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Open RAN Global Forum 2024

Key Findings

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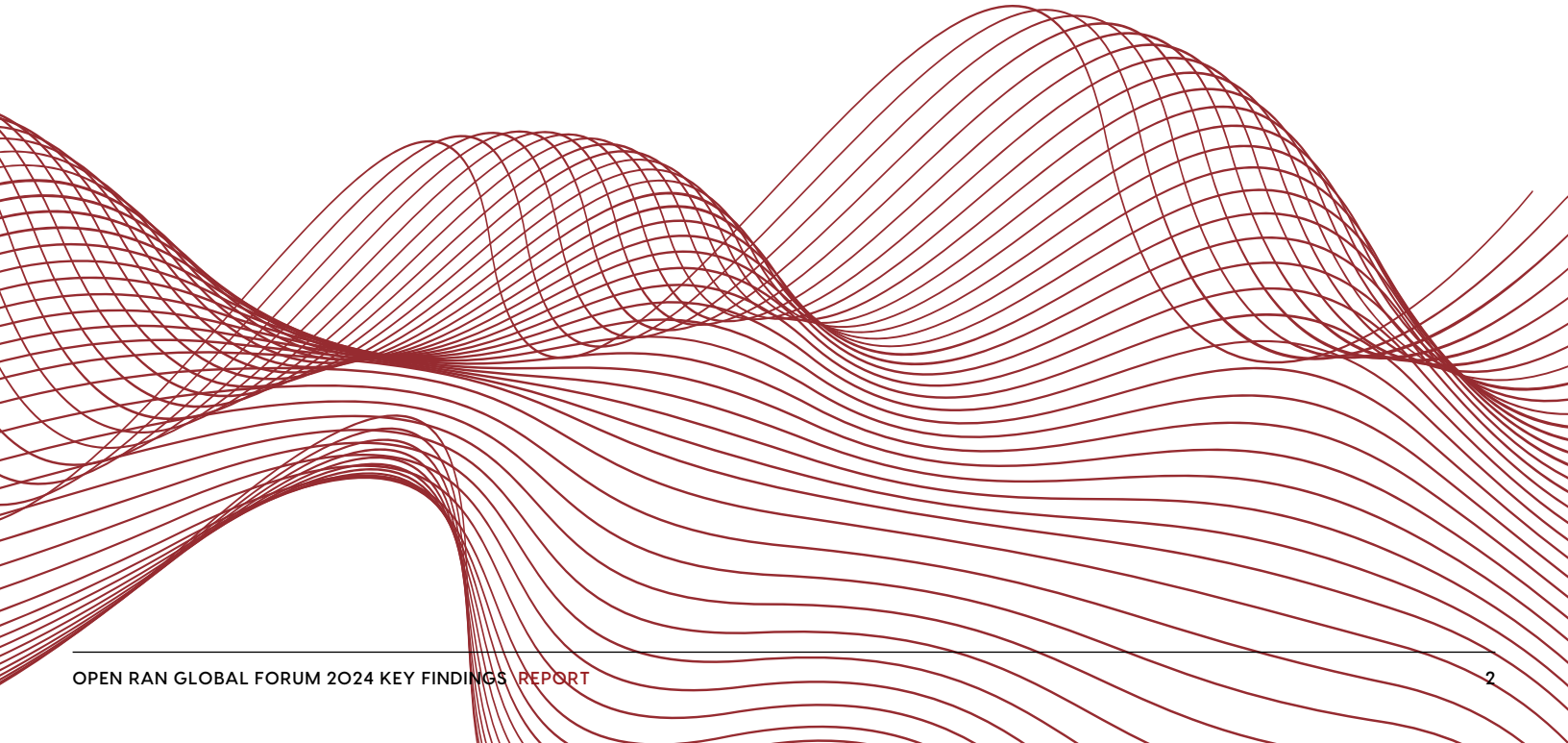
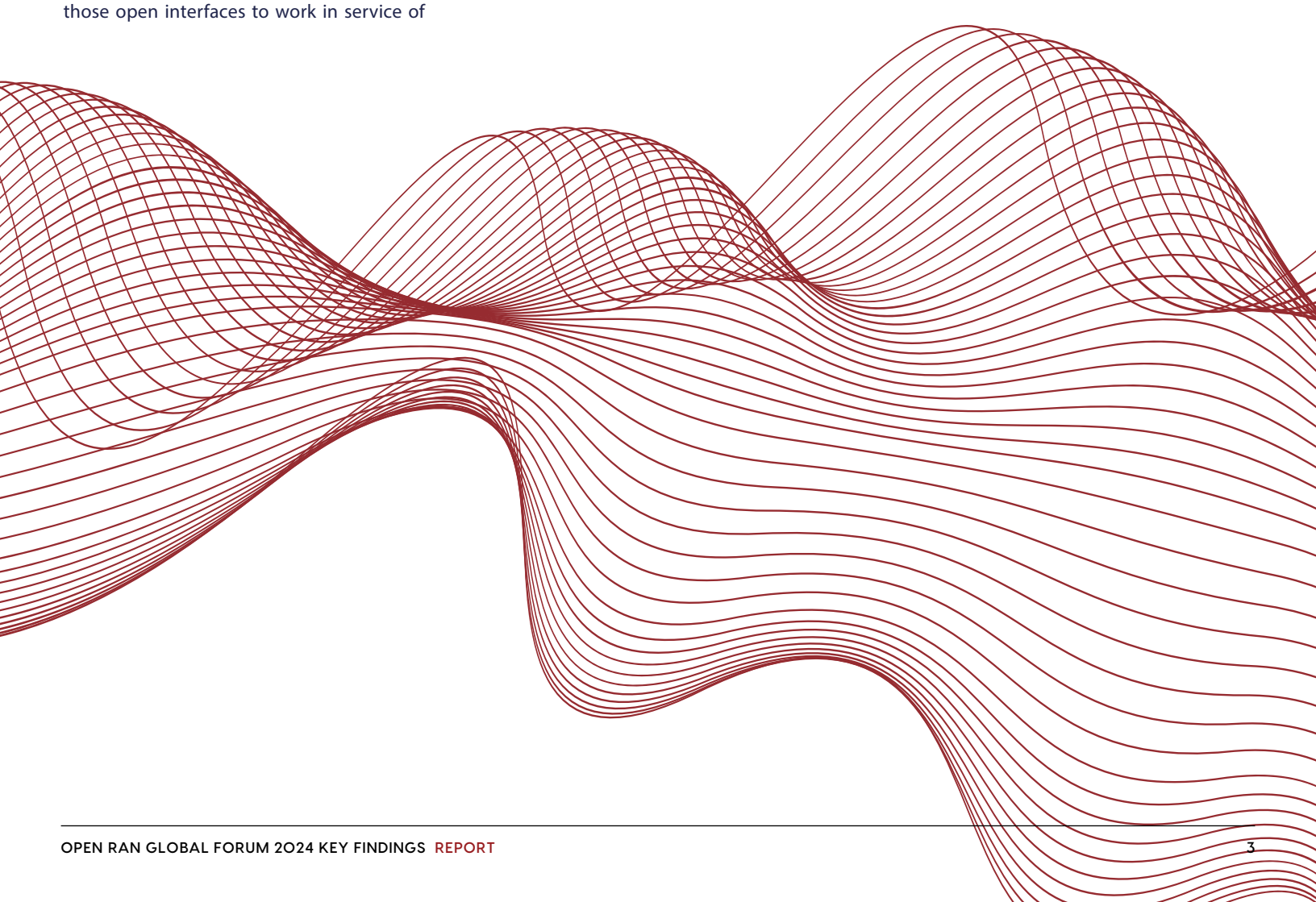


INTRODUCTION

For five years now *RCR Wireless News* has convened a range of industry experts for the Open RAN Global Forum with the goal of taking stock of where the industry is in the long move to disaggregate the radio access network (RAN), and evolve the RAN into a more dynamic, programmable platform for innovation. It's been a tough road; working through the standardization of open interfaces, testing that interoperability in the lab, proving performance in the field and developing replicable deployment strategies was a tall order. But based on global traction to date, along with long-term commitments from the biggest operators on earth, we're through the knothole. So now the attention turns from open interfaces to putting those open interfaces to work in service of tangible innovation both technological and from a business perspective.

While innovation can be conceptually nebulous, innovative technologies have some common traits—things like novelty, practical applicability, differentiation that can lead to disruption and strong economic implications. In the context of Open RAN, it's certainly new, we've seen these open architectures used to address a wide variety of deployment scenarios perhaps more effectively than integrated RAN, the ability to imbue intelligence throughout a distributed architecture sets the stage for service differentiation, and challenging the long-standing model of single-vendor RAN has important economic benefits.

So clearly, Open RAN has reached a stage of maturity; during the Telecom Infra Project's recent Fyuz event, we heard the current (new) phase of Open RAN described as Open RAN Advanced. This ties directly to the notion that the nuts-and-bolts work is deployment-ready, so now it's time to focus on innovation in its many forms. Everything from energy efficiency to quality on demand and platform-based business models and edge AI are on the table. It's time to reflect on the good work that has been done and keep the momentum going with a laser-focus on execution in service of delivering something new, something practical and something that changes the economic trajectory of the telecoms industry.



(Image courtesy of 123.RF)

DID (OR WILL) OPEN RAN DELIVER ON ITS ORIGINAL PRIORITIES?

Did Open RAN deliver on the technological and market-based promises it was meant to bring to life? Tough question. And what were those initial promises again? We went back through the O-RAN Alliance archives to a white paper published in October 2018. At that time, the group established to lead the way forward focused on a two-pronged vision—openness and intelligence.

The openness piece was about "building a more cost-effective, agile RAN;" open interfaces would "enable smaller vendors and operators to quickly introduce their own services…[and] customize the network to suit their own unique needs." This multi-vendor kit would enable "a more competitive and vibrant supplier ecosystem" capable of delivering "more democratic and permission-less innovation.

As for intelligence, the alliance identified automation as the way to "tame.. complexity;...networks must be self-driving, they should be able to leverage new learning-based technologies to automate operational network functions and reduce opex." The idea was to "embed intelligence in every layer of the RAN architecture."

Using those open interfaces, "AI-optimized closed-loop automation is achievable and will enable a new era for network operations."

So how'd all that go? We asked a panel of experts who, generally, viewed Open RAN as a work in progress marked by significant achievements but with the best yet to come. Also of note, disaggregating the RAN is part of larger network transformations involving everything from cloud-native core and fiber densification to SMO evolution and BSS/OSS modernization. And, of course, AI has a huge role to play across networking domains.

Over to Wind River's Randy Cox, vice president of product management. Reflecting on those wide-ranging initial promises, he distilled it to flexibility, innovation and total cost of ownership (TCO). "On flexibility, if you look at that, I think we're experiencing that in carriers who have actually decided to…deploy Open RAN." Armed with the ability to mix-and-match best-of-breed hardware and software gives "the carrier the power to decide the make up of their network." He continued: "In terms of innovation, I definitely believe it's created because you have different vendors contributing and bringing a wealth of creativity and technology together that starts to feed on each other." As for TCO, Cox acknowledged the "competitive aspect" of that, but added that "new technology, as it advances, that also brings in the element of reducing total cost of ownership."

Mavenir has been a driving force in Open RAN since before we called it Open RAN, and the company has pushed hard to achieve broad interoperability with other vendors. The company's Rick Mostaert, vice president of product management, said vendor interoperability has been "achieved times 10…The ecosystem is huge…We see not just open fronthaul being implemented but multiple cloud stacks, multiple Layer 1 protocols, multiple servers, etc…It's up and down the entire technology stack where we've done integrations with other vendors. And that's just great for everybody. It allows new people to come into the industry, which is desperately needed."

As for the market dynamics, Mostaert said that bit is "more complicated. Not everybody is bought in…There's still an element of vendor lock-in." That said, he described the issue as "not a technology issue. It's a will issue."

Long term, however, "Operators are just not going to accept the status quo… and that market dynamics piece of it will evolve…I see great things ahead but it's been probably a little bit slower than we would've liked."

There's a relatively new area of discourse within Open RAN around the idea of "single vendor Open RAN" wherein the vast majority of the radio system is provided by large incumbents with limited integrations of third-party radios. To pick that apart however, these same implementations, in addition to featuring third-party radios, also feature variety in servers and chipsets. That to say, you could make the case that single-vendor Open RAN isn't necessarily an accurate descriptor, but it is also not a full-blown multi-vendor implementation. So what does that suggest for the initial vision of multi-vendor?

Cox said, "There are stages and a progression in this journey." Moving to Open RAN is a big, long-term decision operators have to make, he said. And "once they make that decision, they have to actually execute and move forward in a way that is fast-paced but also achieving the goals that they want. There's a basic network level that you need to be able to achieve obviously." From there, Cox said, the focus is on time-to-value and delivering new innovations enabled by an open architecture. "I do believe that bringing in new technology will be a lot faster paced... You do have to get over the initial hurdle, but after that … the time-to-market in terms of bringing that new capability is definitely accelerated."

Single-vendor Open RAN isn't a phrase in his vocabulary, Mostaert said. "The ecosystem that is being built up around Open RAN is actually one of the most exciting things about it…It's just a force multiplier for everything.

"Now is everything perfect where some small company can just come in and just join and provide some product? Not yet. But the architecture is there, the platforms are there, the open architectures are there, and it's all been proven. Now it's just business."

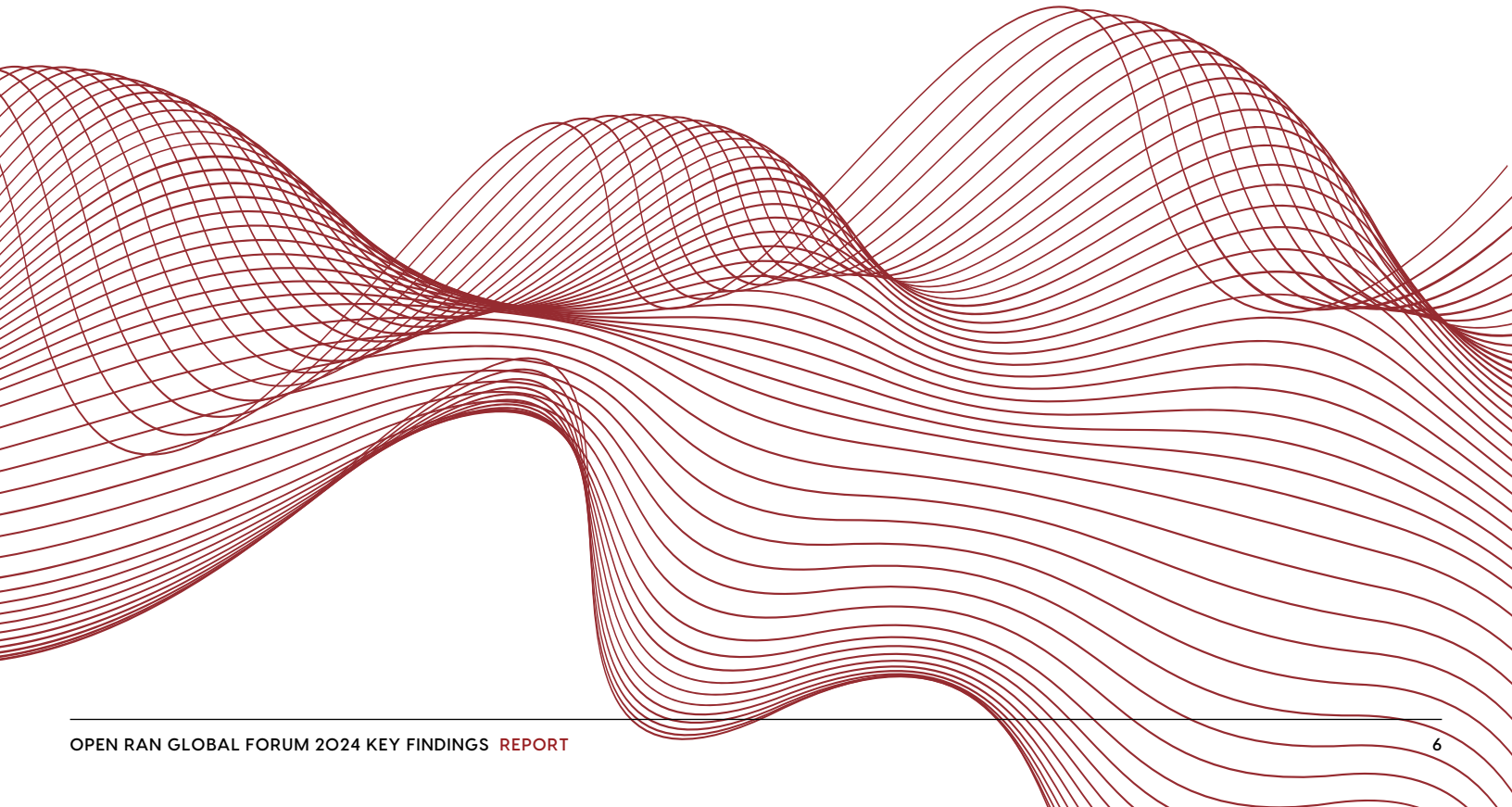
And beyond delivering benefits to operators, Mostaert said it's also "an absolute advantage for a company like Mavenir" who can choose their own preferred partners at different points in the technology stack. "We have ultimate choice…There're different ways to deploy, the ecosystem is growing, it's very powerful, and the amount of money, of capital, and engineering talent that is now in the wireless network infrastructure business through Open RAN is a great thing for everybody—consumers, operators, vendors. I just see it getting better and better."

From open interfaces to open-ended innovation

So what's next for Open RAN? There's certainly global investment and support, a strong standardization apparatus and capabilities that are consistent with the early vision for 6G.

"I think that as we look forward, I do think that, in the terms of 6G…that many of the topics we're discussing here in 5G will in some sense be table stakes for 6G," Cox said. "New technologies like cloud-native networks, automation, AI energy and efficiency, those are going to be absolutely required in 6G. He also pointed out that the deployment of new spectrum with 6G plays to the software-based flexibilities built into Open RAN, particularly around a unified infrastructure capable of supporting multiple generations of cellular. And, perhaps most importantly, Cox called out that successful technology transformations come in tandem with successful workforce transformations. Carriers are "going to be needing to plan and really build their resources to handle a new network like this. That requires upskilling their teams, broadening their capabilities and really retooling their workforce for new areas of advanced technology."

Mostaert divvied the outlook into three parts: interoperability, scale and innovation. As far as proving out open interfaces, "We're well pas that," he said. On scale, "We're seeing larger scale deployments…That'll continue through this year and into next year." On innovation, "Now that we have the basics of the technology, we have the vendors that can scale Open RAN, operators that know how to run it…we'll see the power of the ecosystem, of the innovation…We've come a long way in five years. The basics are there. Now it's time to innovate and see where we can take this."



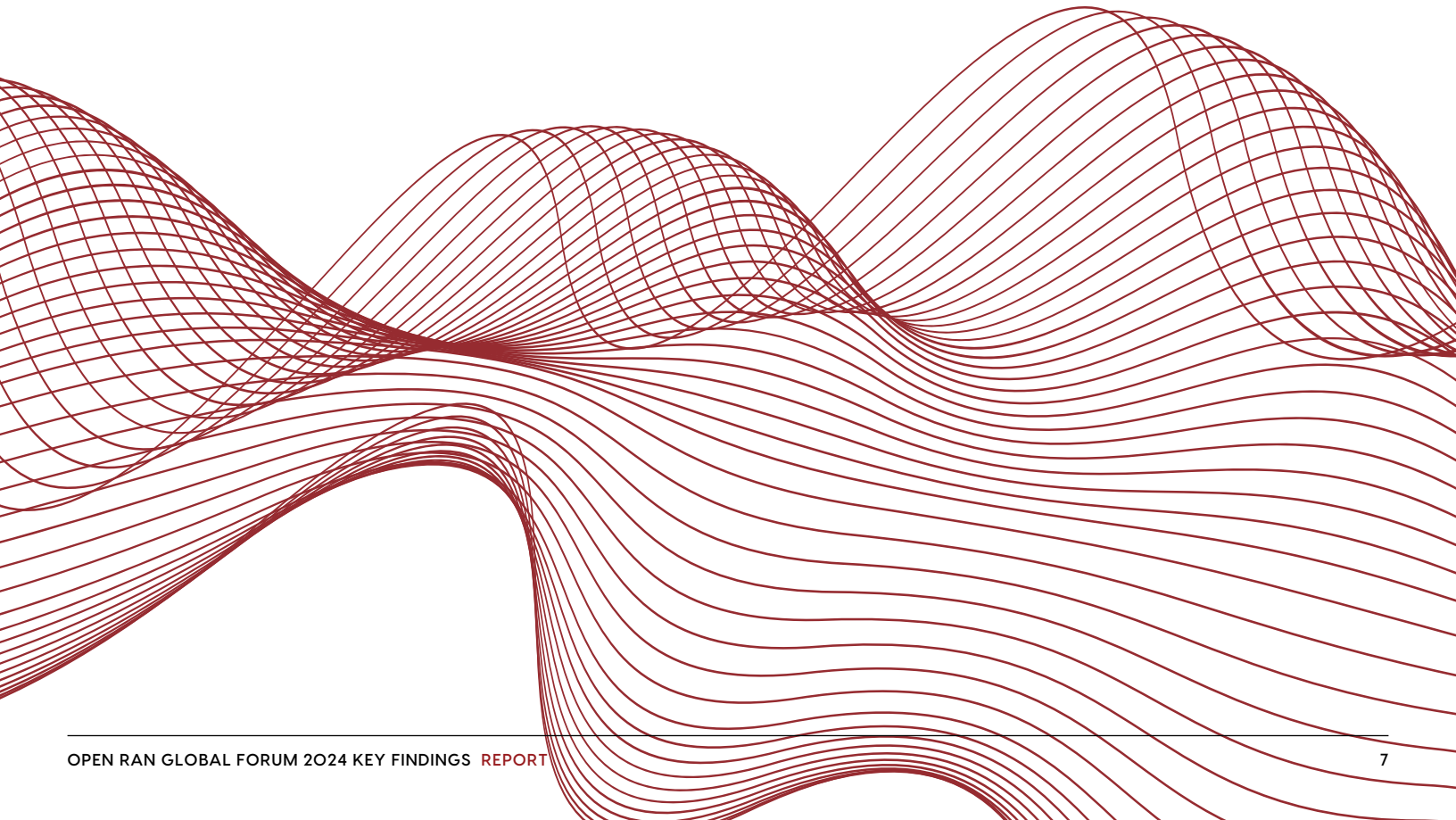
TELUS ON OPEN RAN INTEGRATION—IF WE CAN DO IT, YOU PROBABLY CAN TOO

A Huawei rip-and-replace mandate prompted Telus to pivot to Open RAN

Canadian operator Telus began working on virtualized Open RAN with Samsung in June 2020, and in February 2024 expanded that collaboration to include its 4G and 5G networks. Prompted by a governmental mandate to replace Huawei gear, Telus VP of Wireless Strategy and Services Bernard Bureau said, "We didn't want to just replace the equipment with the same architecture…We wanted to take this opportunity…to jump into a new architecture."

Bureau discussed Telus's approach to integrating its disaggregated radio systems, including massive MIMO radios, and emphasized that if Telus can do it, so can most operators. He noted that Telus has 10% to 15% of the market cap of Tier 1 carriers in the U.S., and has an excellent but small technical team.

Bureau described three primary parts of the integration process. Integrating the virtual baseband, the network operating system and container platform fell to Samsung. "We didn't see the value in inserting ourselves," he said. Integration of open radios with the virtual baseband was done jointly with Telus, Samsung and another unnamed open radio unit provider. "We were able to arbitrage and resolve issues we encountered very rapidly. Our two suppliers had a great attitude, and the focus was on getting the job done, not pointing fingers. He said that process took six weeks. The third part was integrating



various service management and orchestration (SMO) components with Telus taking the lead.

"The difficulty for integrating the SMO components together or integrating the Open RRAN with the virtual RAN, I think it's been blown out of proportion," Bureau said. "Some industry stakeholders are trying to make money out of it and it's OK. When they argue that it's too complex for an operator such as us to take this on, I completely disagree with them…It's not a walk in the park…[but,] I can certainly attest that this was within our means for an operator our size."

More on that: "I would really like to encourage all mobile network operators to push their suppliers to move faster into the O-RAN ecosystem…Don't accept the rhetoric from established suppliers that O-RAN is more expensive; it's not. That is doesn't perform as well; it does. And that you need bespoke hardware; you don't. If this is achievable for an operator the size of Telus, it's likely attainable by lots and lots of operators globally."

Beginning in the second half of 2023, Bureau said Telus began deploying Open RAN sites in the downtown area of an urban market, and were initially surprised with the performance quality and lack of issues. He said that was "confirmation that we needed…to leave traditional RAN behind." In addition to Samsung, Telus's Open RAN vendors include HPE, Intel and Wind River. Bureau said the Open RAN beta testing "exceeded performance parity against equipment we were removing."

"We're very satisfied with our O-RAN performance, and it's only going to get better as time goes," Bureau said.

BERNARD BUREAU
Vice President
Wireless Strategy and Services, Telus

"I would really like to encourage all mobile network operators to push their suppliers to move faster into the O-RAN ecosystem."

(Image courtesy of 123RF)

WHAT WILL IT TAKE TO INDUSTRIALIZE OPEN RAN?

Ericsson takes stock of Open RAN standardization, integration and scaled deployment

Before examining what it will take to industrialize Open RAN, let's look at what it means for a technology to be industrialized. At a high-level, it needs to be standardized, cost efficient, able to integrate with other technologies and into other systems, and it needs to be deployed at scale. Historical examples include the steam engine, the mechanized loom, Eli Whitney's concept of interchangeable parts, Henry Ford's assembly line production methodology, and the telegraph. That last one, the first form of electrical telecommunications, is what started Lars Magnus Ericsson's eponymous company which, 148 years later, is now considering industrialization of another telecommunications technology—Open RAN.

To understand where Open RAN is on its industrialization arc, *RCR Wireless News* talked with Ericsson's Head of Distributed Unit and Infrastructure Matteo Fiorani. To frame the conversation, we talked through with Fiorani the current state of, and outlook for, Open RAN standardization, cost efficiency, integration considerations, and deployment at global scale.

To the standardization point, Fiorani called out Ericsson's long association with the O-RAN Alliance, and the company's significant contributions. "For us, standardization is super important," he said. "It's the basis for everything we do." Looking at current focus areas within O-RAN Alliance, he noted work on the non-real time RAN Intelligent Controller (RIC) and R1 interface "which is a fundamental interface to be able to build a multi-vendor rApp ecosystem."

Fiorani also noted Ericsson's work on higher- and lower-layer split interfaces; specific to lower-layer split the development of Uplink Performance Improvement (ULPI) specification for open fronthaul connecting massive MIMO radio. Other focus areas he mentioned were the O2 specification for cloud infrastructure management and, broadly, Open RAN security. "It's not possible to deploy Open RAN at scale without having proper security solution[s] and proper security controls."

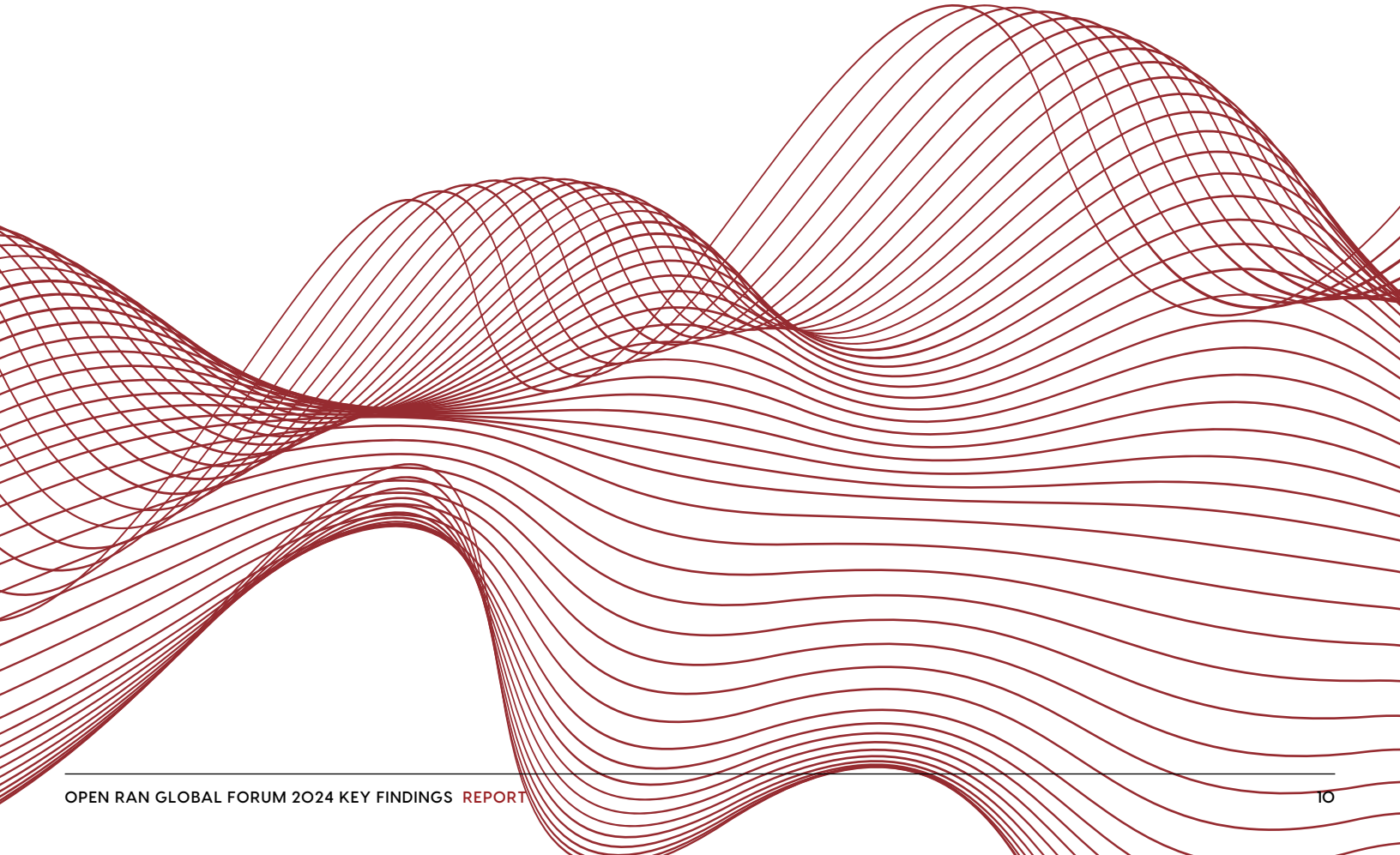
As to cost-effectiveness, it's important to remember that one of the original Open RAN thesis statements was radio system disaggregation prompting a rise of specialists, which would increase competition amongst RAN vendors, let operators benefit from the improved economics that flow from heightened competition, and otherwise spur innovation. Worth noting that Ericsson, which is consistently in the top three by revenue globally of RAN vendors—so very much an incumbent—also has the world's biggest Open RAN deal with AT&T; that five-year deal is worth around $14 billion.

"We have absolutely not given up on the idea of creating a multi-vendor ecosystem," Fiorani said. "We think that Open RAN and multi-vendor are going hand-in-hand… There will be a multi-vendor ecosystem enabled by Open RAN." He said the rise of specialists, and scaled deployment of multi-vendor systems "is maybe not exactly what was expected maybe two or three years ago" in terms of modular, plug-and-play, any-to-any solutions. This idea segues directly into the next characteristic of industrialized technology—the ability to integrate with other technologies and slot into larger existing systems.

Back to this vision for any-to-any, plug-and-play RAN, Fiorani said, "It's not that simple to connect different vendors' products… There is always a system integration/ lifecycle management aspect that creates a certain level of complexity." In practice, this usually means either the operator will take on the system integrator role or give that responsibility to a primary vendor. He said that's a "pragmatic" approach, and also called out that different vendors follow different software update cadences, meaning that interoperability has to be re-established and the release schedules need to be coordinated.

Circling back to the outlook for multi-vendor, Fiorani said the nascent xApp/rApp ecosystem is a great way for specialists to bring their unique capabilities into an Open RAN system by way of the service management and orchestration (SMO) platform. Another way into multi-vendor Open RAN is radio specialization. AT&T, for instance, has integrated Ericsson's baseband with Fujitsu radios, and at the Open RAN Global Forum indicated that it had selected a small cell vendor that would soon enter its network. "So lots of opportunities even if the first entry point from the operator perspective is a primary vendor. And this may smooth out over time as integration becomes simpler."

With the AT&T deal, and with a coming wave of Open RAN replacements across the European Union, is Open RAN approaching global scale and industrialization? "Yes," Fiorani said. "I think that the Open RAN revolution will happen."



(Image courtesy of 123RF)

HOW TO SCALE OPEN RAN—TCO AND LIFECYCLE MANAGEMENT ARE CONCERNS

Open RAN technology is proven and operators are committed, but the lingering questions around integration costs and lifecycle management in a multi-vendor network remain

A panel comprising a leading Open RAN vendor, a leading Open RAN test firm, and a major global operator dissected the next phase of disaggregated radio systems. The headline is that Open RAN is technologically feasible and global interest is obvious; but, looking beyond simply building and commissioning an Open RAN network, longer-term considerations focused on TCO and how to effectively manage a multi-vendor system over the entire lifecycle of the technologies need to be sorted for this new architecture to rapidly scale.

Wind River's Prakash Desai, senior director of product management for intelligent cloud, highlighted ongoing global commitments and deployments of Open RAN by Tier 1 CSPs, concluding that, "Open RAN as a technology is proven beyond doubt." That said, "The journey has just begun." He called out interoperability and TCO as areas "that need some work…I think to sum it up a lot of momentum, a lot of ecosystem expansion, the timing is right, the technology is proven. I think we should see some commercialization take up in the next couple years."

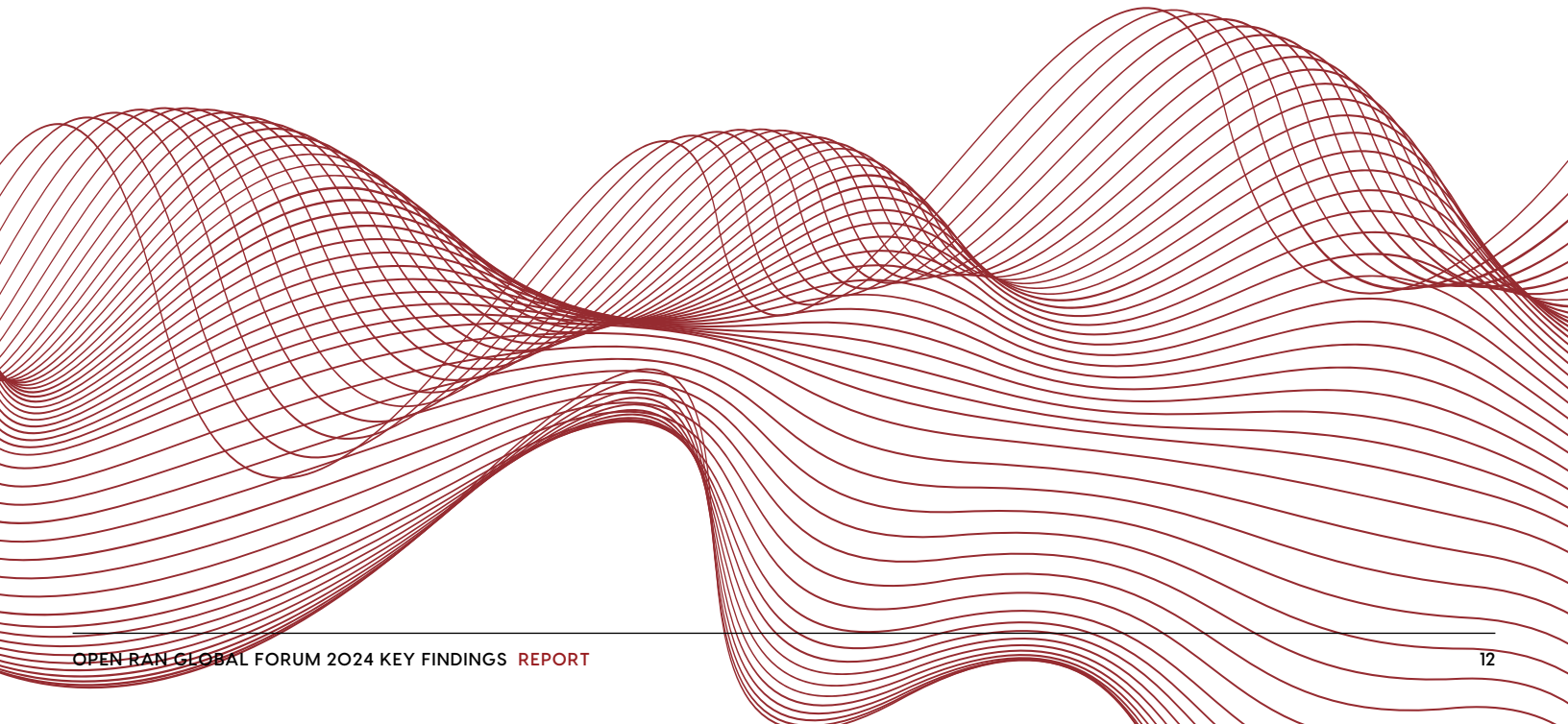
Wind River's Prakash Desai, senior director of product management for intelligent cloud, highlighted ongoing global commitments and deployments of Open RAN by Tier 1 CSPs, concluding that, "Open RAN as a technology is proven beyond doubt." That said, "The journey has just begun." He called out interoperability and TCO as areas "that need some work…I think to sum it up a lot of momentum, a lot of ecosystem expansion, the timing is right, the technology is proven. I think we should see some commercialization take up in the next couple years."

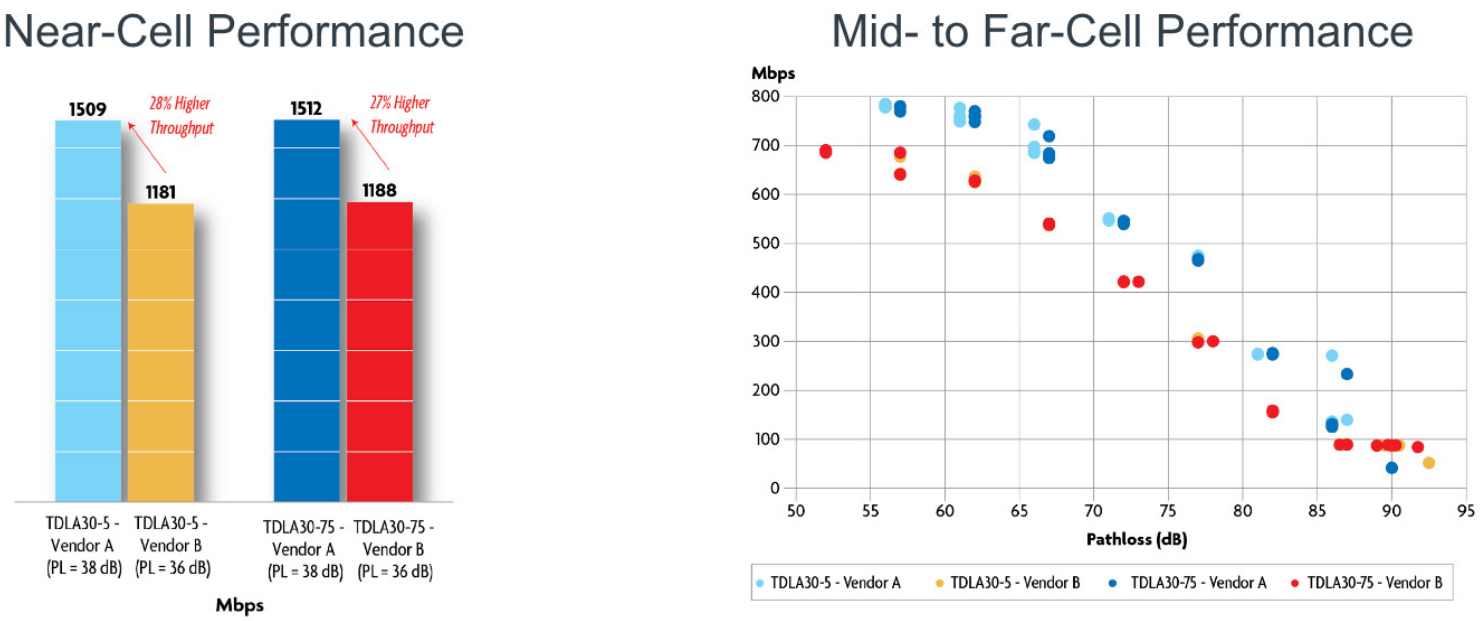
From the test perspective, Spirent Vice President Anil Kollipara said the industry has done a "great job" getting Open RAN into the "early market phase." The technology, he said, is valuable and feasible, and supported by a robust and growing ecosystem of vendors. "If you look at where we are now, we are facing the mainstream, the industrialization aspect of it. The biggest challenge we have is the chasm in front of us. What worked for us until now is not going to work for us going forward." Now, he said, it's about aligning metrics with the real-world needs of operators, namely performance parity versus integrated RAN and TCO. "Those are the things we're going to focus on. Industrialization is the most important aspect to achieve those types of metrics."

Saurabh Mittal, vice president of networks for Bharti Airtel, gave the operator perspective. He outlined challenges associated with evaluating technologies from a bigger, and still growing, pool of vendors, delegating out system integration responsibilities (in-house or prime vendor), and scalability. For context, he said when Airtel was in the midst of deploying 5G, they were lighting up 1,000 sites per day. And, of course, Mittal said this all needs to align with Airtel's, and most other operators', primary objectives of "brilliant" customer experience and optimal cost efficiency. "The Open RAN technology has to enable deliveries on the north stars."

Kollipara described a give-and-take in terms of the opportunities presented by Open RAN of mixing and matching hardware and software, and the cost associated with the requisite integration. "The premise of Open RAN has been to avoid vendor lock-in. That was one of the founding principles…So having all these different suppliers, this is great, this is addressing that very specific aspect of it. But it does introduce a lot of challenges." Putting a figure to it, he said Open RAN, as compared to traditional RAN, increases complexity "100x or more…The only way you can address that is through a complete lifecycle management, through a complete automation approach, where all the changes…that are coming in from any part of the ecosystem go through a complete testing cycle…Having the lifecycle management approach as the only approach to manage this operational complexity is a must, and that's where you'll see the ROI and TCO get kind of controlled and addressed."

Bottomline, does Open RAN bring TCO savings over its lifecycle? "That's the million, or more, dollar question," Desai said. Given that the price/performance comparison is against established, hardened integrated RAN, the bar is set quite high, he said. Standardization is key, and not just for open radio interfaces but also for SMO frameworks meaning, "We need full-stack, integrated blueprints from infra to cloud to applications." And, "I think automation is the key." Recalling Mittal's example of commissioning 1,000 sites per day, "There is no way we can have that done manually. Automation is the key."





(Image courtesy of Spirent/SRG)

KEY TAKEAWAYS FROM SRG'S OPEN DU/RU TESTING

Testing the various components of Open RAN networks—the open control unit, distributed unit and radio unit, or O-CU, O-DU and O-RU—has been the focus of multiple plugfests and other extensive testing as operators, vendors and test companies work out the intricacies of interoperability, specification conformance and various features in multi-vendor O-RAN environments.

Signals Research Group recently took open RUs and DUs to the lab and tested their performance under different, simulated radio conditions, using test tools from Spirent Communications.

"The scope of this study was particularly unique in the context of Open RAN testing, which has historically focused on compliance or in some cases energy efficiency," SRG said in an accompanying report based on the testing. "It is all fine and good to have multi-vendor tests to demonstrate different radio components can 'talk' with each other and even establish a voice/data call. However, that capability is table stakes in today's environment. Mobile operators want networks that not only work but which work well by delivering good user data speeds with realistic/ challenging conditions and which can scale by supporting a large amount of data traffic in the most efficient means possible."

"To get to the next phase [of Open RAN], we need to focus on a new set of metrics, to really prove that the technology is ready for scale, and wide-scale adoption," said Spirent's Anil Kollipara, VP of product management for test and automation, during a session at Open RAN Global Forum discussing the DU test results with SRG President Michael Thelander.

What did SRG test?

The company tested two Open RAN distributed units (O-DUs) and accompanying control units (CUs) at a Spirent facility in Texas, and three Open RAN RU reference platforms at Spirent's facilities in New Jersey.

What type of tests were conducted?

The tests included emulation of multiple UEs interacting with the DUs and RUs via uplink and downlink testing under ideal/static radio conditions, as well as uplink receive sensitivity tests and a "multitude" of fading channel scenarios (using scenarios specified by 3GPP) in the uplink and downlink, including simulation of movement from walking to driving at highway speeds.. "We want to really understand how these different vendor implementations perform under these real-world conditions," said Kollipara.

What were the results?

Under favorable RF conditions, SRG said, "there weren't any meaningful differences in performance." That changed, however, with more challenging radio conditions.

SRG's results indicate some pretty stark performance differences between different vendor implementations of Open RAN RUs and DUs (and companion CUs). But the performance differences were not as simple as, one vendor performed better than another—it was more a situation of, the vendors performed better than one another under specific network conditions.

For example: While the specific vendors weren't named, SRG found there was a 27-28% difference in "goodput" performance (or the measured throughput adjusted for the associated bit error rate) between the two DU platforms—but each one performed better under different conditions. In near-cell conditions with little path loss, the "Platform A" performed 28% better than Platform B; at the cell edge, "Platform B" performed 27% better than Platform A, including being able to better maintain coverage/connections with the UEs, despite more path loss, according to Thelander. That suggests the platform from the first vendor is more optimized for enhanced mobile broadband use, Thelander said, while the second platform is arguably more optimized for an IoT-type deployment. Those would be important considerations for any operator weighing its Open RAN options.

SRG found that in the RU testing, meanwhile, the differences in the receive sensitivity among the three RUs ranged from high single-digits to low double-digits of dB, while differences in "goodput" ranged from the mid-to-high double digits, or even triple digits, across the various fading scenarios. That has direct implications for deployment. "This difference in sensitivity could translate to double the cell radius or four times the cell size," SRG pointed out, adding that the outcome also "indicates there are RUs on the market today that are Open RAN compliant butby no means worthy of deploying in a commercial network, even if they are given away."

What were the implications?

SRG noted in its report that sizable performances differences are to be expected across the Open RAN ecosystem, which was meant to put new network equipment and software vendors in play—so it shouldn't be a surprise that testing can reveal differences among such vendors, or differences between new players and established NEMs who have also embraced Open RAN.

As SRG pointed out, the performance and coverage metrics that an Open RAN platform can achieve, determine the cell size that an operator can reliably plan for, and heavily influence the customer experience. And if available Open RAN platforms can deliver performance only under optimal conditions or in the lab, but falter in real-world performance testing, that's an existential problem for Open RAN.

"At the end of the day, what really matters is, can you deploy a solution that delivers on its promises?" Thelander said in the Open RAN Global Forum session. What SRG testing illuminated, then, was the "stark differences" in the capabilities of Open RAN RUs and DUs delivery under the same network scenarios.

AT&T SEES OPEN RAN ENABLING 'CONTINUOUS INNOVATION'

AI, cloud and Open RAN are decoupling network enhancements from a cycle of virtuous Gs

AT&T is in the early days of a massive radio access network (RAN) modernization program. The operator is investing $14 billion over a five-year deal with primary vendor Ericsson toward the goal of having 70% of network traffic running across open platforms by 2026. According to AT&T Vice President of RAN Technology Robert Soni, the big goal is to maintain focus on "continuous innovation and continuous delivery of new technology as opposed to putting us into a cycle of virtuous Gs.".

Soni, recently selected to serve as board chairman for the Telecom Infra Project, explained that industry trends around artificial intelligence (AI), cloud-native networking and Open RAN all "decouple" innovation from the roughly 10-year G cycle. "The ability to consume these new technologies, I think, is largely predicated on the ability to move to open and programmable networks…That will allow us, in the future, to potentially bring other players in."

With Ericsson's Cloud RAN portfolio, Soni said AT&T is taking a "crawl, walk, run" approach given the underlying shift in baseband architecture. Cloud RAN, he said, "allows us to run…the workloads for RAN in a distributed fashion with some functions centralized on a cloud-based platform." Citing O-RAN Alliance standardization work, Soni called out the O1 interface "used for management and control as well as observability of the network on the workload side," and the O2 interface that connects the service management and orchestration (SMO) platform to the open cloud platform. He also noted work around the R1 interface that connects third-party applications to the SMO.

Additionally on Cloud RAN, Soni said AT&T has conducted a trial in Red Oak, Texas, involving a three-site radio cluster. This was an opportunity to see "what actually are the challenges that we might face." The next step, he said, will be larger-scale trials in Atlanta and Memphis to better understand "what does it take for us to scale Cloud RAN." He expects a deployment inflection point in 2026.

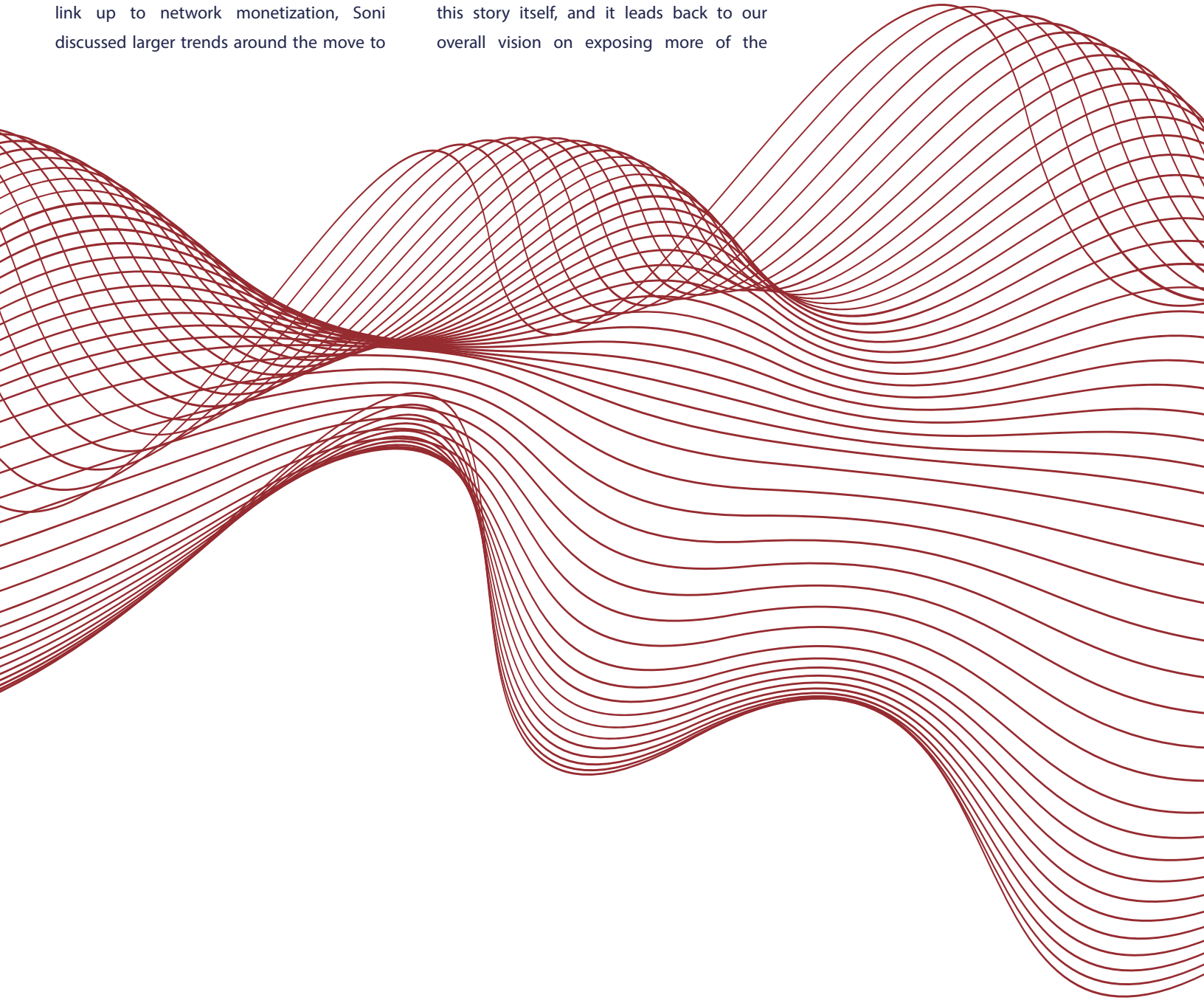
ROBERT SONI
Vice President of RAN Technology
AT&T

"We anticipate a lot more differentiated services being able to be offered to consumers."

AT&T is currently using Ericsson basebands and radios as well as radios from Fujitsu. Soni said the operator has completed a request for proposals and made an award for an additional third-party radio provider that he didn't disclose. He said the focus in on small cell densification. "That is coming and we're pretty excited about them entering our network as a radio provider. We're not done there."

Looking at how the move to Open RAN will translate to customer experience, and link up to network monetization, Soni discussed larger trends around the move to 5G Standalone (SA) and cultivation of open APIs that expose network data to third-party application developers. With regard to 5G SA, he said, "We anticipate a lot more differentiated services being able to be offered to consumers. Of course, we have to make sure it's available to every application. But the opportunities exist for us to provide that not just to mass market, to consumer, but also to enterprises to have differentiated services on-demand when they need them."

He continued: "That's a huge part of this story itself, and it leads back to our overall vision on exposing more of the network and providing network APIs and visibility in the network. Those kinds of things will ultimately translate into direct user experience impacts." He added that enhancements around RAN energy efficiency—AT&T spends about $1 billion per year on power for its RAN—to create a cycle where opex reduction is converted to capital investment, letting the company build more infrastructure that, in turn, will further benefit AT&T customers.



(Image courtesy of 123RF)

OPEN RAN FRONTHAUL TESTING CONSIDERATIONS—AUTOMATION IS KEY

End-to-end fronthaul testing, as well as isolation testing, provide the big picture and granular data needed to drive Open RAN adoption

Given one of the primary goals of Open RAN—providing architectural flexibility by breaking up the centralized unit (CU), distributed unit (DU) and radio unit (RU), and opening up theinterfaces used to connect the different parts of the radio system—it's not surprising that fronthaul interfaces have been a focal point since the beginning. And in the 5G era when massive MIMO radios became key to optimizing capacity/coverage in mid-band spectrum, fronthaul became even more vital given the integration of radio, antenna and some of the intelligence usually associated with the baseband into one unit.

The work has come along, driven by the O-RAN Alliance, albeit with some compromises along the way that are arguably contrary to the idea of Open RAN as a vector for decreasing RAN capex. Needless to say, RAN vendors have generally aligned around the 7.2 fronthaul specifications for simpler radios, up to eight transmitters and receivers, called Cat A; then Cat B which is geared toward massive MIMO radios. Within Cat B there are two sub-options: operation mode A puts uplink functions like the equalizer in the RU, whereas operation mode B keeps the equalizer in the DU.

Okay. So the specifications are there, there are plenty of real world examples of these radios working in commercial networks, and the long-term outlook for Open RAN is positive. But fronthaul testing is still tricky work because, in part, the optionality within the specifications then maps to complexity in testing multi-vendor Open RAN. Experts from test specialists Litepoint and VIAVI talked through key fronthaul testing considerations, particularly as it relates to massive MIMO.

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Looking at Open RAN from a macro perspective, Litepoint Director of Marketing Adam Smith said big issues around cost, integration complexity and power consumption are continuously improving but, "We're basically deploying a new technology, new capability, new architecture, in a very mature market at this point…If we look at where we are on the capabilities of products that support Open RAN architecture, we're still a bit on the steep part of the curve."

With regard to the longer-term push from single-vendor Open RAN to true multi-vendor Open RAN, he said our present state (single-vendor) isn't surprising. "It makes a lot of sense," from the operator's perspective. But, "The risk in that, of course, is that we don't head towards a single-vendor O-RAN; you might just call that RAN 2.0…I think for the ecosystem, we need to get to a multi-vendor ecosystem to get to what the goal was for O-RAN…I do think we'll get there. We're just going to be on different timelines."

The Litepoint point of view, Smith said, is about focusing on real-world RU performance in a way that balances end-to-end system testing, and isolated component-level testing. He acknowledged that the end-to-end look helps you "see the network as the user sees it. But what do you do when you see problems?...One thing we're focused on is actually performing isolated testing."

This involves a test process and solution that emulates the DU side of the fronthaul link, including vector signal generators and analyzers, the additional elements that come with MIMO radios, and the software that glues the system together. "It's a relatively complex setup," Smith said, "but I think most importantly there's a huge domain expertise problem in this picture." He sees a disconnect between the 3GPP specifications on the air interface side and the lack of uniformity on the fronthaul side. Smith said RUs are the "perfect case" of needing combined RF and Ethernet domain expertise which is solved through automation and simplification.

From a solution perspective, Litepoint has integrated fronthaul uplink and downlink communication and synchronization, MIMO signal generation and analysis, and C/U/S/M-plane fronthaul conformance, all wrapped up with automation. By taming complexity with simplification, Smith said the resulting test setup is reliable, repeatable and provides granular control of multiple variables.

VIAVI's Ammar Khalid called fronthaul an absolutely "critical element…of the O-RAN infrastructure." However, "The development work has taken a lot of shortcuts or workarounds" that put it outside of compliance with O-RAN specifications and lead to vendors influencing commercial reality by getting well ahead of the specification work. In sum, he said, this leads to a good deal of inconsistency that has to be accounted for in the test process.

"Because of that development variability and compliance gaps," Khalid said, "it leads to the third challenge, which is the interoperability parts, which means that once this solution in the fronthaul from the oRU perspective and oDU, which is a multi-vendor environment, is being put into a test." These variations and gaps "lead to a significantly higher risk of failures." In terms of a path forward, Khalid laid out the following:

- Functional testing and extensive feature validation and test scenarios beyond conformance standards.
- Conformance and certification with rigorous testing for O-RAN WG4 and 3GPP compliance.
- Performance testing, including dynamic load testing with advanced SU-MIMO, MU-MIMO, and 256 QAM configurations.
- E2E testing with validation of multi-vendor fronthaul integration with seamless end-to-end testing.

To do all of that, Khalid said it has to be a function of automation. "We need to ensure that there is less manual intervention and the testing is as credible as possible." The crux to this solution would be starting from a very streamlined CI/CD workflow. Beyond that, he called for automated test suites that are single click to minimize human error, and zero-touch automation for API-driven test scheduling, deployment, configuration, execution and reporting. Further, comprehensive reporting and software management provide consistent, automated verification, reporting and database management. And, from the end-to-end perspective, a single interface for managing the complete setup with dashboards providing real-time insights adds efficiency, as does decoupling scripts to ensure test portability across different system testing configurations.

VODAFONE ON OPEN RAN– 'I DON'T THINK WE'LL EVER GO BACK'

Beyond cost reduction, Vodafone sees Open RAN as a vector for innovation; cites work with Cohere Technologies

After six years of collaborative work, Vodafone has moved from a proto-Open RAN demo run on a laptop in the company's stand at Mobile World Congress in Barcelona to large scale deployment of disaggregated RAN systems throughout its footprint. And there's more coming as its radio tender progresses; that RAN modernization program covers 170,000 radio sites in Europe and Africa comes with a goal of replacing 30% with Open RAN.

Paco Martin, head of Open RAN at Vodafone, discussed lessons learned and what's next for the multinational operator in a conversation with *RCR Wireless News*.

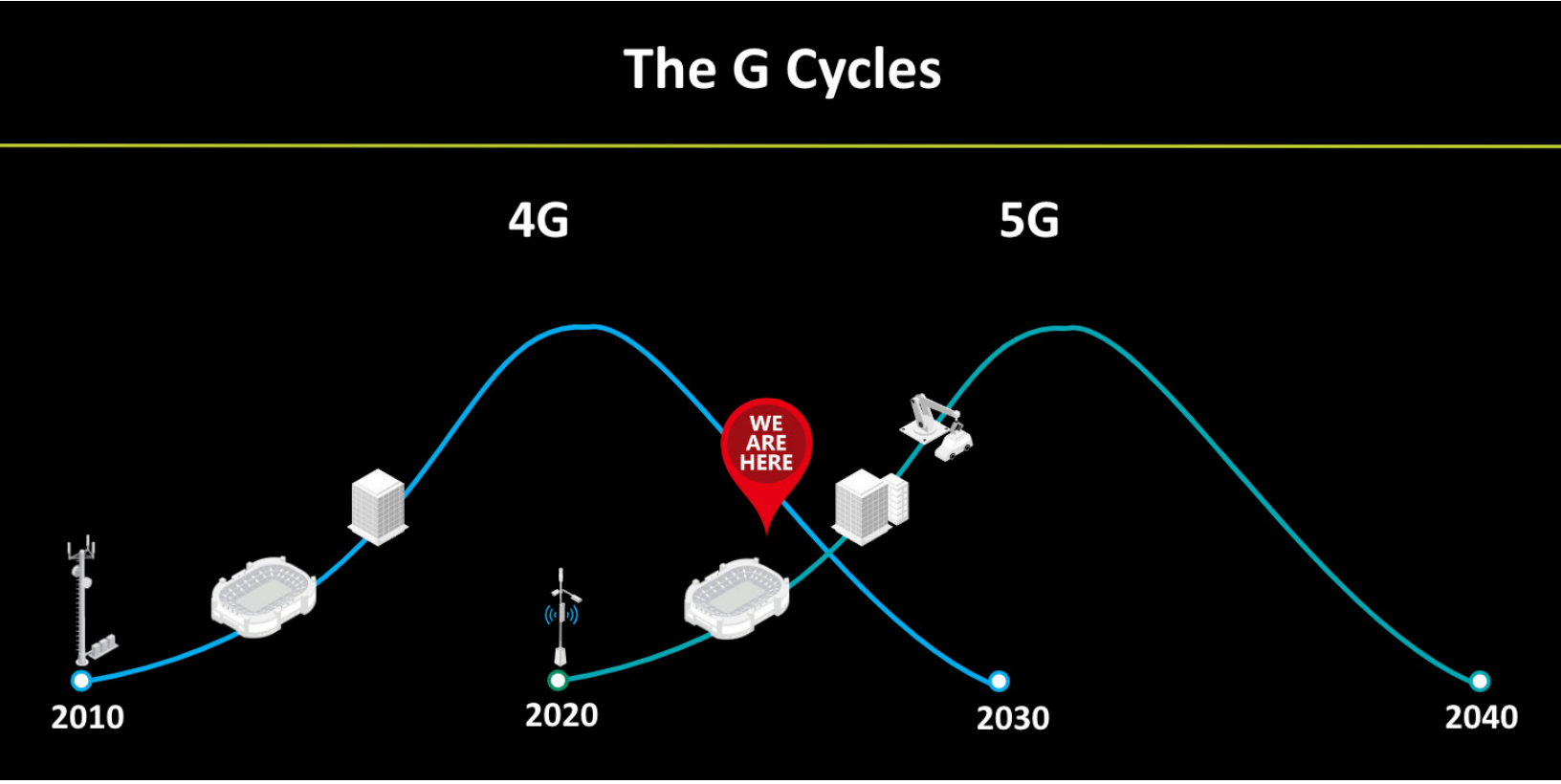
At a high-level, Martin said, "I think now we are able to…define the destiny of our radio…because we really know the details. That has changed forever. We really know what we buy end-to-end. We are in control. We can drive things to suit our needs. That's been a key improvement for us as a company. I don't think we'll ever go back."

He sees this change for Vodafone reflected in the wider telecoms industry given the ecosystem-led approach to Open RAN that at least has been predominant. "I think there has been a clear change in the industry," Martin said, noting that smaller specialists, the largest incumbent vendors and even hyperscalers have gotten involved. "Going forward, we need more of this, more deployments so suppliers get money for R&D and things continue to flow. And we also need to see some innovations being successful. Open RAN is not just about delivering something cheaper. It's also about enabling a significant step change in the industry in terms of innovation."

To the innovation point, Martin called out Vodafone's work with Cohere Technologies which has built Universal Spectrum Multiplier (USM) software. Vodafone in February tested Cohere's USM product on a multi-vendor Open RAN network near Madrid; "engineers from both companies registered improvements iperformance using unmodified devices working on existing network antennas and hardware," according to a press note from Vodafone. "When we get step changes like that is when you prove that Open RAN was the right thing to do," Martin said.

PACO MARTIN
Head of Open RAN,
Vodafone Group

"I think now we are able to…define the destiny of our radio…because we really know the details. That has changed forever."



(Image courtesy of CommScope)

FOUR DRIVERS OF OPEN RAN FOR IN-BUILDING CELLULAR

CommScope sees market opportunity, TCO, ecosystem support and convergence all making the case for in-building Open RAN

Reflecting on the typical 10-year cellular G cycle, as well as the roughly 20-year lifecycle of a G, CommScope's Luigi Tarlazzi, vice president of engineering, pointed out that attention is historically turned to in-building investment at roughly the mid-point of the decade. So 4G was launched in 2010 and in-building investment ramped around 2015. If you count the start of 5G as around 2020, that means the in-building step is upon us.

"This is happening now," he said. "We've started to see a huge uptick in 5G deployments for large public venues," including stadiums, airports and the like. But what does that mean for Open RAN which has similarly increased in interest along with the build out of 5G?

Tarlazzi said investment in Open RAN "will continue, and we'll see more and more wide adoption of this new way of building cellular networks." That includes, he said, multi-carrier in-building cellular systems and private cellular networks. He pointed out challenges carriers are navigating around implementing Open RAN in brownfield networks; "in-building cellular, actually…is a little bit kind of lower-hanging fruit in terms of risk that an [mobile network operator] would take to deploy a new technology in this environment." Essentially, in-building cellular networks and private networks are inherently greenfield and isolated from the macro network.

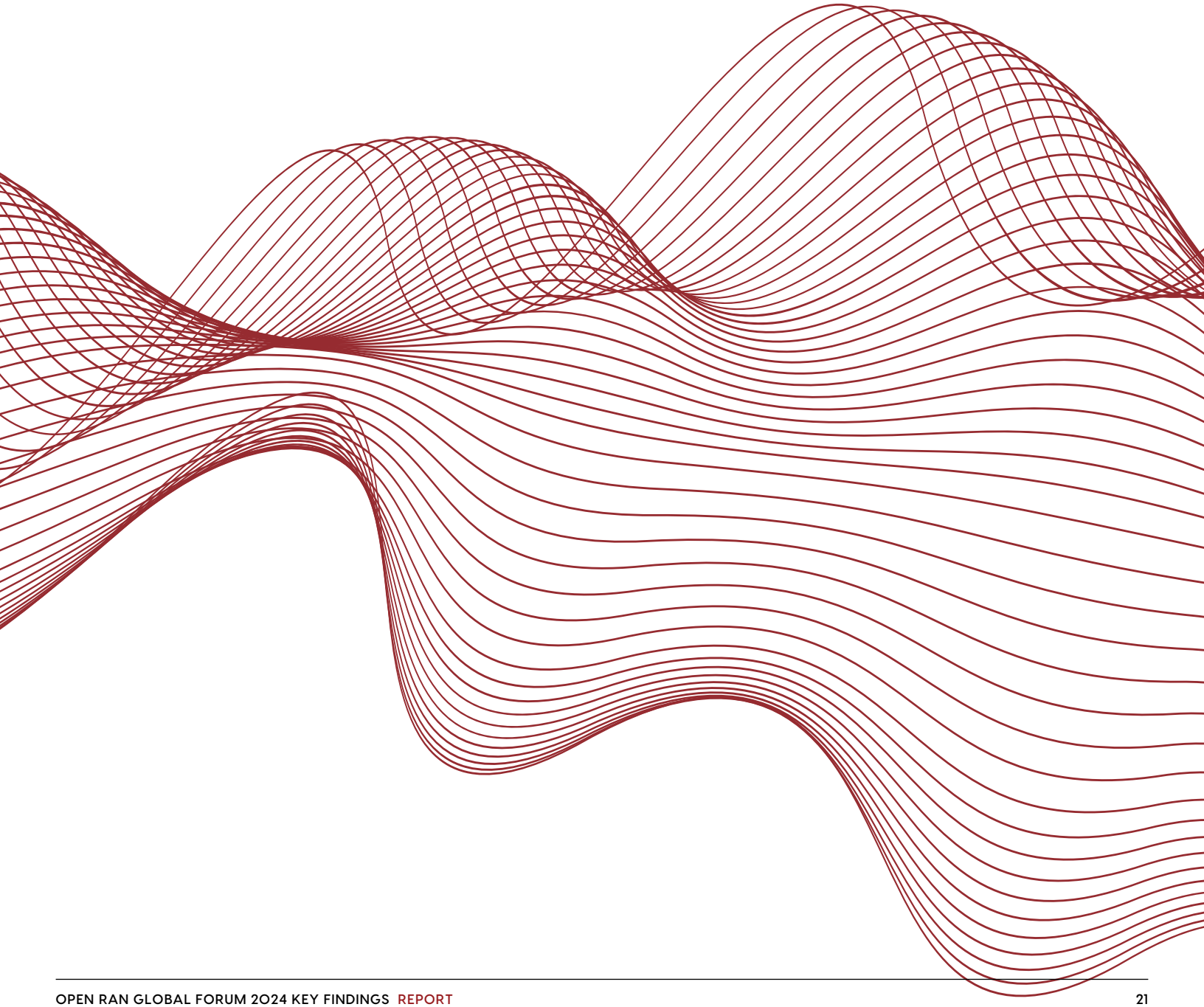
"When there is no coverage, you bring new coverage," he said. "It's basically a greenfield scenario…Indoor is probably, from a timeline standpoint, where we see—potentially see—the fastest adoption." In

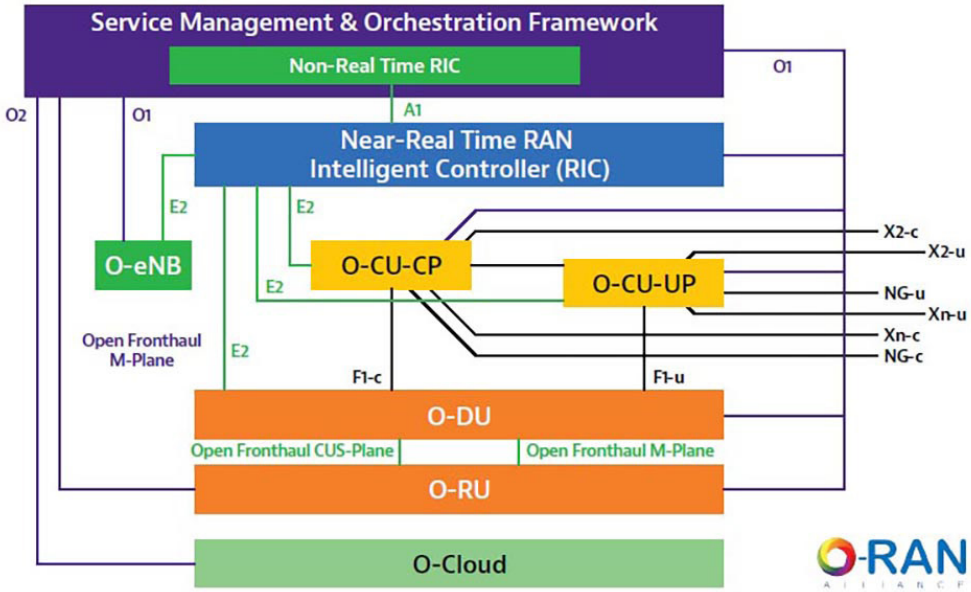
In addition to the macro opportunity, Tarlazzi highlighted TCO benefits given reduction in on-prem footprint and reduced energy consumption as compared to a traditional distributed antenna system (DAS).

And from an enterprise perspective, Tarlazzi said Open RAN is more user-friendly because it's more IT-like than integrated cellular. "There is an opportunity, we believe, to allow the enterprise maybe to actually source some of the hardware that is needed, then bring in the carriers, their software and RAN workloads, to actually operate the network."

To the ecosystem point, he said there's an established pool of in-building specialists, including system integrators, neutral host providers and managed service providers. "There is already a proven ecosystem supporting what can come from the carriers…and then can be integrated into what is deployed on prem…The indoor ecosystem is ready…to take ownership of these solutions."

Tarlazzi then talked about convergence—convergence of public and private cellular on a shared infrastructure, convergence of licensed and unlicensed spectrum, and convergence of multiple software elements for different use cases on a unified hardware platform. "We believe that even more looking forward, looking at how quickly the network and the technologies are evolving…there is the need to have a network in a venue or an enterprise that can actually scale up and be upgraded seamlessly via software."





RIC REALITY CHECK—WHAT'S WORKING, WHAT NEEDS MORE WORK?

The RIC can support quick wins but further standardization, and a more coherent approach to AI/ML integration, is needed to foster

Back to this idea referenced in the introduction—how to leverage Open RAN interfaces for real-world innovation—it all comes down to the RAN Intelligent Controller (RIC) and the growing pool of rApps and xApps being developed for the non-real time and near-real time RICs, respectively. And with the injection of more powerful, domain-specific AI and ML tooling, this platform for intelligence has broad implications for how networks are dynamically controlled and optimized for the benefit of both operators and users.

VIAVI's Owen O'Donnell, TeraVM marketing manager, listed off a number of RIC use cases, including traffic steering, energy saving, anomaly detection, network slicing, massive MIMO and beamsteering—all "types of features where these tend to be the top of the operators' use case lists because they're quick wins and they don't need operator intervention to run them. And that's the important thing."

He noted that many of the capabilities are evolutions of features previously associated with C-SON and D-SON, and that now need to be migrated to the RIC. O'Donnell gave the example of pairing anomaly detection with traffic steering; one is looking for anomalies then using ML to figure out what associated patterns go along with those anomalies; armed with that information, traffic can be manipulated to ensure service continuity while the issue is mitigated in a more proactive fashion. "It's a lovely example of two apps working together to spot a KPI, see an issue, improve the situation by making the change, and all automatically within a couple milliseconds without operator intervention or approval required. That's what's critical for early deployment—that these apps can be trusted to do a job without making a mess."

Covering off the role of the RIC in supporting network slicing and location-based services, O'Donnell, again, got it back to operators trusting the system. He said network slicing is "one of the more realistic 5G killer apps that can be actually delivered," and operators understand the revenue-generating capabilities of dedicated quality for a particular service. "The biggest concern to operators though is how to guarantee the quality of the session for as long as it's required. And this an ideal use case for a RIC app…They're all about revenue generation and faster time-to-market for new features. With network slicing they see exactly this, but their fear is in ensuring the network slice adheres to the SLA they've made to the user."

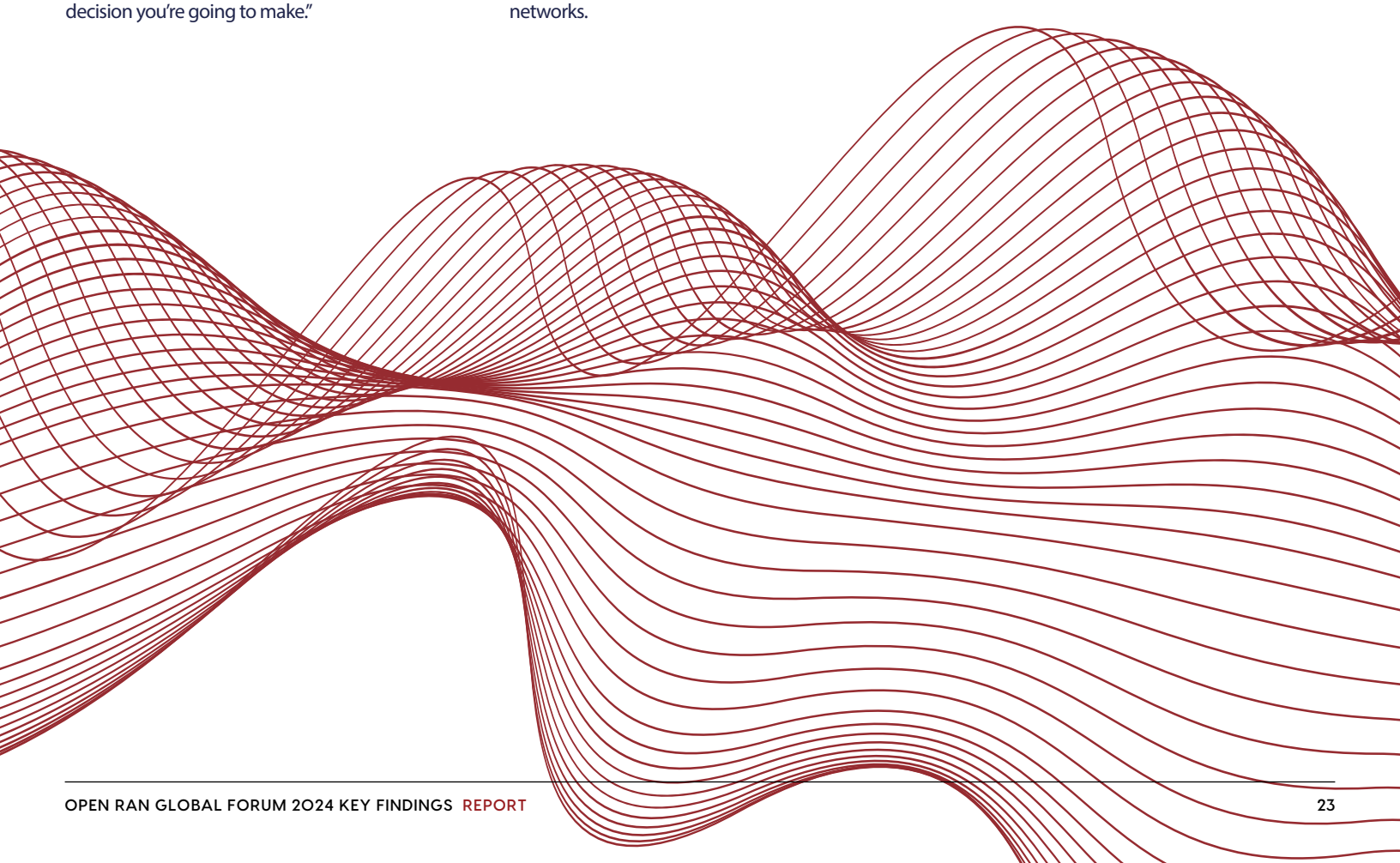
With regard to location-based services, O'Donnell pointed out that VIAVI, in addition to its extensive testing work, is also developing applications. He said device location is essentially an additional contextual data input to the RIC and its apps that enable the platform to decide on the best action to take. "The more inputs, the more feeds you have, the better the decision you're going to make."

Ganesh Shenbagaraman, head of standards, regulatory affairs and ecosystems at Radisys, was generally bullish on the future ability of the RIC to deliver meaningful new capabilities to operators, but he was clear that there's a good deal of standardization work that needs to be done before real-world deployments accelerate at scale. He noted that implementations have to degrees gone ahead of standardization resulting in a bit of a "mixed situation."

Looking specifically at challenges around integration of xApps and rApps with CUs and DUs, Shenbagaraman noted that with standardization maturity and more clearly-defined use cases, "the interoperability becomes easier…[But], this is one of the reasons where it is being taken a little slowly into the network." Operators, he said, are "a little too worried about the impacts and the intended and unintended consequences of the actions being taken." He likened the maturation curve to Open RAN fronthaul which, after more than five years of standardization, compromise and testing, is now being deployed broadly in commercial networks.

Considering the importance of AI and ML in the RIC and attendant apps, Shenbagaraman said the telecoms industry at large needs to figure out how to move away from business confidential data and establish a larger, anonymized data pool; this, he said, would accelerate the broader development and adoption of the RIC and its app ecosystem. "I think the networks are moving to 5G SA now and that becomes a pre-condition for testing more and more scenarios…for these various xApps and rApps…The AI and ML is definitely there and we are going to leverage that."

In a bit of sobering, but also lighthearted and hopeful commentary, Michele Polese, a research professor for Open RAN, 5G and 6G at Northeastern University, said that for the RIC, "Right now the expectations are quite low…but I think this is the piece of the overall O-RAN architecture that has the potential to change the most how we interact, deploy and optimize cellular networks."



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