widespread adoption several times over the past decade or two but has not really taken off in the mainstream.

The RU is the highest volume part of a RAN and the most expensive in opex and capex terms. In an open RAN deployment, operators source the RU from an independent vendor. It is expected that this model will introduce greater transparency to RU pricing, will attract independent vendors to create RU products, and thereby will increase competition and innovation. A single-carrier RU is the simplest type of RU product. Nearly all vRAN and O-RAN deployments to date use single-carrier RUs with 2x2 or 4x4 MIMO capability. Many established operators, however, use multi-carrier and/or multi-band RUs (or remote radio heads, or RRHs, in LTE terminology) as part of a "single RAN" deployment. They aim to

support multiple technologies and/or multiple spectrum bands in a way that limits the physical footprint on cell sites and enables cross-technology and cross-frequency optimization.

Figure 23: Of the following radio unit (RU) configurations, which two do you expect to be most widely deployed in your multi-vendor open RAN network in the next three years? (Select two)



n=75
Source: Heavy Reading

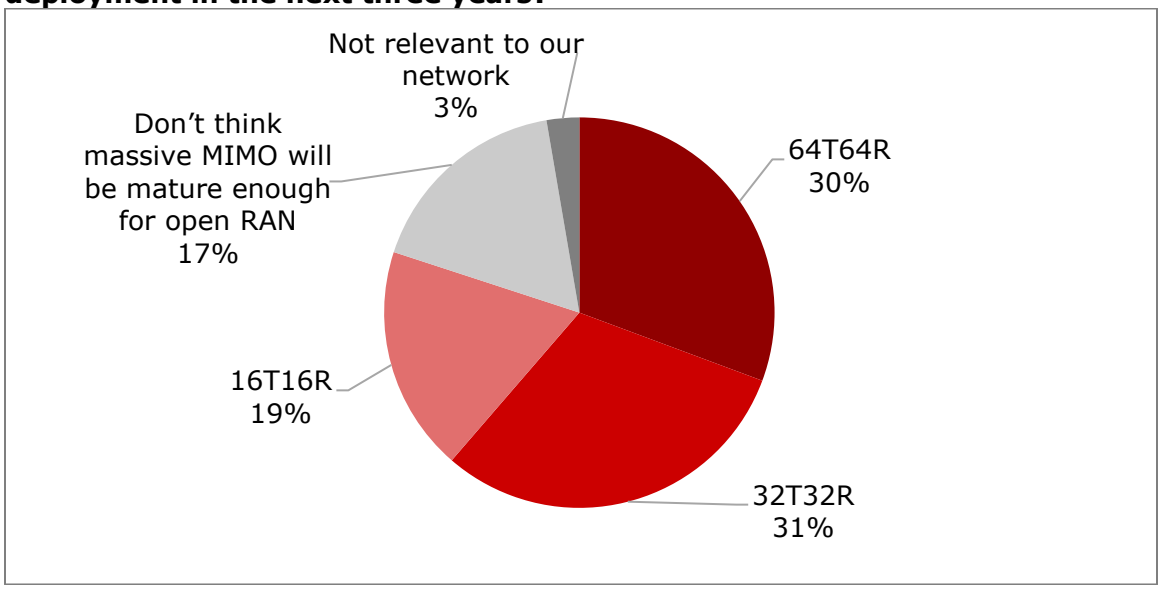
According to **Figure 23** above, there is no strong preference for single-carrier and multi-carrier RUs for open RAN deployment among the respondent base. There is a preference for 4x4 systems; single-band 4x4 RU (45%) is just ahead of a 4x4 multi-band RU (41%). However, 2x2 multi-carrier variants also score reasonably well with scores of 31% and 27%. The takeaway from this result, therefore, is that there is a market for a wide range of RU product variants.

Mid-band spectrum is the major capacity band for 5G in most world regions. By virtue of being time-division duplexing (TDD) spectrum and typically allocated in wide channel widths (e.g., 100MHz), mid-band is well-suited to massive MIMO technology, which can increase cell capacity, improve cell edge performance, and provide superior downlink and uplink performance to end users. Many operators have already deployed massive MIMO for 5G, typically in 64T64R and 32T32R configurations.

For several technical reasons, particularly related to uplink processing and the need to co-optimize RU and DU processing to make massive MIMO work effectively, there are very few open massive MIMO RUs on the market. At the time the questionnaire was fielded, there were none. Even in 4Q20, at the time this report was written, the available product should best be thought of as pre-commercial.

Nevertheless, **Figure 24** shows only 17% of respondents think massive MIMO will not be mature enough for open RAN deployment over the next three years. The majority, therefore, expect it to be technically and economically viable to deploy. This appears to reflect confidence in the ongoing work on massive MIMO RU product development, open fronthaul standards, and DU software to handle the increased processing requirement.

Figure 24: Thinking about mid-band spectrum, which, if any, of the following massive MIMO radios do you expect to deploy as part of a multi-vendor open RAN deployment in the next three years?

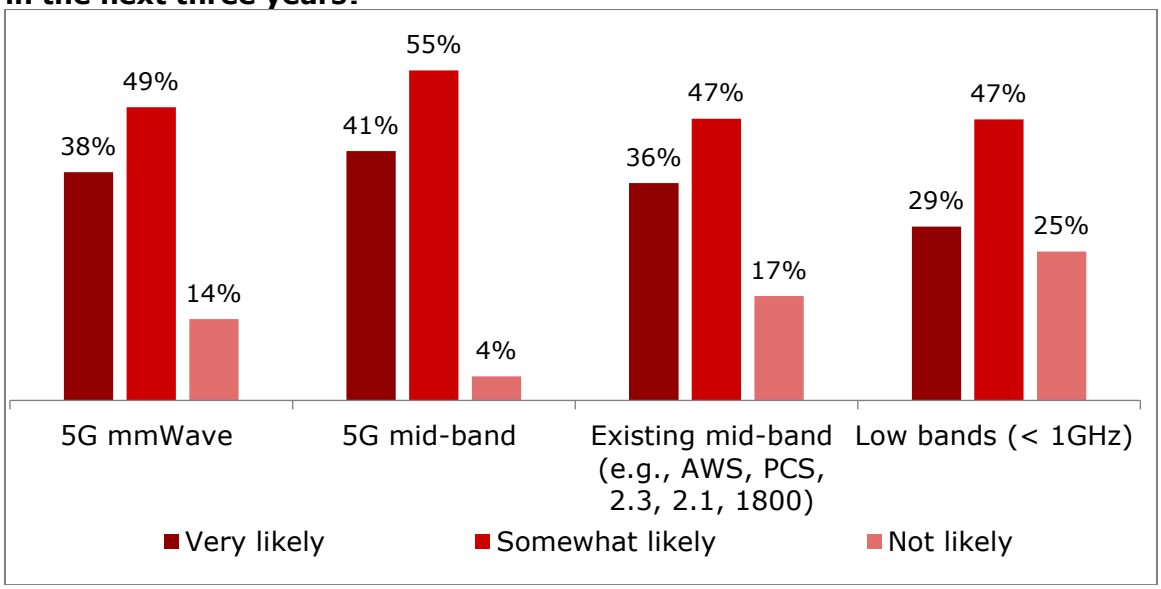


n=75
Source: Heavy Reading

The equal split of respondents with a preference for 64T64R (30%) and 32T32R (31%) aligns well with today's massive MIMO market, with both configurations widely deployed. The 19% response for 16T16R is perhaps a little higher than expected given this configuration has yet to find its niche in today's live networks. However, as mid-band 5G pushes into less dense areas or areas with lesser capacity demand, it may become an attractive option relative to 8T8R.

The final question (**Figure 25**) on spectrum for open RAN did not generate a particularly revealing response. Operators are likely to deploy open RAN across high-, mid- and low-band spectrum, just as they do now with classic, integrated RAN. With widely varying capacity and coverage demands, operators need all these frequency bands to address common deployment scenarios.

Figure 25: How likely are you to deploy open RAN in the following spectrum bands in the next three years?



n=75
Source: Heavy Reading

US respondents are in general more likely to respond "very likely" across all the frequency bands discussed in the question. This is particularly notable for mmWave, which is more widely deployed in the US than anywhere else and scores 51% "very likely" in the US versus 23% in RoW.

BACKGROUND TO THIS STUDY

Heavy Reading's 2020 **Open RAN Operator Survey** was conducted in the summer of 2020, and this analysis was written in September and October. The online survey generated 75 responses from individuals working at communications service providers after non-qualified responses were deleted from the survey. Respondents were asked to self-assess their knowledge about mobile RAN strategy. Those that reported "no direct knowledge" or only "a little knowledge" of their company's RAN strategy were also excluded from the survey and their responses are not considered in this analysis.