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Perspective

Open RAN progress drives confidence it will deliver on operators' strategic objectives

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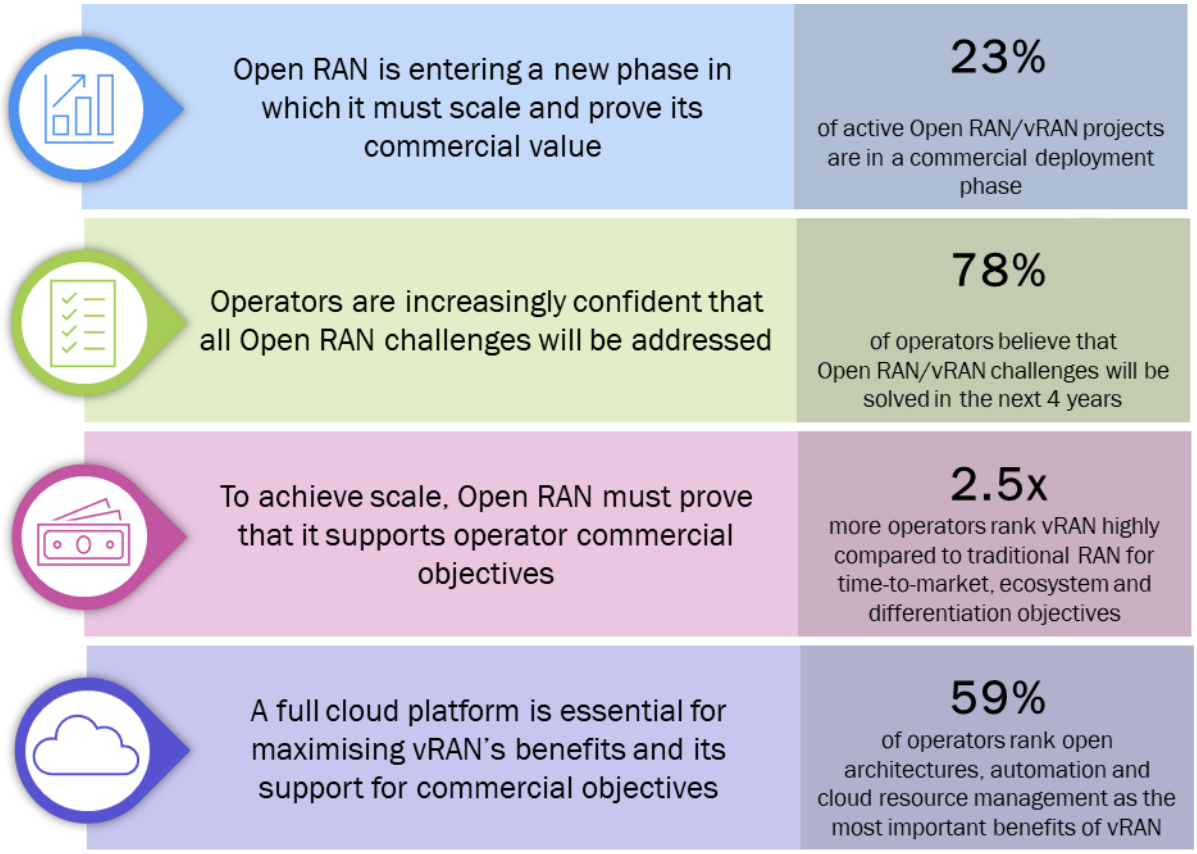
1. Executive summary

Virtualised RAN (vRAN) has achieved significant progress so far, with a range of operators, vendors and government stakeholders driving momentum through tests, trials and towards commercial deployments. There still remain challenges to vRAN and Open RAN adoption, but many of the issues related to performance and total cost of ownership (TCO) uncertainty, previously the biggest barriers to vRAN adoption, are being effectively addressed, and operators are confident that all major challenges facing the technology will be overcome.

However, even when challenges are addressed, operators still need to be certain that vRAN justifies new investment in terms of business returns. Before they accelerate their progress towards at-scale commercial deployments, vRAN must clearly demonstrate that it supports operators' most critical strategic objectives. This paper demonstrates the evolution of operator confidence in vRAN and Open RAN and the value that it provides to deliver on their commercial and technical goals. The findings are based on a unique survey of over 60 operators worldwide that have already deployed, or are planning to deploy, Open RAN or vRAN technologies before 2027. This paper highlights a range of key considerations and provides recommendations for the industry to support and prepare for Open RAN's next phase (Figure 1.1).

Figure 1.1: Key considerations for stakeholders in driving Open RAN's next phase of deployment



Source: Analysys Mason

It is clear from the survey results that operators believe vRAN can offer better support than traditional RAN for almost all of their commercial objectives. This includes both operational goals and those relating to new revenue generation, differentiation and quality of experience (QoE). However, there are still efforts needed from the industry to accelerate progress and ensure Open RAN moves quickly to wider deployments. These include refocusing efforts on new and evolving challenges, and proving that Open RAN's capabilities are driving business value in real-world deployments. These efforts will only be maximised where the industry incorporates operator commercial objectives as the central consideration in their technical innovation and deployments, and aligns them with Open RAN's key strengths in agility, flexibility and automation that are facilitated by a full cloud platform.

2. vRAN and Open RAN are entering a new phase of adoption and evolution

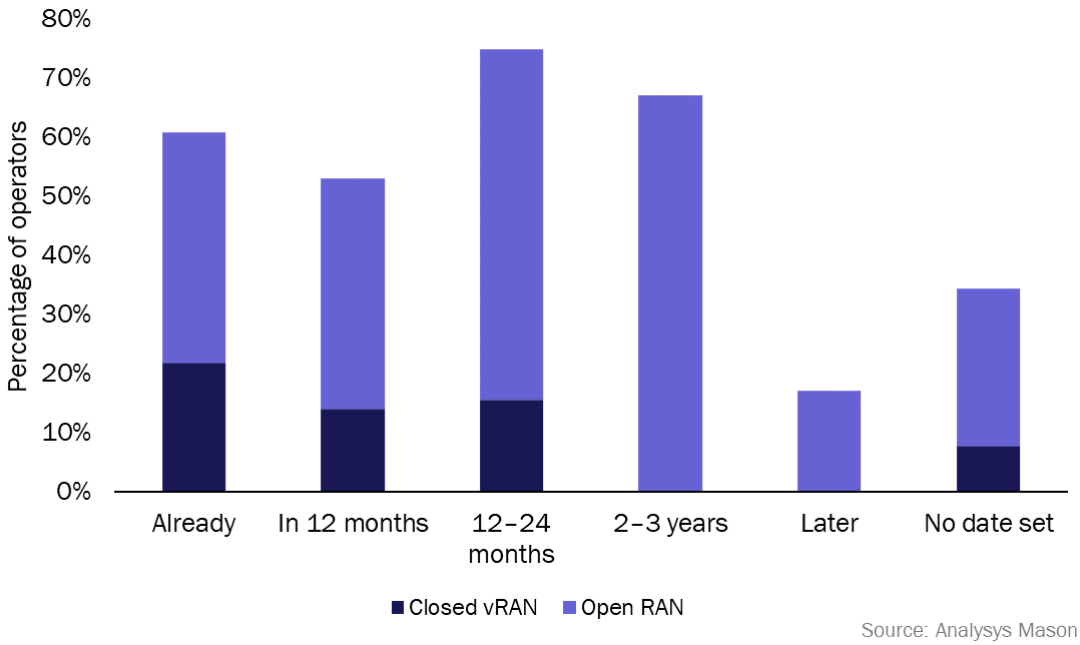
The past 4 years have seen significant operator interest in cloud-based architectures for their next-generation radio access networks (RANs). In a virtualised RAN (vRAN), most mobile network functions are abstracted from specialist hardware and implemented in software on a cloud stack. In Open RAN, which we define as a subset of vRAN, all the interfaces conform to open specifications to allow for multivendor interoperability. With such architectures, operators aim to apply the benefits of cloud platforms, such as scalability and flexibility, to the most business-critical, and expensive asset in their business, the RAN.

vRAN and Open RAN have made considerable and valuable progress during the first phase of development, in terms of evolving the specifications and platforms, and learning from many trials and a small number of large-scale commercial deployments. However, commercial deployments have been held back by various challenges. Uncertainty about TCO savings and concerns about performance trade-offs ranked highest as barriers to deployment for operators, along with systems integration complexities and coexistence with existing RANs. These challenges resulted in slow adoption of vRAN and Open RAN. Analysys Mason estimates that close to 5% of cell sites deployed in 2023 supported vRAN.

However, roll-out is expected to accelerate as platforms and business cases mature and a growing body of operators are actively evaluating and trialling vRAN or Open RAN for deployment between now and 2027. In Q4 2023, Analysys Mason surveyed 64 Tier 1 and 2 operating companies engaged in evaluation, testing, trials or deployment, to understand their timeframes, drivers, challenges and commercial objectives. Key findings from this study are included in this paper.

Within this influential group, progress has been far faster than in the operator community as a whole. As Figure 2.1 shows, over 60% of the respondents have started some form of vRAN test, trial or roll-out, and most have more than one project ongoing or planned.

Figure 2.1: Operators' active or planned vRAN and Open RAN tests, trials and deployments 2023–2027; n=64



Source: Analysys Mason

Stakeholders have made significant efforts to address key challenges over the past 18 months, especially in the critical areas of TCO and performance (see chapter 3). Open RAN, which we treat as a subset of the total vRAN market, has gained particularly strong support from operators, vendors, and various government agencies and has made good progress in trials and tests.

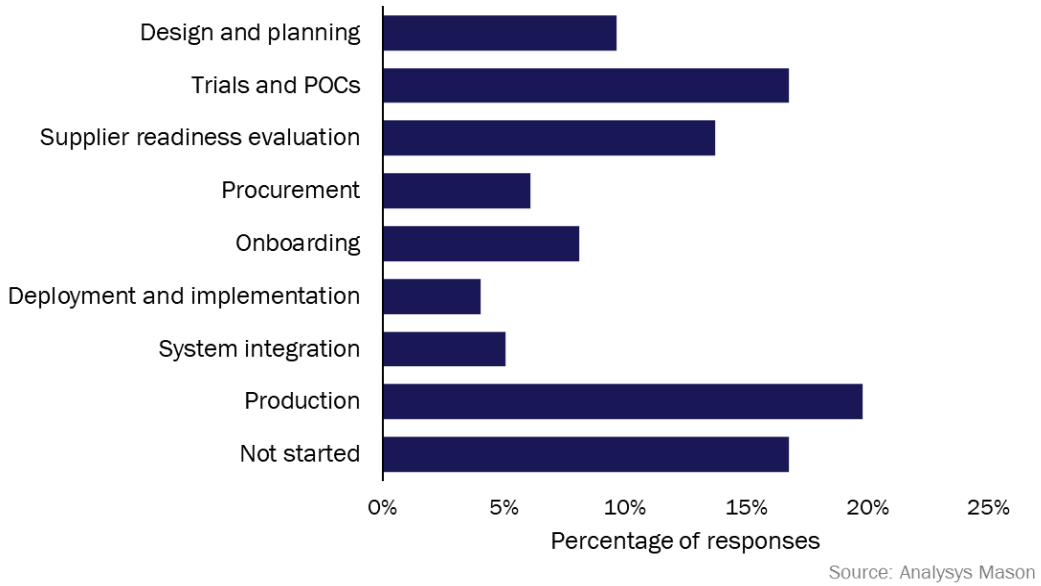
Government support for Open RAN has been particularly prevalent in some countries. For example, in the US, the National Telecommunications and Information Administration (NTIA) has provided USD50 million in Open RAN funding to Dish and recently announced a further USD42 million for two R&D labs in Texas and Washington, D.C. The US government has targeted an overall budget of over USD1.5 billion in funding for Open RAN, and at the beginning of 2023 the National Institute of Standards and Technology (NIST) became a participating member of the O-RAN Alliance. Meanwhile, the UK government has also demonstrated significant investment in Open RAN. As well as recently committing GBP88 million in funding to 19 projects via its Open Networks Ecosystem (ONE) competition, the Department for Science, Innovation and Technology (DSIT) has continued to directly fund open RAN innovation via its Digital Catapult programme, SONIC Labs.

This progress and support has helped to drive forward the deployment plans of operators, and especially the active community represented in our survey. By 2026, 75% of the surveyed operators will have a test, trial or deployment in place and there will be a clear shift from small-scale tests to commercial systems, and from proprietary to open vRANs (although open RAN may be procured from a single RAN vendor supporting open interfaces).

These developments have established a solid foundation for future Open RAN deployments and initiated a new phase for the technology. Operators are now starting to firm up their deployment plans, and the survey indicates significant momentum towards wider at-scale deployments in 2024. Many operators have multiple cloud-based RAN projects and these are beginning to shift from design, planning and trial stages toward commercial deployment, with 23% of active operator projects now in the production phase of the deployment lifecycle (Figure 2.2)[1].

[1] 23% of *active* projects (excluding those not started yet) are in commercial deployment (production) phase.

Figure 2.2: Stage of development for operators' vRAN and Open RAN projects n=64 (multiple projects per respondent)



Source: Analysys Mason

While Open RAN deployments are building momentum, the transition to commercial deployment brings new challenges that must be addressed to propel Open RAN into the next stage of maturity and enable it to support operators' most critical commercial objectives.

Transition to vRAN remains a significant undertaking for operators, and stakeholders must ensure that the ecosystem and technology are mature enough to demonstrate the potential of vRAN to deliver real business value to operators. The rest of this paper examines the state of play as of early 2024, the strategies and expectations of operators, and recommends ways for all players to unlock the value of vRAN and Open RAN.

3. Open RAN challenges are being addressed convincingly, and are moving on from performance and TCO

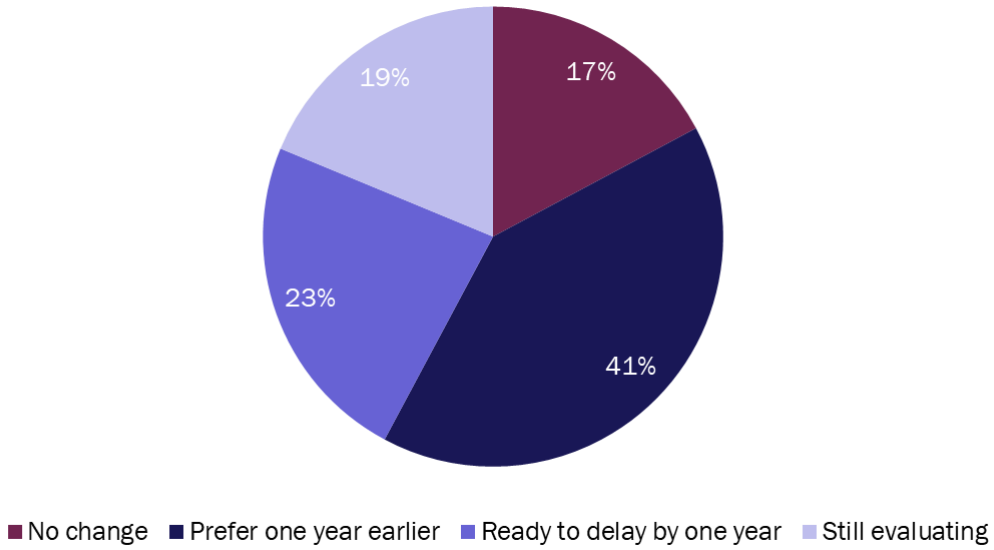
Open RAN and vRAN are entering a new phase of growth and scale and many operators have clearer and more realistic deployment plans than they did even 12 months ago. There are still significant challenges that could impact their deployment timelines, but the focus is shifting away from TCO and performance concerns. In the first years of vRAN, fears that it would incur TCO and performance trade-offs compared to traditional RAN dominated the debate. Now these concerns are being addressed and operators are gaining confidence in vRAN's cost and performance. The focus has moved to challenges that relate to scale and commercialisation, and directly to the operators' business objectives, as their goals for vRAN grow clearer and more ambitious.

Substantial progress is already being made towards addressing these challenges. This is clear from growing operator confidence, as seen in the survey and in the results shared by early deployers. However, that confidence needs to be justified, and addressing operators' business-critical concerns effectively and quickly will be vital to progress in vRAN and Open RAN deployment.

3.1 Operator deployment dates are not fixed, and addressing key challenges could accelerate progress

It is critical for the large-scale adoption of vRAN and Open RAN that commercial roll-outs, which have advanced slowly to date, are accelerated. That will build economies of scale to improve TCO and operator confidence. Analysys Mason calculates that at least 40% of Tier 1 mobile operators plan to start commercial vRAN or Open RAN deployment by 2027, and most have set a target year to begin. However, these target timescales are subject to change, and operators are prepared to delay or accelerate their adoption of the new architectures depending on how quickly their main challenges are overcome and the commercial case is proven.

Figure 3.1: Operators' preferred timescales to start commercial deployment of vRAN; n=64[2]



Source: Analysys Mason

As demonstrated in Figure 3.1, the vast majority of operators that responded to our survey are flexible about their date to start deploying these new architectures. Only 17% say their start date is fixed, while 41% would prefer to move a year earlier than planned, if the platforms were sufficiently mature and capable. This demonstrates that further efforts and breakthroughs towards solving open RAN's key challenges could significantly improve adoption timeframes and progress towards widespread deployments. However, 23% are ready to delay their roll-out by at least a year if the platform is not mature, meaning a quick transition to scale over the coming 3-4 years is not guaranteed.

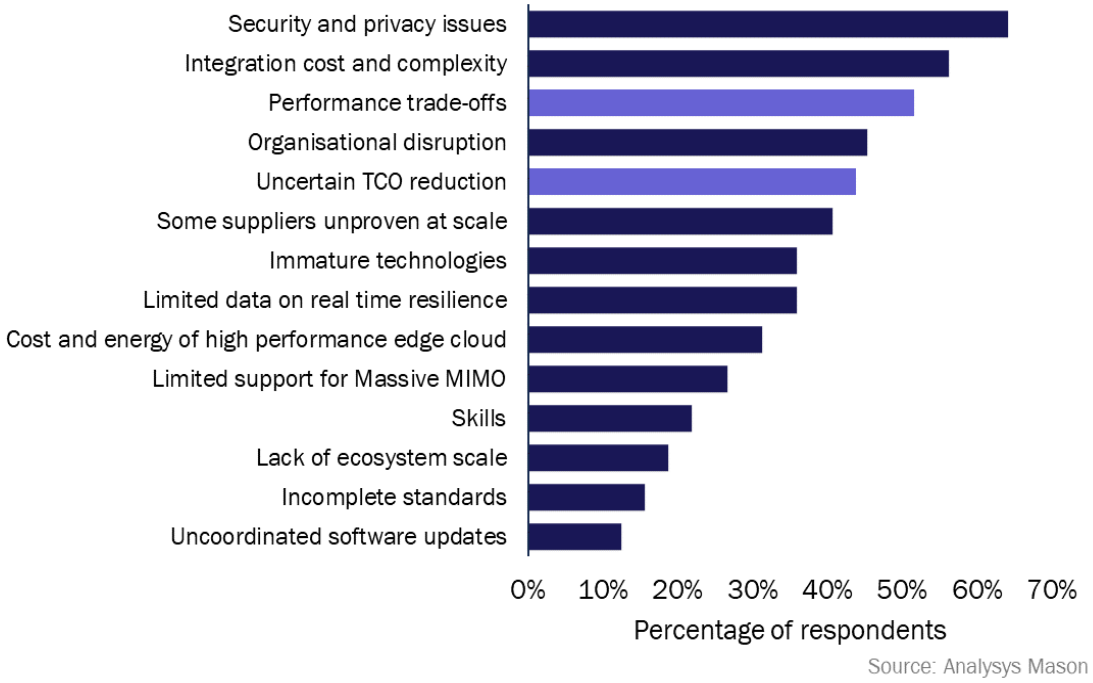
3.2 Operators are shifting their focus away from TCO and performance, and towards challenges associated with commercial deployment

Since the inception of vRAN and Open RAN, TCO and performance have been the primary concerns for operators. That vRAN should perform at least as well as a traditional RAN, and cost less, were table stakes for any plan to deploy commercially. However, the conversation is changing to become more focused on challenges with at-scale deployment and supporting operational objectives, such as efficient systems integration and robust security/privacy. This demonstrates that visible progress is being made towards addressing TCO uncertainty and performance concerns and shows that, as operators move on from testing and trials to

2 Operators were asked 'Is your targeted date to start commercial deployment of vRAN fixed, or do you expect to move it depending on the progress of the platform?'

commercial vRAN deployment, there will be growing emphasis on overcoming obstacles that relate to ease of roll-out, operations and return on investment (ROI).

Figure 3.2: Key challenges facing vRAN and Open RAN adoption n=64[3]



Operators considering vRAN deployment now see security and privacy issues, and integration cost and complexity, as the most important challenges (64% and 56%, respectively, said they were a top 5 challenge).

However, the challenges themselves are evolving. For example, rather than just focusing on whether vRAN is fundamentally secure, operators are now also challenged with ensuring data privacy in commercial deployments across their networks. This requires new skills, additional efforts at the integration stage, and careful consideration of regulation on a per market basis.

Furthermore, challenges are becoming far more centred around achieving scale in deployments, for example ensuring openness and simplicity in systems integration or mitigating the risk that smaller challenger vendors may lack ability to deliver on large projects. This focus on real-world deployability demonstrates that significant progress has been made in overcoming the foundational technical and TCO challenges of open RAN. However, it also requires the industry to refocus their efforts on these new challenges while continuing to demonstrate progress in network performance and cost.

3.3 Improved visibility from real-world deployments is building confidence that vRAN will deliver TCO savings and performance gains

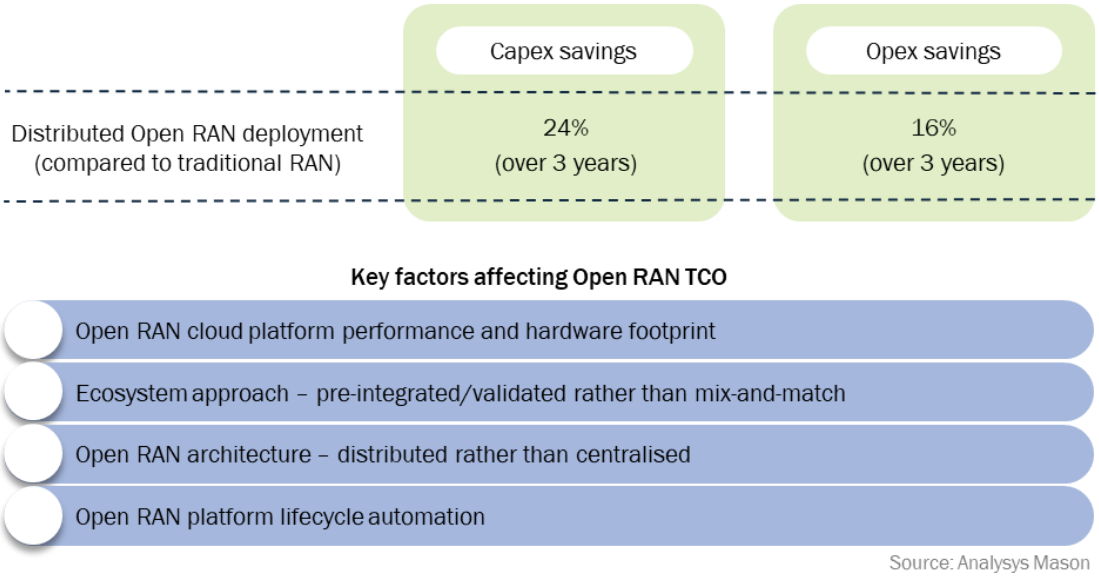
As outlined above, the evolution of operator concerns to focus on at-scale deployability indicates that they are confident that the fundamental TCO and performance issues are being addressed (though of course, TCO and

[3] Operators were asked to provide a list of all the challenges that could delay their adoption of vRAN or Open RAN. A list of the 14 most-cited challenges was drawn up and respondents were asked to score the 5 most important to their business

performance will always be key considerations and will be a moving target as network requirements change). Clear TCO models and lessons from early movers are delivering real proof points in terms of cost efficiency.

As demonstrated by Analysys Mason's in-depth research on open RAN TCO, the forecast cost savings that could be open to operators through vRAN and Open RAN are significant. For many, TCO saving has been a primary driver for their adoption of Open RAN architectures. However, the nature of TCO means that savings cannot be fully proven until operators have completed a full TCO cycle. As a result, there will be some uncertainty around TCO savings for some time, but detailed modelling, based on the findings of early trials and deployments, is improving visibility and reducing risk. Analysys Mason has developed such a model, and as seen in Figure 3.3, we calculate that vRAN can significantly outperform traditional RAN across a range of cost areas, assuming vRAN is deployed at scale and in cloud-native mode on an open, horizontal cloud platform.

Figure 3.3: Projected TCO savings over 3 years for distributed vRAN or Open RAN compared to traditional RAN



As Open RAN and vRAN continue to make progress in larger deployments, it is expected that these cost savings will continue to be realised and proven, driving further confidence for operators.

In terms of network performance, technical progress in vRAN acceleration and new standards are also creating confidence that key challenges will be effectively addressed. Performance concerns have mainly related to whether a cloud-based baseband can support high-performance Massive MIMO antennas to the same level as integrated RAN. To address this, chipset manufacturers such as Intel, Marvell and Qualcomm are driving significant progress in baseband processing with their vRAN acceleration solutions. For example, Intel's latest 4th Gen Xeon processor with integrated vRAN boost claims to deliver twice the vRAN capacity of its previous generation, and the company has plans to double performance with every chipset generation. In partnership with Wind River as the main containers-as-a-service (CaaS) provider, this latest solution from Intel has already been deployed in Verizon's network, and is due to be deployed in Vodafone UK's commercial network in the first half of 2024.

At the same time, new specifications from the O-RAN Alliance are also helping to improve Massive MIMO performance by providing new options for splitting RAN functions across the radio unit and virtualised baseband. These new specs within Split 7.2, collectively called Next Generation Lower-Layer Split (NG-LLS), offer an approach to improving Open RAN's ability to support advanced layer 1 processing for Massive MIMO.

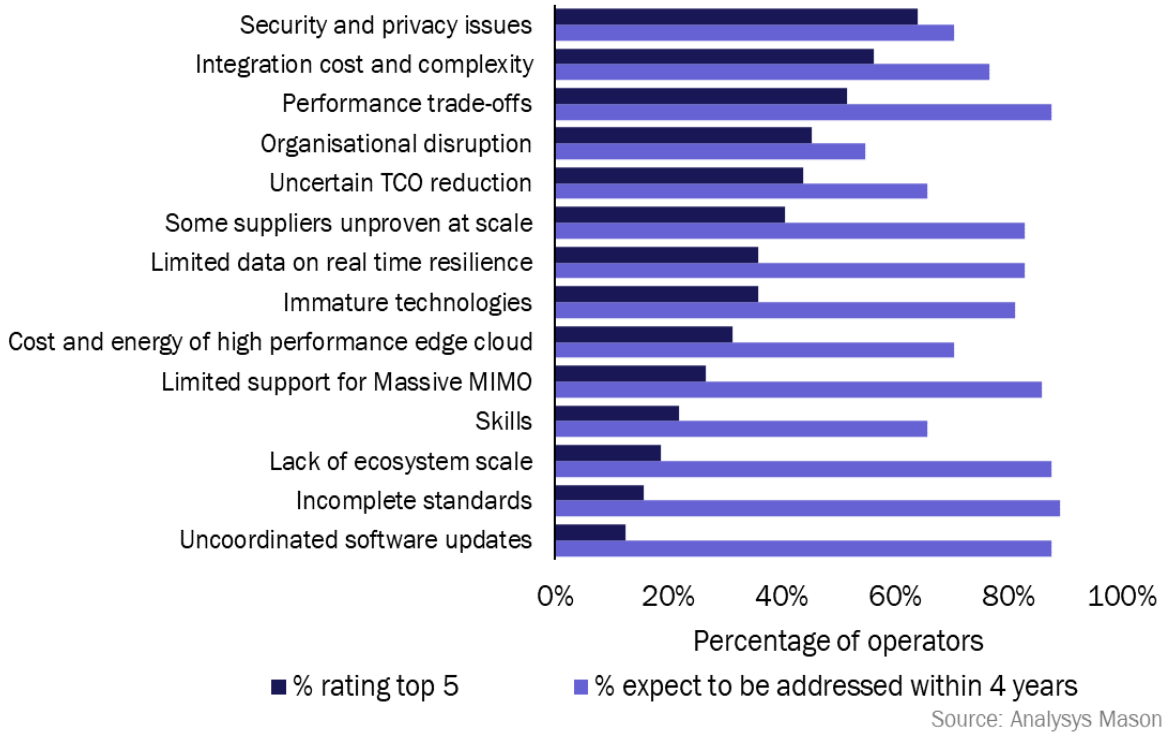
However, by far the most important driver for operators' confidence in addressing performance, TCO and other key challenges, is the increase in real-world deployments by early movers, and the willingness of many of these deployers to share the results and lessons learned from their projects, creating a knowledge base that is accessible to all. Operators such as Verizon and Vodafone have been leading deployments of vRAN and Open RAN, and are beginning to prove that challenges are being overcome and positive results achieved.

With support from partners, Wind River and Samsung, Verizon has deployed over 15,000 ORAN compliant vRAN cell-sites (with 130,000 ORAN compliant radios), and is over three quarters of the way to its previous target to reach 20,000 sites by 2025. Of specific note is Verizon's deployment of vRAN-supported Massive MIMO in multiple cities in the US. Similarly, Vodafone has been making significant progress in the UK, with commercial deployments of multi-vendor Open RAN in Torquay and Exeter. These early deployments have yielded positive results, both in terms of interoperability and network KPIs, and will be a blueprint for Vodafone's wider roll-out plans across its global footprint. The operator has announced goals to reach 2,500 active sites in the UK by 2027 and is targeting Open RAN for around 30% of its network across Europe by 2030. Most recently, the company announced it is deploying Open RAN commercially across 20 cities in Romania.

3.4 Operators are confident that all major Open RAN challenges will be addressed effectively within the next four years

In light of this continued technical progress and positivity from early adopters, there is significant confidence from operators that the major challenges facing vRAN will be overcome within the next 3–4 years, and if the ecosystem can further improve on that timeframe, deployment will be accelerated. Figure 3.4 shows the level of confidence of the survey respondents, that each of the main challenges outlined above will be addressed within 4 years or less.

Figure 3.4: Operator confidence that key vRAN and Open RAN challenges will be fully addressed within 4 years; n=64



Source: Analysys Mason

As shown in the graph, at least 50% of operators believe that all major challenges facing vRAN will be overcome within 4 years. For the top 3 challenges that operators believe are most important, an average of 78% of operators expect these to be successfully addressed in the same timeframe. Of particular note is that 88% of operators believe performance challenges will be effectively addressed over the coming 4 years. There is also high confidence that challenges related to ecosystem scale, resilience and platform maturity will be overcome.

There is somewhat lower confidence regarding TCO, but as stated in section 3.3, there will still be some level of uncertainty about TCO savings until operators complete a full TCO cycle. Despite this, 66% of operators still expect these uncertainty challenges to be addressed over the next 4 years.

The challenges that show the least confidence from operators in being overcome relate to skills and internal organisational disruption, which must largely be addressed by the MNOs themselves within their own structures. The results of the survey indicate significant trust and confidence in vendors' ability to solve technical challenges, but demonstrate that there is still significant work needed from operators to adapt their own processes and partnerships to deploy vRAN at scale. Regardless of the pace at which technical and deployment challenges can be overcome, the implementation of vRAN still requires new skillsets and organisational change for operators. Therefore, the benefits of vRAN and Open RAN must justify that investment in new skills, new processes and new infrastructure.

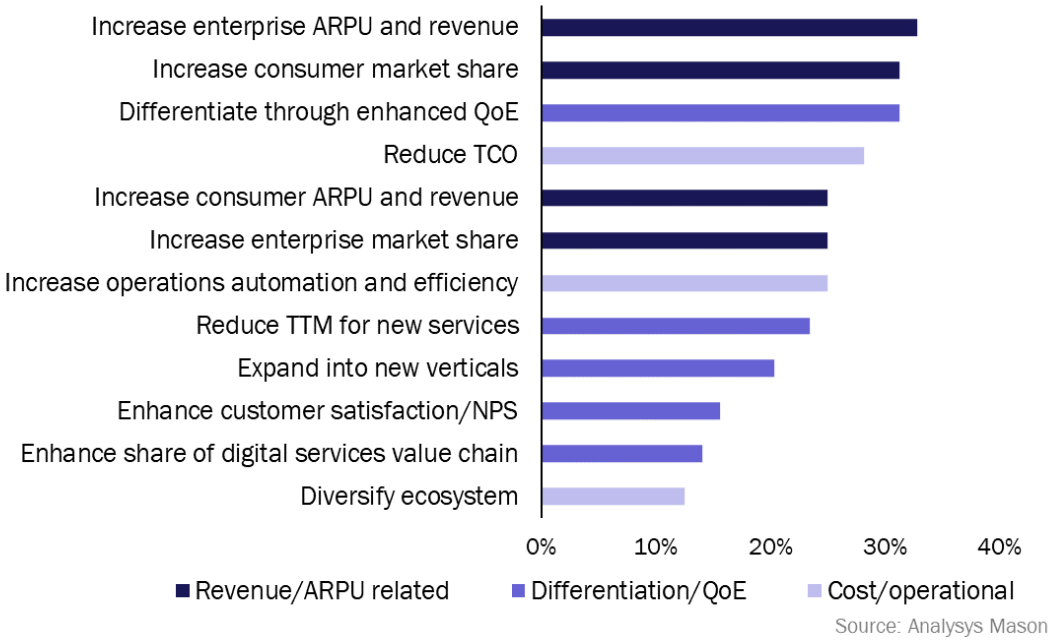
4. Operators must be sure Open RAN will support a broad range of goals before they trigger wider deployments

As seen above, operators are confident that the major challenges facing vRAN and Open RAN will be effectively addressed over the coming years. However, technical issues and challenges are only part of the equation. To make the leap to wider deployments, operators must be sure that vRAN will also deliver real business value and contribute to their most critical commercial objectives. These objectives are extensive in number, and the RAN is becoming increasingly important in helping operators to achieve them.

4.1 Operators have a broad range of commercial objectives, with a focus on driving new revenues and differentiation

The survey respondents were asked to rate their most important overall commercial objectives. As Figure 4.1 shows, while reducing TCO is a major objective, improving revenues and differentiation are rated as most important. 33% of operators said that increasing enterprise revenue was a top-3 commercial goal, while 28% said the same about TCO. This highlights that focusing on cost efficiency alone will only support businesses for so long, and creating new revenue streams, addressing new markets and differentiating their offering is vital for a sustainable business plan. As a result, to create maximum business value, vRAN must enable both reduced costs, and support a wide range of commercial objectives that help to generate new revenue.

Figure 4.1: Most important commercial objectives (percentage of operators placing each objective in their top 3, n=64



As demonstrated in Figure 4.1, operators have a wide range of commercial objectives.

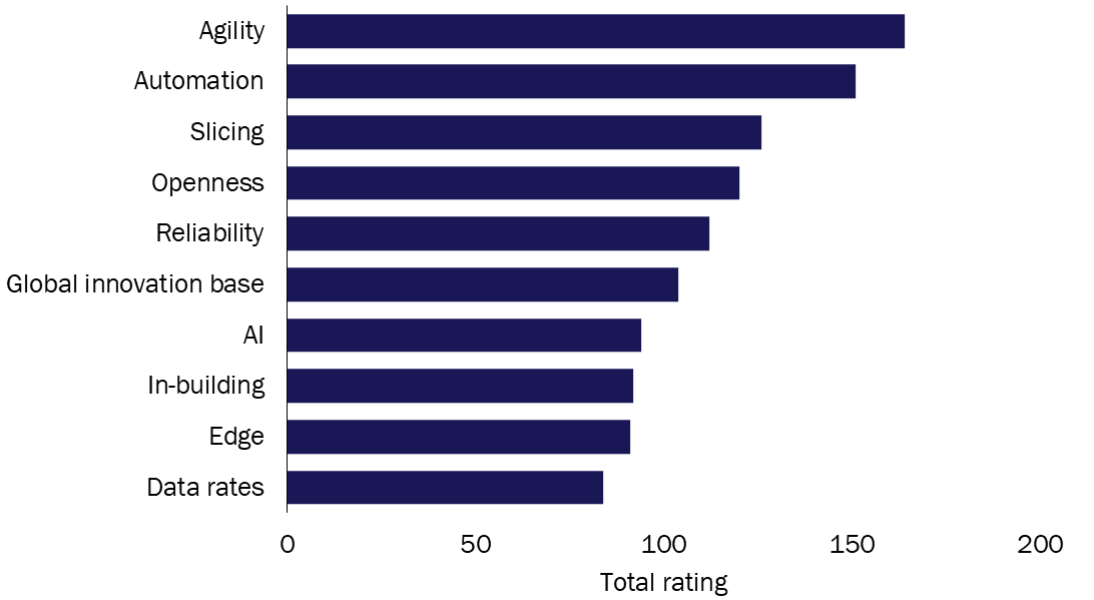
TCO reduction alone is not likely to create significant urgency to deploy at scale, so focus is required on areas where vRAN could drive business value in enabling new revenue opportunities, improving quality of experience (QoE) and gaining market share.

Ranked most highly in operators' commercial objectives are "increasing enterprise ARPU and revenue", "increasing consumer market share" and "differentiating through enhanced QoE". The RAN – whether virtualised or not - needs to deliver capabilities that will support these key commercial objectives. The RAN is becoming more important than ever in this respect, as operators aim to address different applications and customers (e.g enterprise, private 5G, IoT and application developers) that have very different RAN capability requirements compared to traditional consumer mobile broadband users.

4.2 The RAN is vital in supporting operators' commercial objectives, and needs to deliver on a wide range of capabilities that support them

The RAN is becoming increasingly central to operators' ability to grow revenues and differentiate their business. Historically, innovation at end-device level, through processing power and app development, has driven rising data usage and corresponding innovation in consumer data plans, impacting ARPU and market share. However, with these trends levelling off and consumer data ARPUs reaching a plateau, increasing pressure is now being placed on the RAN to deliver new capabilities that can help support new users and different value opportunities. These new opportunities hinge on far more than just raw performance and capacity, and significantly broaden the capabilities that operators desire from their RAN.

Figure 4.2: Most important RAN capabilities (any RAN architecture) that are required to support operators' commercial objectives n=64[4]



Source: Analysys Mason

Figure 4.2 demonstrates the RAN capabilities that operators consider most important to support the commercial objectives outlined in the previous section (Figure 4.1). It is clear that operators require a wide range of RAN capabilities to achieve their commercial objectives, and the most important by some margin are agility, automation and network slicing.

Agility affects how long it takes to add additional capacity to a network, how quickly an operator can upgrade its network, how quickly new features or services can be introduced, and how effectively the network can respond to changes in user requirements or operating environment. Speed of actual deployment is a key consideration, and to what extent updates require new hardware, manual labour and site visits. Agility can also help service providers close networks or stop services rapidly and reallocate RAN functionality with a reduced burden of sunk costs.

Automation ranks as the second most important RAN capability overall and is also a key enabler of agile networks. Automating processes drives cost reduction by relieving the need for human intervention and reducing staff costs. However, it is also vital in enhancing QoE, improving operational speed, and even automating network slice implementation. Not only can automation decrease the burden of repetitive tasks, but it can also improve the time in which they are executed whilst creating more consistency and reducing errors compared to manual processes. Therefore, it is also a key component of network agility, helping to optimise the network, or deliver new capacity and services automatically and more frequently. Furthermore, automation can then be further enhanced by AI/ML-based analysis and prediction, with automation acting as a basis for more intelligent AI controlled processes.

Operators also rate highly the ability to slice their networks in order to assign specific capacity and QoE characteristics to individual services, users, enterprises or tenants. Slicing is enabled by automation and in a 5G environment can be a key enabler of agility and of new revenue opportunities.

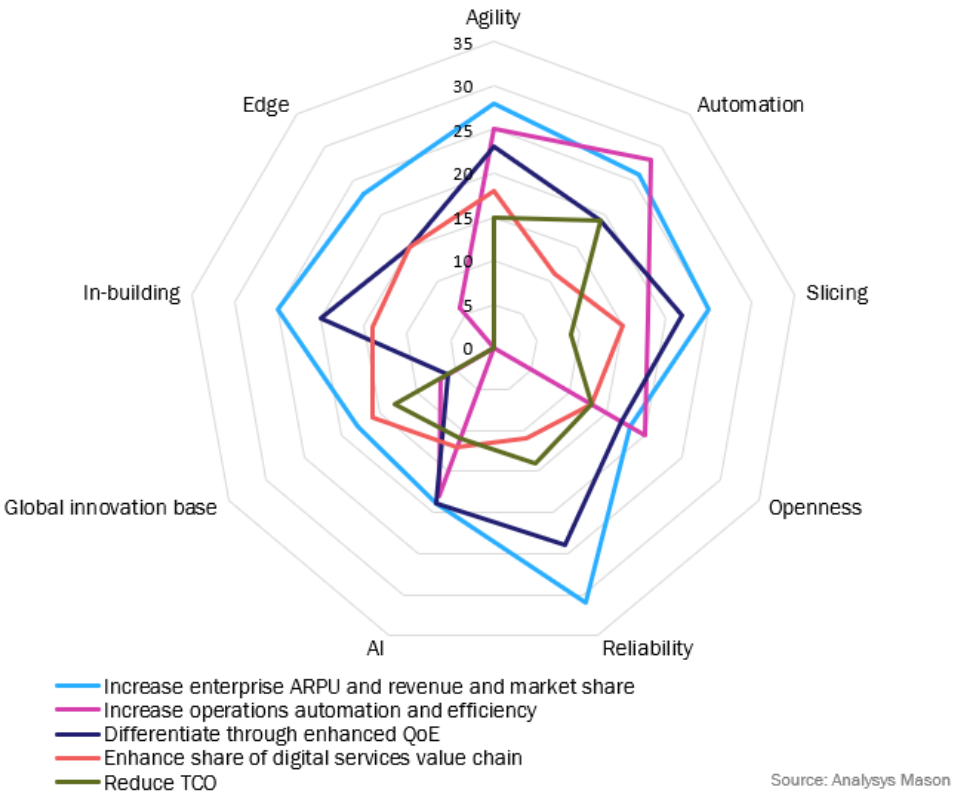
[4] Survey respondents were asked to select RAN capabilities that were essential to help achieve their top 3 commercial objectives (from Figure 7). Ratings indicate the total rating across all 12 objectives.

4.3 Each commercial objective requires a different set of capabilities, and the RAN must be able to support these holistically and flexibly

Although operators rank agility, automation and slicing as the highest priorities for their RANs, to achieve all their commercial objectives many other capabilities are valued and an effective RAN will need to address all of them. As operators' RAN procurement increasingly considers factors beyond just TCO and raw performance, it will be essential that the RAN supports a broad range of capabilities that help enable progress towards a varied and changeable set of operator commercial KPIs.

Figure 4.3 demonstrates the varied mix of capabilities required of the RAN to achieve operators' key commercial objectives and shows just how holistic the RAN's capabilities must be to effectively address the most important operator commercial objectives.

Figure 4.3: The significance of eight key RAN capabilities in supporting operators' top 5 commercial objectives n=64



For example, reliability and low latency is ranked mid-table overall, but when operators' top 2 commercial objectives – enterprise revenue and consumer market share – are considered alone, this has close to the highest average score for any RAN capability. This demonstrates that one RAN capability isn't necessarily more important than another, but priorities change depending on the individual commercial objectives that each operator is pursuing.

The goal that is most important to operators overall is to increase enterprise ARPU, revenue and market share. This goal alone requires a broad range of capabilities. As demonstrated in Figure 4.3, operators believe almost all of the key RAN capabilities are important to supporting this objective, with reliability and low latency being most important.

In contrast, other key commercial objectives, such as differentiation through QoE or enhancing share of the digital services value chain, have different RAN requirements from enterprise services. They rely less on reliability and low latency and more on RAN agility and slicing. In this context, slicing could allow operators to provide a differentiated service, and agility supports the speed and ease of implementing these new services. These same commercial objectives differ in how far they rely on two other RAN capabilities – edge integration and a global innovation base. QoE differentiation is more reliant on edge integration, while for the value chain goals, a broad base of RAN innovation is important.

The broad range of capabilities needed to address just a single operator business objective means that, more than ever, the RAN has to deliver a wide range of capabilities. The RAN has to adapt to the specific requirements of each operator and evolve with them on their efficiency and monetisation journeys. It must be able to deliver on these capabilities in a way that best supports operators' commercial goals, and where necessary adapt its capabilities as operator priorities change.

Many of the capabilities, particularly agility, automation, slicing and openness, are heavily associated with the cloud and so vRAN is potentially the best-placed architecture to enable them. The vRAN ecosystem needs to demonstrate that the new architecture can support the majority of the targeted capabilities better than traditional RAN, both in terms of cost efficiency and in creating new revenue and business value. It also needs to demonstrate it can offer the flexibility and agility to support a wide range of varied or changing operator objectives. Only then will vRAN demonstrate the added value that will accelerate its adoption. In the next chapter we examine how far operators believe vRAN will out-perform traditional RAN, once the platform is mature, in supporting these business-critical capabilities.

5. Confidence is growing that vRAN is the most capable architecture to support operators' goals

Clearly the RAN, regardless of its architecture, is fundamental to a mobile operator's commercial success. It is effectively the lifeblood of the business, and so a decision to move from a traditional to a cloud-based RAN is an extremely important one. Of course, operators must be convinced that a new architecture will not cost more, or perform less well, than an integrated RAN in the same scenarios. But that will not be enough to justify the significant effort and disruption of migrating to the cloud. Even if all the challenges outlined in chapter 3 are addressed, most operators will still lack urgency to cloudify their RANs. To adopt vRAN at scale, they need to be convinced that it will deliver their most critical commercial objectives more effectively than continuing to upgrade a traditional RAN.

5.1 Operators are assessing their next-generation RAN against an increasingly sophisticated matrix of criteria

Our survey indicated that, among operators that are actively evaluating vRAN, there is rising sophistication in how they consider the potential impact on their business. Even two years ago, most operators that shared their vRAN assessment processes were primarily focused on TCO reduction, improved efficiency and a reduced time to market for new services, driven by leveraging cloud capabilities. Meanwhile, they were concerned that these benefits should not be achieved at the expense of raw performance in demanding 5G environments.

All these factors remain very important, but our latest survey shows that most operators have progressed their thinking and their evaluation process significantly, in two ways in particular. They are modelling the impact of vRAN on their business using a far more complex matrix of criteria; and they are assessing its likely effect on the broadest and most strategic goals for their companies, not just on tactical advances or cost efficiencies. Their targets, then, are more ambitious than they were in previous years, because they better understand the potential of cloud-based networks, and because they will only justify such a foundational change in their systems and organisation if they can expect significant contribution to achieving their most important strategic goals.

Figure 5.1 highlights the changing expectations for vRAN in terms of commercial impact. There was over 85% commonality between the operating companies surveyed in late 2021 and in late 2023 but the top commercial targets reveal a significant evolution in thinking. The most important benefits targeted in the earlier survey related to automation and cost efficiency; even improved cloud-driven agility was mainly seen in terms of more flexible traffic management. In the later survey, the top two objectives are some of the most foundational for any mobile business, to increase new revenue streams, most of which are seen to come from enterprise; and to increase market share among consumers (market share ranks more highly than increased consumer ARPU in many of the geographies where the respondents are based, which are very saturated, meaning gaining market share is often a more important KPI).

Figure 5.1: Projected commercial benefits of vRAN that were rated most highly by operators surveyed in November 2021 and November 2023[5]

2021	Rating	2023
Increase network automation	1	Increase enterprise revenue
Reduce TCO	2	Increase share of the consumer market
Improve network agility to support traffic change	3	Differentiate with advanced QoE
Diversify supply chain	4	Reduce TCO
Reduce time to market for new services	5	Increase consumer revenue and ARPU
Enable new enterprise applications	6	Increase operations automation and efficiency
Facilitate rural expansion	7	Reduce time to market for new services

Source: Analysys Mason

This comparison shows that operators are gaining in confidence that a new RAN architecture can impact on their most strategic commercial KPIs, not just on factors, such as flexible traffic handling or improved time-to-market (TTM), that are directly underpinned by the network. These factors remain very important, but the perception of vRAN's potential benefits has, for many operators, moved up a level to be part of top-level corporate strategy.

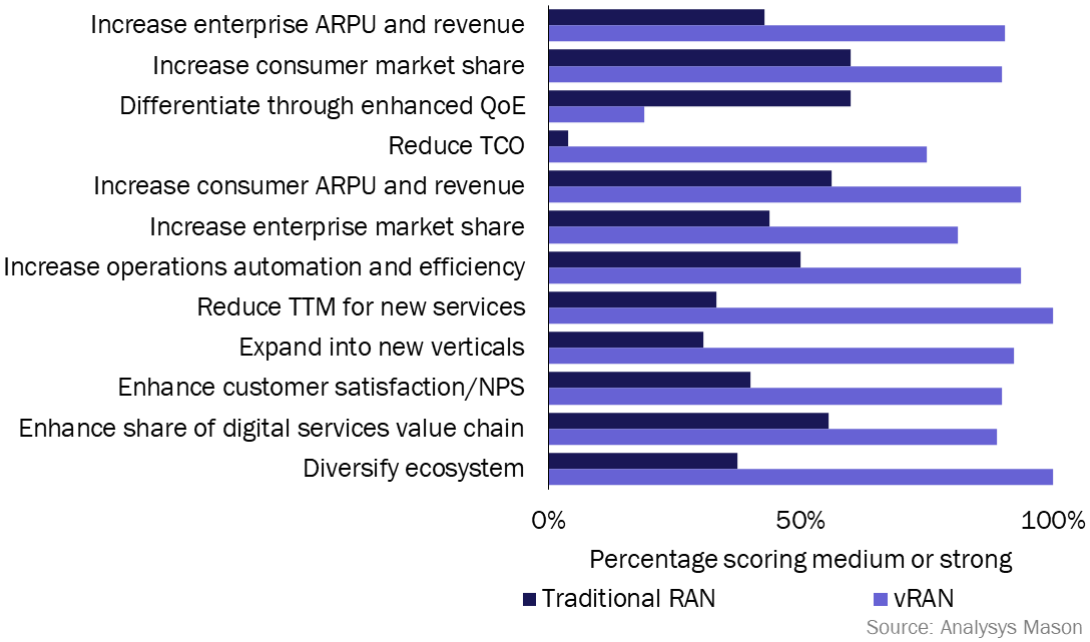
5.2 vRAN is perceived to contribute more strongly than traditional RAN to many key commercial objectives

Figure 5.2 provides evidence, from the new survey, that operators believe vRAN can outperform traditional RAN in contributing to many of their strategic objectives, a conviction that will be essential to trigger at-scale deployments in the next few years. Although this group of respondents is weighted towards vRAN believers, as

[5] Survey respondents were 61 in 2021 and 64 in 2023 with over 85% commonality of operating companies responding. Respondents first provided a list of all their targeted benefits. A list of the 12 most-cited was compiled and respondents were asked to select the three most important to their business plan

all of them are actively evaluating or trialling the architecture, once their rising confidence translates into commercial roll-outs at-scale, that should build confidence in the wider operator community too.

Figure 5.2: Comparison of perceived effectiveness of vRAN compared to traditional RAN architecture in supporting operators' top 12 commercial objectives (ordered by operator ranking of most to least important)[6]



In 11 out of the 12 commercial objectives that were identified as the most important by the respondents, they believe vRAN will contribute more than traditional RAN once deployed at scale. For each objective, the operators that had placed that KPI in their top 3 were asked to rate vRAN and traditional RAN as strong, moderate or weak in expected support for achieving that goal. The chart shows the numbers that scored each architecture strong or moderate.

The highest expectations for vRAN were in achieving a diverse ecosystem and reduced time-to-market for new services. In these cases, all the respondents rated vRAN a strong or moderate contributor. More than 90% said the same for four further commercial objectives: increased enterprise revenue, increased consumer market share and ARPU, increased operations automation, and improved customer satisfaction/ net promoter score.

The objectives where operators perceived the biggest contrast between the effectiveness of vRAN and traditional RAN were TCO reduction, expansion into new industry verticals, reduced TTM and ecosystem diversity. In all cases, vRAN was scored strong or moderate at least 2.5 times more frequently than traditional RAN. In the case of TCO, 18 operators said this was a top-3 commercial objective, and 15 of those expect vRAN to make a strong or moderate contribution to reduction, while only 4 expect the same for traditional RAN. The only objective in which the impact of traditional RAN is seen as higher is in delivering enhanced QoE, which many operators still associate primarily with physical radio characteristics (data rates, coverage).

6 Respondents that had placed each objective in their top 3 were asked to rate traditional RAN and vRAN as strong, moderate or weak to contribute to achieving that objective. The score relates to the percentage that scored strong or moderate.

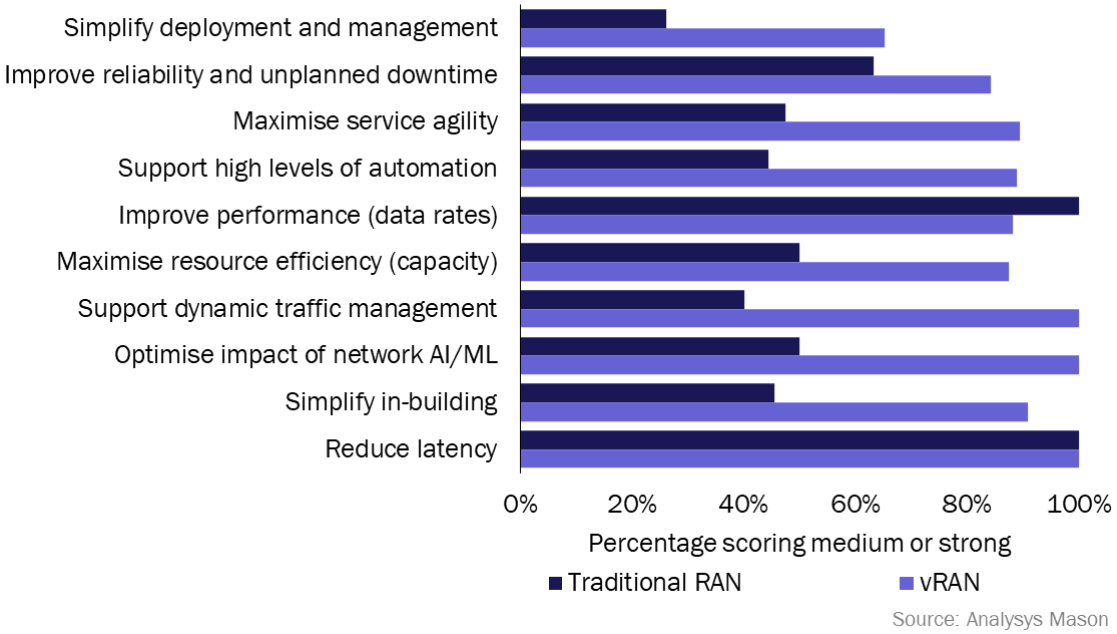
5.3 vRAN is also increasingly expected to deliver technical KPIs more effectively than traditional RAN

The survey also asked operators to select the most important technical KPIs they would set for their RANs, to enable the business-critical capabilities that will deliver commercial results.

The most important technical KPIs for the RAN relate to simple deployment and management, reliability, service agility, automation and high data rates.

The operators were asked to rate vRAN and traditional RAN, using the same process as for commercial objectives, for expected impact on technical KPIs. Figure 5.3 summarises the scoring for the 10 technical KPIs that the operators identified as the most important in this regard.

Figure 5.3: Comparison of perceived effectiveness of vRAN compared to traditional RAN architectures in supporting operators' top 10 technical network KPIs (ordered by operator ranking of most to least important)[7]



Source: Analysys Mason

As with the commercial objectives, vRAN scored more highly than traditional RAN in all but one of the KPIs. vRAN was rated strong or moderate by all operators in three technical KPIs – reduction of latency, support for dynamic traffic management and optimising the network impact of AI/ML. The biggest contrast in perceived contribution of vRAN vs traditional RAN was also seen in dynamic traffic management, as well as in simplified deployment and management.

The categories where traditional RAN outscored or equalled vRAN were improved data rates and reduced latency. These are clearly RAN capabilities that are primarily delivered by the physical radio, but it is interesting that vRAN is starting to be rated highly even for technical processes that are not specifically based on cloud technology. For example, high levels of automation and strong leveraging of AI might be seen as natural cloud attributes, but while scoring well for these factors, vRAN is also expected to improve ease of network roll-out and in-building coverage.

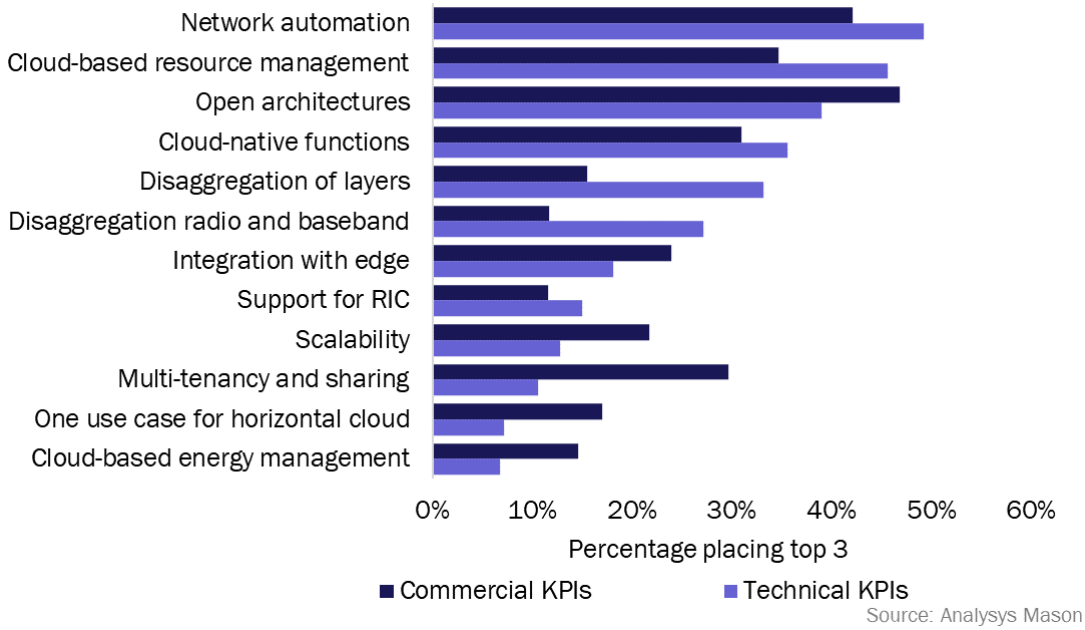
[7] Respondents that had placed each KPI in their top 3 were asked to rate traditional RAN and vRAN as strong, moderate or weak to contribute to achieving that objective. The score relates to the percentage that scored strong or moderate.

These are physical processes that are critical to TCO efficiency and enterprise QoE, but do not seem naturally associated with cloud networks. However, they may be enhanced by vRANs that are based on open platforms. This is because open vRAN broadens the ecosystem of vendors, encouraging an increased variety of equipment form factors including simplified radio units and pre-integrated networks. These can simplify deployment and make RAN viable in under-tapped environments such as enterprise and industrial buildings. In other words, the open ecosystem and innovation base that cloudified networks encourage may be as important to operators' commercial objectives as the cloud architecture itself.

5.4 Openness, automation and cloud-native platforms are vRAN's key strengths in supporting operators' objectives

For the vRAN ecosystem, it is important to understand which specific characteristics of vRAN best support operators' commercial and technical objectives, so that their development can be prioritised by the ecosystem. The survey asked each operator to select the three vRAN characteristics they considered most important to achieving the KPIs they had prioritised. Figure 5.4 shows the percentage that placed each characteristic in their top three, averaged across both their commercial and technical objectives.

Figure 5.4: Most important vRAN characteristics to help deliver operators' commercial or technical objectives (percentage of operators placing each in the top 3, averaged across all the objectives)



Source: Analysys Mason

The same four vRAN characteristics lead the rankings for supporting both commercial and technical objectives, though with somewhat different weighting. Those four key capabilities are open architectures, network automation, cloud-based resource management and cloud-native functions. To help achieve operators' commercial goals, openness and automation are selected as top 3 requirements by the largest percentage of operators – over 40% in each case. For technical KPIs, automation is the leading requirement, followed by cloud-based resource management, and again, these two were cited as top 3 requirements by over 40% of respondents.

These four leading success factors can be seen as the defining characteristics of a cloud platform, but have been challenging to apply to a RAN, which in turn has led to somewhat diluted definitions of vRAN and Open RAN in early deployments. Closed architectures running on proprietary processors, or Open RANs that support open

radio interfaces but not a full cloud platform, have been valuable in driving the ecosystem forward. But the survey findings indicate that operators understand that these semi-cloudified RANs will achieve only a fraction of the objectives they have set for their next-generation networks. A full implementation of the cloud platform is recognised to be essential by operators that are assessing vRAN seriously, and this is a clear call to action for the whole industry to make that platform deployable as quickly as possible to address operators' pent-up demand.

The survey results also highlight the wide range of vRAN capabilities that are considered valuable for achieving operators' goals, meaning that a successful vRAN platform needs to be sufficiently flexible to support any combination of these to suit an operator's particular model. For commercial objectives, there is a high priority placed on enabling multi-tenancy or network sharing. Operators are increasingly considering shared networks to reduce their own costs or to support expanded wholesale business, and with a cloud-based environment, sharing and wholesaling can be implemented in a flexible and software-defined way using slicing.

Other important vRAN capabilities to be prioritised for commercial success include integration with edge computing, with many operators evaluating edge deployments that could not only support the network functions for a distributed, cloud-based core and RAN, but also enable new edge/5G services for enterprises.

On the technical side, disaggregation is the most important vRAN characteristic, after the big four capabilities, in helping operators achieve their performance KPIs. Both disaggregating the network layers, with open and independent hardware and software, and disaggregating the radio units and cloud basebands using open interfaces, are considered to be top-three requirements by a significant percentage of respondents (33% and 27% respectively).

Overall, operators with serious vRAN evaluations, trials or deployments are widening the range of commercial and performance benefits that they expect to gain from vRAN, which raises new challenges for the ecosystem to prove that the new architecture can deliver more than efficiencies. The survey, however, also indicates growing operator confidence that vRAN can indeed deliver the targeted results, leveraging the openness and agility of a full cloud-native platform to support a wide range of KPIs, in a sufficiently flexible way to support any operator's individual priorities and business plan.

The survey concentrated on large operators, since these will be the main investors in large-scale vRAN and will be essential to move the market forward. However, it is important to remember that those deployments will have benefits for a wider ecosystem than just MNOs and their supply chains. Open, cloud-based platforms lower the barriers to entry for new service providers, either to build their own networks affordably in targeted locations (such as private enterprise RANs), or to use slices of a host operator's multi-tenanted network. The expansion of the 5G ecosystem should be accelerated by vRAN, especially in enterprise services, bringing increased monetisation opportunities for network operators as well as new 5G stakeholders.

6. Operators and vendors can take significant steps in 2024 to unlock the vRAN and Open RAN markets

This paper has analysed the scale of the opportunity for vRAN and the readiness of a substantial group of operators to trigger at-scale deployment in the coming 1–3 years. The potential benefits of vRAN (section 5) are becoming more visible to operators and are more business-critical than most stakeholders had envisaged 2–3

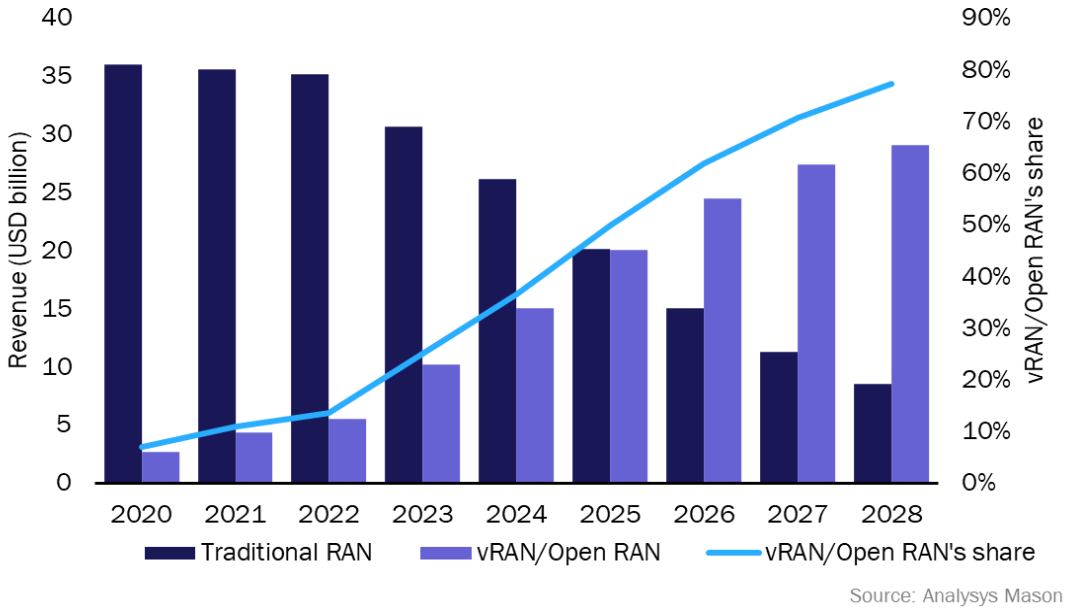
years ago, and there is rising confidence that potential performance trade-offs compared to traditional RAN will be addressed over the coming years (section 3.4).

However, belief and confidence in vRAN need to be translated into large roll-outs in order to expand the ecosystem and prove the real-world results that operators can gain from a new architecture.

The survey shows that operators are no longer thinking just in terms of cost efficiency or opening up the radio supply chain using open interfaces. These are very important goals, but to be approved at CxO level, a major vRAN project needs to contribute to achieving the most foundational business goals, of expanding revenue streams, market share and profitability (section 4.2). A full implementation of the cloud platform is recognised to be essential to such ambitions (section 5.4), and this is a clear call to action for the whole industry to make that platform deployable as quickly as possible to address operators' pent-up demand.

If the ecosystem collectively responds to this demand, significant growth in vRAN deployment and industry revenues will be unlocked. Analysys Mason calculates that, if every operator planning to start vRAN deployment before 2027 sticks to their targeted date, or brings it forward by one year, vRAN will account for three-quarters of spending on new RAN sites deployed by 2028, as Figure 6.1 shows.

Figure 6.1: Forecast ecosystem revenues (products and services) from vRAN, Open RAN and underlying cloud platforms



Source: Analysys Mason

6.1 Recommendations for operators

41% of operators have indicated that they would bring forward their current targeted date to start commercial vRAN deployment, if they were confident that the networks would support their commercial goals, and that remaining challenges had been addressed (figure 3.1). Acceleration will rely on concerted efforts by the whole ecosystem, but operators can adopt strategies that will help them to start roll-out at an early stage and with limited risk.

- Operators should intensify network tests and trials and ensure that all results are assessed and quantified in relation to business objectives, not just technical performance. All partners in trials should be clearly briefed on the most important business objectives (section 4.1).

- Operators should de-risk commercial deployment by laying strong foundations across the organisation, particularly to implement changes in organisational structure and skills to support vRAN (section 3.4). They should take clear decisions on which aspects of vRAN deployment and operation they want to support inhouse and which should be outsourced or shared with partners. For instance, operators should decide upfront whether to deploy some or all vRAN functions on their own telco cloud, on a vendor cloud or on public cloud.

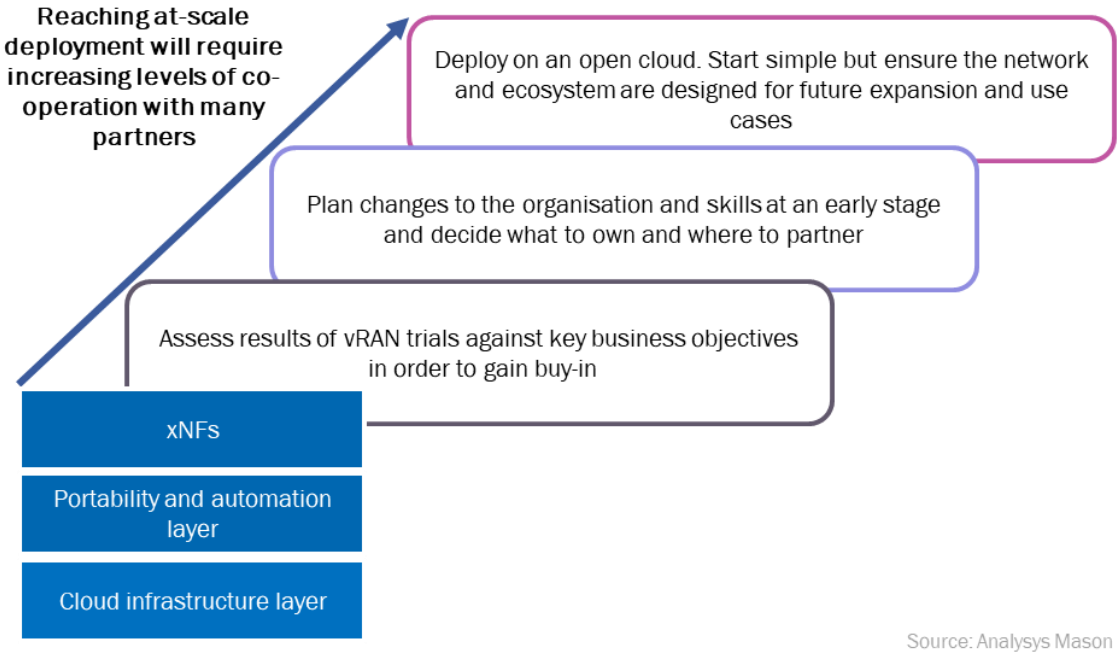
- Operators should not plan the vRAN in isolation, but as a particularly complex and critical application on their multi-functional cloud platform. This will maximise return on investment and facilitate future expansion to support new use cases and end-to-end orchestration and slicing, which were identified as key objectives for operators in sections 4.2 and 5.3.

- Operators should cooperate with one another and their partners to share their experience with vRAN in order to reduce the deployment learning curve, and to define clear technical and commercial requirements to drive the priorities of standards organisations and the whole vRAN ecosystem.

- Operators should be realistic about what they can achieve in the near term and start with relatively simple commercial deployments in order to gain real-world knowledge before progressing to the most demanding environments. Many operators indicate that they will initially deploy vRAN in relatively low-traffic areas such as suburbs, or will work with just one RAN vendor at first before moving to a more complex multivendor platform, to help alleviate the system integration and performance challenges highlighted in section 3. However, any first phase deployments should strongly consider a progression path to open interfaces, to enable them to be scaled-up and extended to new environments and use cases as required.

- The network and its underlying cloud should be fully future-proofed so that changes can be made without significant retooling. New vendors, new use cases and services such as 5G slicing and new capabilities such as embedded AI will all enhance the vRAN business case, and need to be supported as readily as possible when they become relevant to the operator's commercial objectives (sections 4.2 and 5.3 highlight the importance of agility, slicing and AI to operators' commercial objectives).

Figure 6.2: Key steps in effective deployment of an operator's vRAN



6.2 Recommendations for vendors

Vendors have made significant progress in addressing the major challenges of vRAN and Open RAN, however to support operators' transition to wider deployments, a renewed focus is needed. Vendors must consider how they can prove their solutions will support key operator commercial objectives, while ensuring they also refocus their attention on challenges associated with achieving at scale deployments.

- Suppliers of vRAN and network cloud solutions and services must prioritise their product development efforts to align with the capabilities that operators regard as most critical. There is a long menu of potential capabilities to implement in a vRAN platform, but trying to address every item will delay at-scale and mature platforms. Instead, the ecosystem should focus its investment and partnerships on the capabilities that operators value most, such as effective slicing and high degrees of automation (capabilities outlined in figure 4.2).

- The vendor ecosystem needs to prove and quantify the commercial benefits of vRAN, including cost and impact on business objectives, and this will require a wide variety of activities including testbeds, case studies, creation of a knowledge base centred on trial or deployment results, ecosystem labs etc. Lessons must be learned from the enterprise and IT industries, where there were similar perceived risks in the early days of cloud or open-source software, that have now been largely addressed.

- As a primary commercial objective for operators, increasing enterprise revenues should be a vital consideration for vendors in their efforts to prove vRAN's benefits (section 4.1). These monetisation goals go hand-in-hand with operators' objectives for 5G standalone (SA) adoption, and vendors should be proving how real-world deployments of both 5G SA and a virtualised RAN can create the optimum infrastructure to support new revenues. This also means providing the necessary ecosystem support and unified APIs that can help drive real innovation on the network.

- Although progress has already been witnessed towards solving open RAN and vRANs major challenges, and operators are confident that they will be overcome in the coming years, effort is still required from vendors to ensure that operator expectations are met. The challenges facing operators' deployment of open RAN and vRAN technologies have evolved, and that requires a renewed focus from vendors. If these challenges are more effectively addressed, vendors could still accelerate progress (section 3).

- System integration is ranked as the second most important of all challenges facing open RAN and vRAN according to operators (section 3.1). It is also an area where vendors could provide critical support. Vendors can support with system integration and its complexity by driving significant investment in their own integration resources and support services, or by creating pre-integrated solutions for multi-vendor deployments.

7. About the authors

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