RCR Wireless News

INTELLIGENCE ON ALL THINGS WIRELESS

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FROM GREENFIELD TO BROWNFIELD:

Open RAN in 2022

By Sean Kinney

Introduction

In 2020 Open RAN was certainly a growing interest and industry discussion was largely focused on the greenfield network Rakuten Mobile built in Japan. There were a lot of important lessons, both technical and practical, learned through that process. But as time has passed, interest and investment in Open RAN has accelerated significantly around the world.

In those early days, the primary value prop being communicated into the market was reducing capex, reducing opex, and giving operators vendor optionality. We've got two other greenfield builds in process now, DISH in the United States and 1&1 in Germany. In the time that has elapsed, the Open RAN landscape and the value prop have matured quite a bit and become significantly more nuanced.

The focus now is on the integration of Open RAN systems into brownfield networks. We've seen major commitments from multi-national operators in Europe and the Middle East and we've heard from other incumbents around the world that they see Open RAN figuring into mid-term deployment plans.

To the value prop piece, capex, opex and optionality are still very much applicable, but we're really starting to understand how establishing non-real-time and near-real- time RAN Intelligent Controller platforms throughout a network can get the industry a lot closer to this idea of an adaptive, zero-touch network, which has been something of North Star for a number of years. In a recent 6G-focused workshop--granted these are very early discussions--the broad stroke sort of scoping of what the next generation of cellular might look like had many parallels with work being done today around RIC.

Greenfield roundup

Rakuten Mobile

In August of this year, around 16 months after initial launch, Rakuten Mobile counted 5 million subscribers on its facilities-based and MVNO 4G and 5G networks. Right now the carrier is working on coverage expansion, deploying millimeter wave 5G, and planning for the transition to standalone 5G. The ultimate vision is for 4,000 micro data centers, along with centralized data centers, supporting around 80,000 4G and 5G base stations.

Perhaps more significant than what it has done in its home market is the work Rakuten has done to productize and sell its approach to building a cloud-native network using Open RAN principles. In addition to development of the Rakuten Communications Platform, Rakuten Group recently created the Rakuten Symphony organization to drive global adoption of its telecom network infrastructure and services, including RCP. With operations across Japan, the United States, Singapore, India, Europe and the Middle East Africa region, Rakuten Symphony aims to bring together all of Rakuten's telco products, services and solutions under a single global portfolio to offer 4G and 5G infrastructure and platform solutions to customers worldwide.

Rakuten has long promoted capex and opex savings associated with its approach to building a network rather than a more traditional build: a 40% capex reduction comes from lower deployment and hardware costs chalked up to virtualized network functions and pooling network resources, and a 30% opex reduction from less rent, less maintenance and more network automation. It's worth noting that,

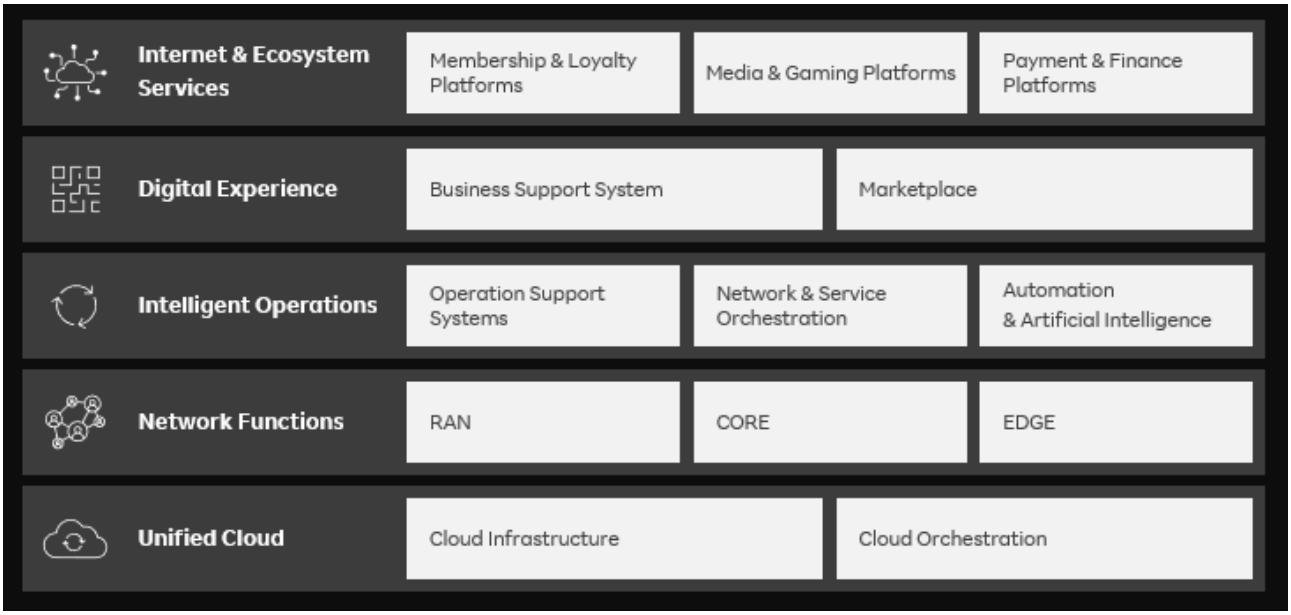

Image courtesy of Rakuten Group

in breaking out these reductions attributed to the RCP approach, Rakuten does project increased costs from data center capacity and data transmission which maps to an architecture involving distributed edge compute facilities.

U.S.-based vRAN software specialist Altiostar was a major vendor to Rakuten Mobile for its build in Japan, and the company is part of the tech stack included in Rakuten Communications Platform as sold by Symphony. In August, Rakuten Group announced it will acquire Altiostar based on a $1 billion valuation. Altiostar CEO Ashraf Dahod said the acquisition will help accelerate technology development and, in turn, time to innovation. "Open RAN architecture and virtualization are key to building software-centric networks that can scale and adapt to meet an explosion of devices and applications driving service velocity and profits."

Altiostar's Shabbir Bagasrawala, head of product go-to-market, said the company has evolved from a RAN software company to having a "portfolio we can present to customers, especially on the automation side. When we did Rakuten, we were focusing on automation. We were focusing on a lot of things that were innovative for the industry as a whole. With the acquisition, it allows us to offer this up to other customers. Previously we were thinking about deploying our RAN software and trying to retrofit some of that automation into an existing telco space. This is something we can give you and you can start using it immediately. You can get all these benefits. And we obviously get the scale of Rakuten."

DISH

The commercialization of DISH's nationwide, 5G standalone network, built using cloud-native principles and an Open RAN architecture, remains in the future, although the company has said its first market will be Las Vegas with beta testing in the fourth quarter

DELL Technologies

intel.

Image courtesy of DISH

"We're opening the door to new technologies that will transform factories, workplaces, entertainment, and transportation in ways people have only dreamed."

Andy Jassy, CEO, Amazon Web Services

of this year.

Dave Mayo, EVP of Network Deployment, moved the company's network organization from centralized to decentralized with a four-region, 36-market division of oversight. At the Wireless Infrastructure Association's recent Connect(X) trade show, Mayo said, "We had to make changes, and that's the point of a decentralized structure."

DISH has been quite public about its ongoing vendor selection process. It will use RAN equipment from MTI and Fujitsu, standalone core solutions from Nokia, and RAN software from Altiostar and Mavenir; he said a current focus is getting those last two companies "to get their RAN software to work well with Fujitsu radios and the AWS core."

The final bit of Mayo's comment highlights perhaps the most unique vendor choice DISH has made. As announced in April, DISH is using AWS Outposts and Local Zones to host all of its network functions in the cloud.

DISH Co-founder and Chairman Charlie Ergen said the tie-up with AWS will allow DISH to "operate not just as a communications services provider, but as a digital services provider harnessing the combined power of 5G connectivity and the cloud...Our approach will revolutionize wireless connectivity by giving customers the ability to customize and scale their network experience on-demand."

AWS CEO Andy Jassy called out the enterprise angle: "Together, we're opening the door to new technologies that will transform factories, workplaces, entertainment, and transportation in ways people have only dreamed."

Further to that point, DISH's Stephen Bye talked through how the cloud network is a differentiator for delivering private enterprise 5G as a logical slice, a capability opened up by the move to 5G Standalone. Bye, the Chief Commercial Officers, said DISH is working on multiple RFPs and RFIs for private networks and also "working on proofs of concepts," and partnering with system integrators "as we bring the services to market. The good thing about these private networks that we're working on is they're not constrained by the geography of building our macro network. So, we're able to serve customers in different geographies within that environment. And then, the other thing, which is also important to highlight, it's across all verticals. There isn't a specific vertical that has an interest in this. We're seeing interest across every vertical and every industrial segment."

1&1

After acquiring 5G spectrum licenses, German mobile network market entrant 1&1 announced in August that it entered into a network partnership with Rakuten Group, Rakuten Mobile's parent company. Rakuten will serve as general contractor for a cloud-based, multi-vendor network using Open RAN hardware and software. Based on its own network build in Japan, Rakuten Mobile launched the Rakuten Communications Platform product that bundles its access, core, cloud and operations solutions.

Ralph Dommermuth, CEO of 1&1 AG, said: "Through complete virtualization and the use of standard hardware, we can flexibly combine the best products. This will make us a manufacturer-independent innovation driver in the German and European mobile market." Rakuten Group CEO and Chairman Mickey Mikitani connected Rakuten Mobile's work with what the company will do with 1&1: "Through technological innovation, we have been able to offer high quality services at an affordable price that challenge the market. We are very excited to now have the opportunity to share this experience and know-how with 1&1 through the Rakuten Communications Platform and to jointly create a next generation network that will set new standards for future mobile communications in Germany and across Europe."

In terms of architecture, 1&1 plans to use four central data centers for the core network connected out to hundreds of decentralized data centers; thousands of antenna sites will be connected using fiber optic cabling. United Internet, 1&1's parent company, is one of Germany's

largest internet service providers and offers fixed and MVNO services for residential users under the 1&1 Drillisch brand, using Telefonica's network.

In December 2019, 1&1 Drillisch signed an agreement to lease 5G spectrum from Telefonica Deutschland, a unit of Spanish telecom giant Telefonica, until its allocation in the 2 GHz band was available in 2026. This agreement involves two frequency blocks of 10 megahertz each in the 2.6 GHz band. The agreement is based on a self-commitment by Telefónica as part of the EU antitrust approval of the merger with E-Plus in 2014. The two frequency blocks will be available to 1&1 Drillisch until December 31, 2025.

At Germany's 2 GHz and 3.6 GHz spectrum auction, which ended in June 2019, 1&1 Drillisch acquired a total of two frequency blocks of 10 megahertz in the 2 GHz band and five frequency blocks of 10 megahertz in the 3.6 GHz band. While the 3.6 GHz spectrum is already available, the frequencies in the 2 GHz band will not be operational until January 1, 2026.

Bagasrawala of Altiostar said his company, as part of Rakuten Group, will work with 1&1 to deploy both 4G and 5G. "There's a lot of work we're going to leverage from the Rakuten deployment. In terms of how do you deploy LTE, how do you deploy 5G, that is in fact the easy part. I think where we really want to go is bringing innovation. This is where we can really shine. We're going to look at the end-to-end orchestration. We're going to look at deploying features at a rapid pace."

Global commitments

European operators Deutsche Telekom, Orange, Telefónica, and Vodafone are joining forces to support the rollout of Open Radio Access Network (Open RAN) in future mobile networks across Europe.

The four carriers signed a memorandum of understanding in which they have expressed their individual commitment to the implementation and deployment of Open RAN solutions.

In a statement, the operators said they will also work together with existing and new ecosystem partners, industry bodies like the O-RAN Alliance and the Telecom Infra Project (TIP), as well as European policy makers, to ensure Open RAN quickly reaches competitive parity with traditional RAN solutions.

Enrique Blanco, CTO at Telefónica, said in a statement: "Open RAN is the natural evolution of radio access technologies and it will be key for 5G networks. Telefónica believes the whole industry must work together to make it a reality. I am excited to be partnering with major European operators to promote the development of an open technology that will help to enhance the flexibility, efficiency and security of our networks."

"Open RAN is the next major evolution of 5G RAN. Orange believes it is a strong opportunity for existing and emerging European actors to develop O-RAN based products and services, starting with indoor and rural areas. This evolution should be supported by a large European ecosystem as it is a unique occasion to reinforce the European competitiveness and leadership in the global market," Michaël Trabbia, CTIO at Orange, said.

In traditional RAN, the networks are deployed using fully-integrated cell sites, where the radios, hardware and software are provided by a single supplier as a closed proprietary solution. With Open RAN the industry is working towards standards and technical specifications

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that define open interfaces within the radio system, including hardware and software, so that networks can be deployed and operated based on mix-and-match components from different suppliers.

The four operators also said they believe that the European Commission and the national governments have an important role to play to foster and develop the Open RAN ecosystem by funding early deployments, research and development, open test lab facilities and incentivizing supply chain diversity by lowering barriers to entry for small suppliers and startups who can avail of these labs to validate open and interoperable solutions.

"Through our open labs and community activities, we facilitate smaller players to enter the market with their solutions. To build on this foundational work, we urge government support and funding for community activities that will strengthen the European ecosystem and leadership in 5G," said Claudia Nemat, CTO of Deutsche Telekom.

Vodafone Group Chief Technology Officer Johan Wibergh said: "We aim to open R&D labs for new, smaller suppliers to develop their products. But to do this we need a supportive investment environment and political backing, and we urge European governments to join us in creating the Open RAN ecosystem."

In July last year, a quintet of Middle Eastern operators signed a memorandum of understanding "to push forward the implementation of…Open RAN solutions in their existing telecom networks, share their industry knowledge and experience setting a clear path to drive innovation for the ICT sector across the Middle East," according to Abu Dhabi-based Etisalat. The coalition includes Etisalat, STC, Zain, Mobily, and du.

Etisalat Group CTO Hatem Bamatraf said in a statement disaggregated radio systems "will help to enhance the flexibility and efficiency of our networks. I am excited about this partnership that will foster a diverse and secure 4G/5G ecosystem…This is also a testimony to Etisalat's commitment and leadership in innovation in the ICT sector and to development and adoption of Open RAN ensuring the best network experience for our customers."

What does this degree of commitment and the investment dollars it implies mean for vendors and other Open RAN ecosystem stakeholders? For one, "It helps the ecosystem coalesce around technical requirements," Viavi Director of RF and Wireless Architecture Ian Wong explained. "It shows that macro deployments in both urban and rural are required. It is quite suitable in general to the Open RAN ecosystem because, at the end of the day, there are so many diverse requirements. It opens up the marketplace for specialists in certain areas."

Ganesh Shenbagaraman, Head of Integrated Products and Ecosystems with Radisys said vendors down to the chipset level are pushing product advancements and interoperability to capture Open RAN market share.

Ganesh Shenbagaraman, Radisys

"It's coming faster than anyone anticipated," he said. "All these major vendors and all the key OEMs in the telecoms space, they will apply the experiences and learning that came over the last few years. The aspect of openness—not only in the RAN but in the core network, hardware/software decoupling, interoperability—I think companies will be very careful with their strategies. They will not build the products the same way."

Deploying Open RAN in a brownfield network—thoughts from operators and vendors

Operators are taking different paths to incorporating Open RAN systems into their networks; some are compelled by regulations against specific equipment vendors or rural coverage expansion while others are reaching in-building environments or thinking holistically about Open RAN as part of a larger infrastructure de-centralization trend.

Terje Jensen, Telenor

Telenor's Terje Jensen, senior vice president and head of global network architecture, explained that there are challenges to widespread adoption of Open RAN, including the ability to provide a net value from cost savings or new business, security, power efficiency and intellectual property rights. "We believe there's still maturing going on there," Jensen said.

"There are quite a few hindrances which...are maybe some of them just on paper, some of them are a bit real, and some them...shouldn't be there at all." But, Jensen said, Open RAN doesn't need to solve all problems from day one. "It could be just as well on some of the in-building cases, some of the more private network cases, and so forth. I think there are things which could very well work today on Open RAN."

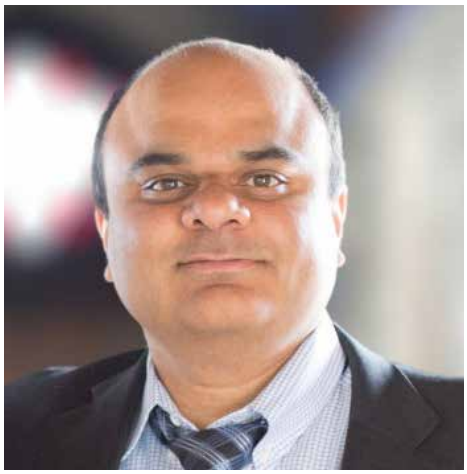
This is consistent with perspective provided by Eugina Jordan, vice president of marketing at Parallel Wireless, who said the topic shouldn't be framed as greenfield vs. brownfield but rather around use cases for Open RAN. "When we talk to customers, they talk about use cases," she said. "Open RAN for a rural use case, Open RAN for an urban use case, Open RAN for a dense urban use case, and they talk about the 5G Open RAN use case. We've been working in the brownfield world for the last five years. For Parallel Wireless, what's more important for us is that the industry makes a leap forward to Open RAN."

NTT Docomo began doing Open RAN vendor interoperability testing in 2019-- "It takes a bit of time to complete," according to VP and GM of Radio Access Network Development Sadayuki Abetta--and began deploying in 2020. Abetta said the operator selected particular vendors based on specific deployment scenarios, including in the deployment of a new frequency band into its existing 5G network. The big sell, he said, is that "We can choose best-in-breed solutions."

NTT Docomo was a founding member of the O-RAN Alliance and, like its compatriot Rakuten, has identified a group of ecosystem partners with the end goal of packaging and selling its recipe for Open RAN. Those partners, announced in February, Dell Technologies Japan, Fujitsu Limited, Intel K.K., Mavenir, NEC Corporation, NTT DATA Corporation, NVIDIA, Qualcomm

Chris Rice, STL Access Solutions

Arnaud Vamparys, Orange



Balaji Raghothaman, Keysight Technologies

Technologies, Red Hat, VMware K.K., Wind River and Xilinx.

The best-in-breed bit is key, according to Chris Rice, CEO of STL Access Solutions. "Who's best at X? I can mix-and-match. [Then] there's this idea that I want this all stitched together. I think that will get better as things get deployed. That's where you really learn. I think to the extent that operators can start moving down this path, start feeding some of this information back, that's what's going to make it better and better."

This summer Orange launched a 5G Standalone, cloud-native network in Lannion, France. The goal, according to Senior Vice President, Seamless Wireless Access, Arnaud Vamparys is to "accelerate our learning curve internally." This includes a degree of openness that would accommodate "plug-and-play small cells for in-building coverage," for instance. Similarly, the company is keen to frame out cross-domain operations in a manner that automates the CI/CD process. In terms of using the experimental network to inform future zero-touch network operations, Vamparys said, "We want to go to the next generation there and really be ahead on the intelligence part. We want to learn ahead."

On its experimental network, Orange is working with technology partners, including Mavenir, Casa Systems, HPE, Dell Technologies, and Xiaomi.

Speaking directly to the challenges associated with introducing Open RAN into a brownfield network, Keysight Technologies Chief Architect for Infrastructure Solutions Balaji Raghothaman called it a "complex proposition. The graceful handling of incumbent hardware and systems, while incorporating new elements is not always easy." He noted that the fronthaul gateway "is one mechanism utilized by operators as a bridge between O-RAN and non-O-RAN network elements." There's also potential around using Split 8 to enable "complete separation of the RF from the physical layer and is representative of earlier deployments using Remote Radio Heads."

Another significant challenge cited by Raghothaman is around integrating Service Management Orchestration (SMO) and

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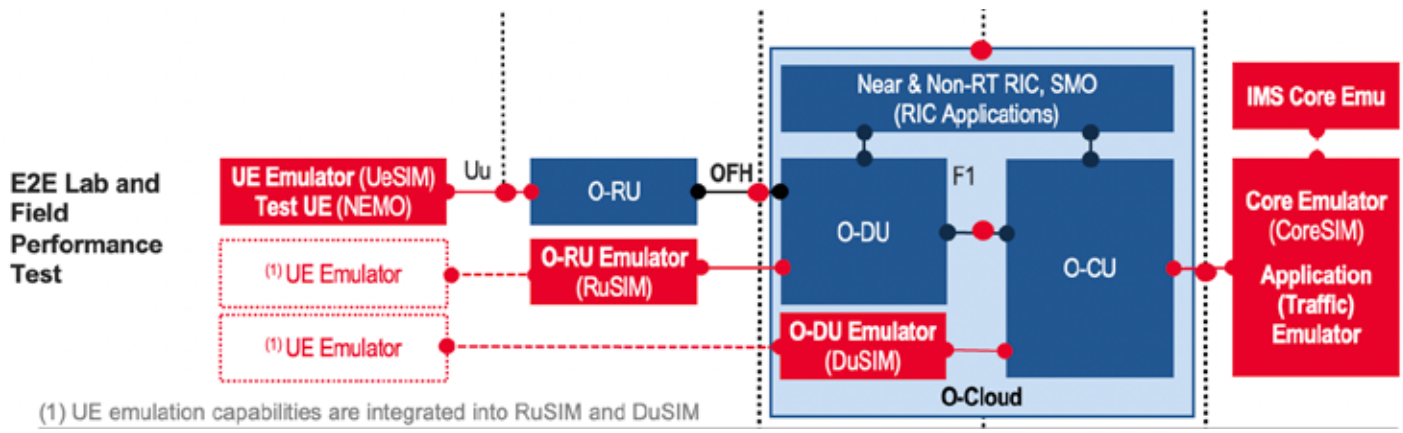

Image courtesy of Keysight Technologies

Operations and Maintenance (OAM) functions. "Operators have a wide variety of legacy management systems, and are in various stages of progress in terms of incorporating standardized SMO procedures. This creates interactions between legacy and newer network entities that are unique to each operator."

Into the blue(field)

In the conversation around Open RAN for greenfield and for brownfield deployment, Ericsson has put a descriptor into circulation: bluefield. "So, what is it, exactly?" wrote Strategic Product Manager Gabriel Foglander. "This new way of approaching network evolution is unlike brownfield deployments, where we expand the capacity of an existing network, or greenfield, where we deploy net new sites.

Image courtesy of Ericsson

Bluefield rollouts represent a fertile middle ground—introducing new technology into an existing network.

For Ericsson customers, this could look the addition of new cloud RAN solutions to an existing network. The company's portfolio includes Ericsson Cloud RAN which is compatible with the Ericsson Radio System and works for Non-Standalone 5G and Standalone 5G as operators go through that important transition. This would also come into play if an operator were to deploy new mid-band or millimeter wave spectrum for use with an existing LTE and Non-Standalone 5G network.

Ericsson North America's Paul Challoner, Vice President of Network Product Solutions, described what it means for a RAN to be "open" in the context of cloudification and automation. To the cloudification piece, "To be open, you've got to be able to operate on any server, on any cloud, on any field or any site. To be open, you have to get a deal with different server types. Any cloud, so typically you'd need a telco cloud which would maybe have bare metal server, maybe some hardware accelerators, container management layer, a platform layer, that's one type of cloud you need. Another type would be the hyperscalers who sort of deal with that whole stack there. To be open you have to deal with both flavors."

The "any field" piece ties together the Open RAN and bluefield concepts. "Really," Challoner said, "brownfield is building more equipment of the same type on an existing installed base. Cloud really is a new type of equipment so we're building that on an existing installed base… To be open you have to be able to deal with a bluefield environment." In terms of "any site," Challoner said that means the ability to work with both distributed RAN and centralized RAN architectures.

Regarding automation— "one of the great benefits of Open RAN maybe not talked about enough," as Challoner said—this includes a service management and orchestration platform that can host AI- and ML-based applications that will be used to operate the network. "All of these things have to be open, all of these things have to be true," Challoner said. "If any of them are not, it's closed."

Gaining confidence one test case at a time

There are myriad test and measurement complexities associated with Open RAN, cloudification of network functions, and the automation enabled by AI and ML. "Ultimately when you disaggregate the RAN, there's a lot more players," Viavi Director of RF and Wireless Architecture Ian Wong said.

He continued: "You really have to come up with the right test methodologies. What you're talking about is really much more complex deployments where you have a mix of traditional and Open RAN. You're talking about sometimes needing the distributed units, of course, supporting the 7.2 interface but some of the radio units are still legacy, CPRI-type, so you need these fronthaul gateways. Mixing and matching these will really put a lot of onus on operators, system integrators and test vendors to test the heck out of in the lab but have continuity in the field."

Fronthaul, the volume of which goes up along with the centralization of baseband units and distribution of remote radios, is an important piece of end-to-end system validation. Keysight Technologies is working with partners like Cisco and Xilinix to make this process easier for operators.

Raghothaman said Keysight has developed a suite of solutions "that can provide individual subsystem's functional testing,"

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How virtual testing and massive automation play into DISH's network strategy

By: Kelly Hill, Executive Editor, RCR Wireless News

The ability to automatically, virtually and in parallel test new 5G Standalone services, slices and software updates in the cloud is key to DISH Network's network strategy and its differentiation, according to Marc Rouanne, DISH EVP and chief network officer for its wireless business. Rouanne said that the ability to rapidly test and certify network software and services has been part of DISH's vision for its network. With the announcement yesterday of DISH's selection of Spirent Communications to enable automated, large-scale 5G core testing, Rouanne offered up some new insights on how DISH plans to leverage the swift and virtualized cloud-based 5G testing capabilities that Spirent is providing.

DISH says it will be the first telecom company to run its service on the public cloud, and it is partnering with AWS on cloud infrastructure. It needs to be able to test and validate its 5G network functions and services on AWS infrastructure — and in July of this year, Spirent had announced the capability to do just that, with a new Landslide 5GC Automation Package that the company said at the time is "designed to help carriers to rapidly deploy 5G networks on AWS." The package combines AWS' Continuous Integration and Continuous Delivery (CI/CD) pipeline with Spirent's 5G test capabilities to enable carriers to "objectively, rapidly, and continuously" validate network functions and services, according to the test company. Doug Roberts, SVP and GM at Spirent, said that the 5G automated core testing is made up of Landslide, plus Spirent's Velocity and iTest automation framework to produce a "single, automated test library specifically for 5G Standalone and NonStandalone applications." The capabilities that this supports, Rouanne says, are "extremely disruptive -- more than what anybody thinks."

DISH, he says, made a strategic decision early on that its testing and lab strategy would be virtual. "The telco industry is a very slow industry, because of the way that labs are set up between the vendors, the operators and then the go-to-market, where there is a very long lifecycle for moving software and capabilities from the vendor development all the way to in-service," he explains. That timeline is average around 12 to 18 months, Rouanne says, although he acknowledges that some "pockets" may move faster. This, he continues, has "made the telco industry vulnerable to attacks from the over-the-top [players]," and so major applications like messaging or video conferencing "have been hard for the telco to keep in the domain of the telco". That software development velocity has advantaged the OTT ecosystem.

"We decided that with 5G SA which is a service-oriented architecture, that we could do something different," Rouanne says. "A very important input in our decision to go to the cloud with AWS was that we wanted to not only have the network in the cloud, but all the testing capability.

"We can spin off a new testing environment within ours, which is kind of building a new lab," he continues. "Imagine I want to test security end-to-end. I can spin off a new lab, end-to-end, that is on the scale of a sub-network, that is much bigger than any lab that an operator would have -- I can do that within hours. I can do another one for roaming testing. I can do another one for some vertical testing. And it's all automated."

He goes on to explain that DISH has asked all of its vendors and partners to come and test in those virtual labs. That is important, Rouanne says, because the various labs used in the stages of telecom software development aren't necessarily representative of the network where the software will ultimately be used. They have different attributes, platforms, paths or perhaps use another Kubernetes layer. "They look the same, but they are different," Rouanne adds. "Which means that when you move the software from a vendor lab to an operator lab, you have to re-engineer everything. And usually it takes weeks just to do that, before you can start testing -- whereas natively now, with DISH, we ask our vendors to test in the lab in the cloud, in the replica that is exactly the same as our network. We have the same stacks, we have the same networking, sub-nets, security, everything is the same. So when our vendors are testing, they are testing in a virtual lab that is just part of our network. That's a big thing."

Similarly, he says, DISH's virtual testing strategy also plays into its strategy to be able to offer one of 5G Standalone's most highly anticipated capabilities for enterprise: Network slicing.

"Our network is designed with slices in mind, which is very unlike any other network today," Rouanne says. "The problems of slices is that if you're not thinking life-cycle management for slices, you can't just spin them off. Our ambition is to be able to offer one or many slices to any enterprise. Each enterprise could have many slices: Some high-speed slices, some very secure slices, some monitoring slices. ... The problem is that they will have different requirements, so they will have different features. They will have different capabilities. Some may optimize for latency, some may optimize for cost, some may optimize for reliability or redundancy or security -- or all of it. Which means that the testing of the slice has to be specific."

Such testing in a traditional lab would be sequential and highly manual, Rouanne says: Test one slice, probably for several months; test a second slice for several months; and so on, changing configurations within the lab between rounds of testing. "Because we test in the cloud and because we can spin off slices or testing environments live, we can maintain testing environments in parallel for different slices and different verticals," he says. "If you don't have that capability, I would guess that you are going to be able to do a few, a handful of slices -- two, three, four. But you won't be able to slice per enterprise, so you won't be able to deliver what they really want: Their own sub-network that they master."

But running slices and parallel test environments at that scale requires massive automation, Rouanne goes on. Most operators, he says, are running a large part of their testing manually, because they're doing it sequentially with a limited number of parameters. "At the scale we're talking, with all these environments in parallel and slices, there's just no way that you can do it manually," he said. From day one, he continues, DISH has told its vendors and software providers that it will require everything to be tested in the cloud, and ultimately, be able to create tickets automatically and virtually, log correlations in network behavior, and so on, in active network operations. "It's like automating a factory," he adds, saying that Spirent ultimately had "the right mindset and ambition" to be selected as DISH's partner in doing so.

For Spirent's part, Roberts explains that the company has been on a multi-year journey of transforming its traditional box-based business to the cloud. "What we realized, as a company ... is, the cloud is here," Roberts said. In parallel, he says, "5G in and of itself fundamentally changes the very infrastructure and the architecture itself." It's no longer an option to pick a custom-built chassis and plan to update it a few times a year. That means testing infrastructure has had to change, right along with the networks themselves. "If you think about the testing infrastructure, whether in the lab, whether pre-production or wether live in production, it really goes back to the monetization of the model of the lab itself," Roberts explains. "We used to spend 90% of our time just simply building the lab out: What's the infrastructure, how much rack space do we need, the HVAC componentry. This is regardless of whether it was a co-located data center or a self-owned, self-managed data center hosting the lab." By having replicable virtual labs hosted on AWS infrastructure, DISH aims to avoid most of those physical-hardware-related questions and focus on testing the software and services in a far faster timeframe.

5G also means working with vendors who have different cadences for updates. Some have new releases every week, Roberts points out. "We're now facing testing and certification demands that in some cases actually run and roll on two to three day cycles," he said. "So the ability to spin up, on-demand, a lab infrastructure with fully-vetted 5G test emulation and certification capabilities, in a matter of minutes, is literally the new standard, the new table stakes ... in the industry. However, I'm very cognizant that just a year ago, it sounded like science fiction."

Rouanne says that DISH had to start with the much more manual processes that existed at the time, and is now programming all of them into Spirent's system as the company moves toward deployment and a new stage for its network.

"I think this is the tip of the iceberg of something which is much bigger, which is all this automation and access to data," Rouanne says. The partnership with Spirent, he says, "is taking us to the next level in terms of agility and speed. ... We have always planned for automated testing and capabilities, it's key in our deployment. We have always said that we want software life-cycle and innovation life-cycle to be two big differentiators for DISH. So Spirent is key in bringing that to us." ●

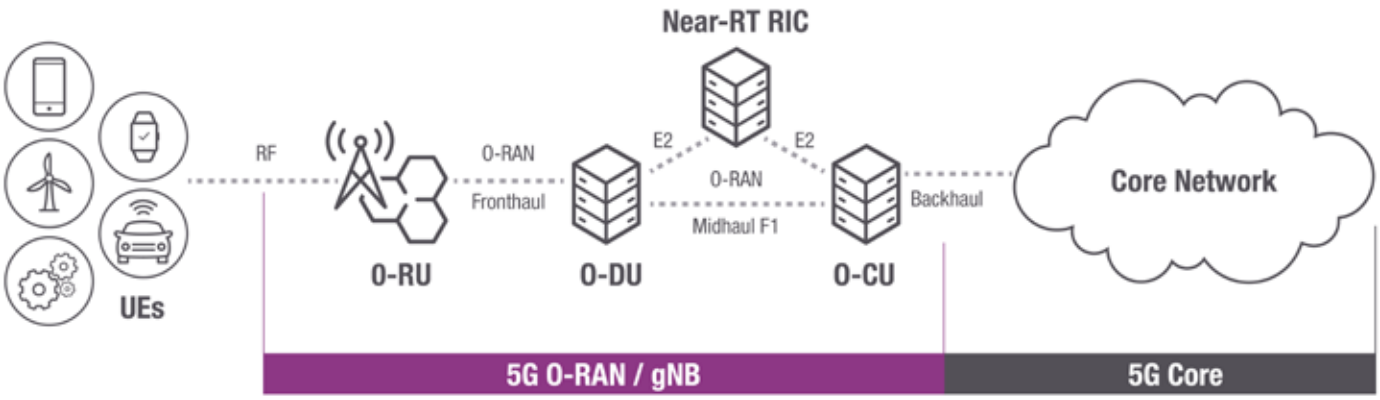

Image courtesy of Keysight Technologies

including distributed and radio units, "and for testing the interoperability and fronthaul performance between a real O-DU and O-RU. Vendors are facing many issues when hooking up O-DUs and O-RUs, sometimes both from the same vendor. Everything from OAM, timing, delay management, and protocol correctness/compatibility need to be verified. Keysight is closely working with vendors and operators on this process."

As highlighted earlier in the examination of the work being done among DISH, Spirent and AWS, the move to cloud-based networks requires an evolution of test solutions, namely tailoring solutions to run on hyperscaler infrastructure like AWS Outposts. As Wong put it, the goal is "to push our test systems to kind of meet these deployments where they are. Ultimately it's about being able to test where the deployments are at scale." In the context of the move toward increasingly cloud-based, automated telecommunications network, the test process itself has to become automated. "It's a huge emphasis and focus for us," Wong said. "It boils down to that automation piece and visibility across the whole lifecycle."

Like with every other aspect of Open RAN, this is very much an ecosystem play with test and measurement playing a vital role at every step. "As we go across the ecosystem," Raghothaman said, "the type of testing needs vary. For example, a chip vendor might be more interested in verifying their design element, say Layer 1 and fronthaul interface, whereas an operator is also interested in end-to-end verification."

In terms of expectations for near-term Open RAN adoption, Raghothaman used interest in plugfests as indicative that, "The interest is global. Compared to last year, there is a higher level of mature implementations. There has been tremendous interest in test and certification activity...O-RAN related test solution suites reflect sustained and expanding growth, both in terms of volume and in

How to secure cloud-native 5G virtual and Open RAN infrastructure (Analyst Angle)

By: Prakash Sangam, Founder and Principal, Tantra Analyst

Ever since the cloud-native virtual RAN (vRAN) and Open RAN architectures have started gaining popularity, one key question both proponents and adversaries have been asking is "What about security?" Considering the massive number of services and critical applications that 5G will connect, security risks couldn't be higher.

Some contend that any disaggregated, virtualized, multi-vendor system will naturally have security vulnerabilities. Others challenge that assertion and suggest that an expansive open ecosystem with many large players will make the system inherently more robust.

No matter which view you hold, the best approach is to have a dedicated hardware-based, AI-powered onboard security. Let's explore why and what it takes to bring such security.

Basics of cloud-native virtual and Open RAN architecture

The security mechanism in traditional RAN networks is relatively straightforward because all the software and hardware in the baseband is proprietary and supplied by a single vendor. But it is not so in new architectures.

In vRAN, the software is disaggregated and runs on off-the-shelf hardware, and in Open RAN that software comes from many different vendors. In a cloud-native approach, the software is containerized, that is, the monolithic RAN baseband software is divided into many containerized microservices: PHY, RLC, MAC, transport, and other functions. These microservices are orchestrated in a Kubernetes cluster. The 5G infrastructure providers have realized that the cloud-native approach used in data centers by cloud service providers (CSPs) is the best architecture to leverage for scalability and efficiency. So, using that same infrastructure and the same Kubernetes architecture saves them from reinventing the wheel. That being said, they must deal with the same issues the CSPs do regarding security, disaggregation, and latency with a focus on those aspects as they pertain to 5G use cases.

Microservices must securely communicate with each other to function. This communication is usually managed by a cloud-native entity called "service mesh" such as Istio. There are two parts in a service mesh: (1) the control plane that sets up the communication channels between the microservices, and (2) the data plane, that manages the transfer of actual data. For our discussion here, we focus on the control plane, as it is much more crucial from a security point of view.

Microservices are heterogeneous and highly distributed. They can run on multiple different servers that are geographically and logically separated, and they might be supplied by different vendors, each providing different baseband functions. Additionally, if vRAN is hosted on the public or shared cloud, microservices from different cellular operators or even non-operators could be running on the same cloud infrastructure. In such a case, one could imagine the complexity of the implementation and the large attack security surface involved.

Another important dimension of this cloud-native architecture is latency. Microservices are transient entities that are created and broken down in terms of milliseconds. Further, the microservices activity in telco clouds is magnitudes higher than other clouds, mainly because of user mobility. For that reason, securing the microservices while managing the latency is even more crucial, especially for 5G URLLC (Ultra Reliable Low Latency Communications) applications and services. So, the timing involved in the creation, as well as the communication between microservices directly impacts the system performance.

Securing cloud-native virtual and Open RAN

Service mesh enforces policies upon the microservices the Kubernetes cluster manages, including where they are running and how they are connected. Service mesh uses certificates to authenticate the microservices and crypto keys to encrypt the communication between them.

The traditional approach is to run the service mesh in the software, on the underlying layers, say, in the operating system. In that

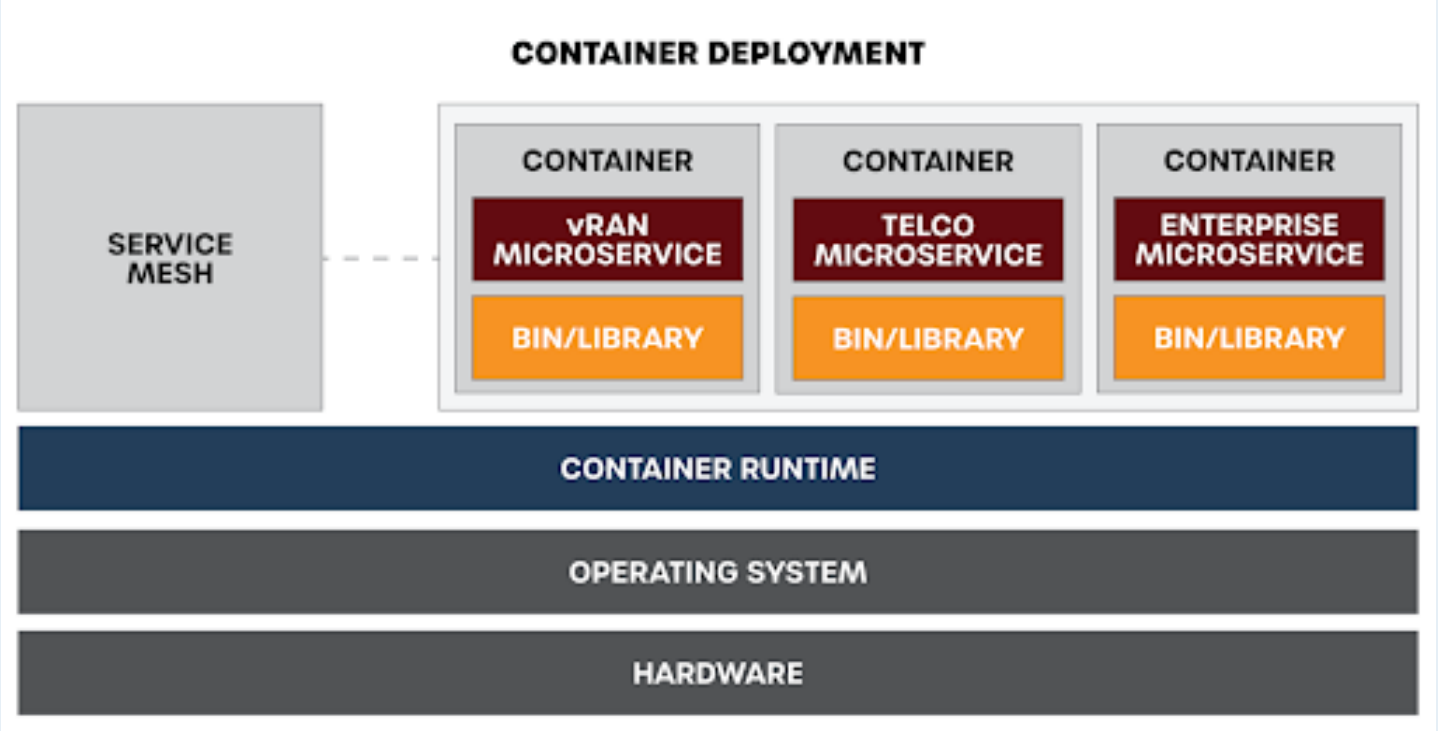

Image courtesy of Tantra Analyst

case, the certificates and keys are generated, stored, and managed locally. Letting the security reside in software makes the whole RAN network extremely insecure, and highly susceptible to attacks.

The best and most comprehensive option to secure cloud-native RAN networks is to relegate all the key security functions, including the service mesh, to a dedicated purpose-built ruggedized processor. A good example of such a processor is the Trusted Control/Compute Unit (TCU™) offered by a leading security solutions company Axiado. Gopi Sirineni, CEO of Axiado, explains "TCU is a state-of-the-art secure processor with hardware root-of-trust (based on its immutable hardware ID), secure boot, secure storage, and Trusted Execution Environment (TEE). He adds, "Such a processor will be tamper-resistant, it can store and manage keys certificates safely, and provide a holistic security cover for the whole system."

Some cloud-native systems utilize a third-party cloud-based service mesh. But that adds latency to the system. To meet the stringent latency requirements of 5G RAN, especially for URLLC applications, a secure processor must be onboard and within proximity to where the microservices are being run.

Some might suggest that most of the vRAN microservices, such as PHY, RLC, and MAC, are always running, and may not require frequent authentication. Hence service mesh can be run remotely on the cloud. However, the biggest promise of cloud-native architecture is enabling extreme RAN scalability—instantly upscale and downscale capacity where and when needed. Running microservices round-the-clock significantly degrades this benefit.

As is true in the non-telco ecosystem, security in the 5G ecosystem is often reactive with predefined rules based on known threat behaviors. A robust service mesh system must not only facilitate secure communications but also observe and identify suspicious behavior. Hence the dedicated security processor should also have AI capabilities so that any potential security threat can be proactively identified and stopped before any damage. AI capability also helps in continuously learning and adapting to the constantly changing security risk landscape. This critical supplement to more traditional security measures will be recognized as a necessity moving forward as the growth of the vRAN footprint attracts an equally growing opportunity for bad actors.

In closing

While the cellular industry is moving toward cloud-native, vRAN, and Open RAN architectures, security is one of the fundamental challenges. With software and hardware disaggregated, being supplied by many different vendors, it is extremely risky to rely on the security of each of the components or only on a software-based approach.

The best option is to utilize a dedicated hardware-based, on-board, AI-powered approach that can provide holistic, future-proof security. ●

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number of customers. These data points lead us to believe there will be a ramp-up of deployments."

The continuous flow of innovation

Continuous Integration/Continuous Delivery is a methodology meant to accelerate the process of software development and delivery with more frequency production releases; it was developed by webscale companies and enterprises to facilitate a fast, responsive process that is highly-applicable to hosting RAN and other network functions in cloud environments. This also has implications to the transition to 5G Standalone wherein software functionality is decomposed into microservices.

Jordan of Parallel Wireless drew a line from hardware/software disaggregation to automation. "You ended up with disaggregated components, you have different software pieces coming from different vendors and you think, 'Oh my god. How am I going to integrate it and how am I going to send upgrades to the sites?' This is where CI/CD comes in. You create one umbrella for all the software pieces just like an enterprise does."

The opportunities enabled by sound CI/CD practices and a more automated, intelligent network are clear, as are the challenges—doing this successfully will require realignments within operator organizations to take advantage of rapid service delivery capabilities not to mention the ongoing collaborative required between operators, their vendors and amongst the vendors.

Scott Heinlein, marketing lead for Open RAN Solutions within Dell Technologies' Telecom Systems Business, observed: "I think a bigger challenge that the industry needs to figure out is how do you enable a constant flow of innovation that comes from Open RAN. How do you take advantage of the constant flow of innovation?"

Heinlein said Dell "is in a very unique position. We're at the infrastructure layer so we're in a great position to really bring together a full stack of ecosystem providers. We have the resources and the know-how to make it all happen."

In June, Dell Technologies revealed intentions to enhance its participation in the telecommunications industry by driving an open ecosystem with its Project Metalweaver and related solutions. In October, the company took its first major step in this journey with the announcement of its first software to come from the project: Bare Metal Orchestrator.

The software offers the breadth and scale for telecom operators to automate the deployment and management of hundreds of thousands of servers across geographic locations to support O-RAN and 5G deployments, the company said in a release.

"This is a pretty important product for us," Dell's Senior Vice President and General Manager of Telecom Systems Business Dennis Hoffman told RCR Wireless News. "[Bare Metal Orchestrator] sort of turns the hardware into infrastructure as code and into a software-defined foundation."

He explained that as operators modernize their networks, they are putting "more and more intelligent components into the network and further out into the network."

"The problem [...] is that every vendor has a tool, but there is no open infrastructure management and orchestration tool that runs on the hardware," he continued. "We are trying to address the inability to ultimately manage these massive and increasingly intelligent networks as they scale without some form of automation that sits just above the infrastructure layer and works nicely with various virtual software from companies like

VMware, Red Hat and Wind River."

In addition to the automated coordination of RAN software upgrades, the development of RAN Intelligent Controller technology allows for non-real-time, and near-real-time orchestration and automation functions that optimize the use of RAN resources. Rice of STL described an "operating system for 5G and the idea is that it's a software platform that essentially sits within the 5G or Open RAN environment." So-called xApps or rApps could do things power savings optimization, zero-touch provisioning, load balancing, and so forth.

Towards 2022: Open RAN and Standalone 5G

Most current 5G networks use new 5G radios and frequencies connected to an LTE network Evolved Packet Core; this is called 5G Non-Standalone. The next step is replacing the EPC with a cloud-native 5G core. The Service Based Architecture of the cloud-native 5G core, coupled with a cloud-based and/or open RAN lets operators conduct cross-domain network slicing, seen as a key enabler of enterprise 5G.

DISH is building a 5G Standalone network, T-Mobile US deployed its 600 MHz spectrum in the standalone mode of operation, and SingTel launched 5G Standalone earlier this year and, more recently, developed new use cases enabled by standalone:

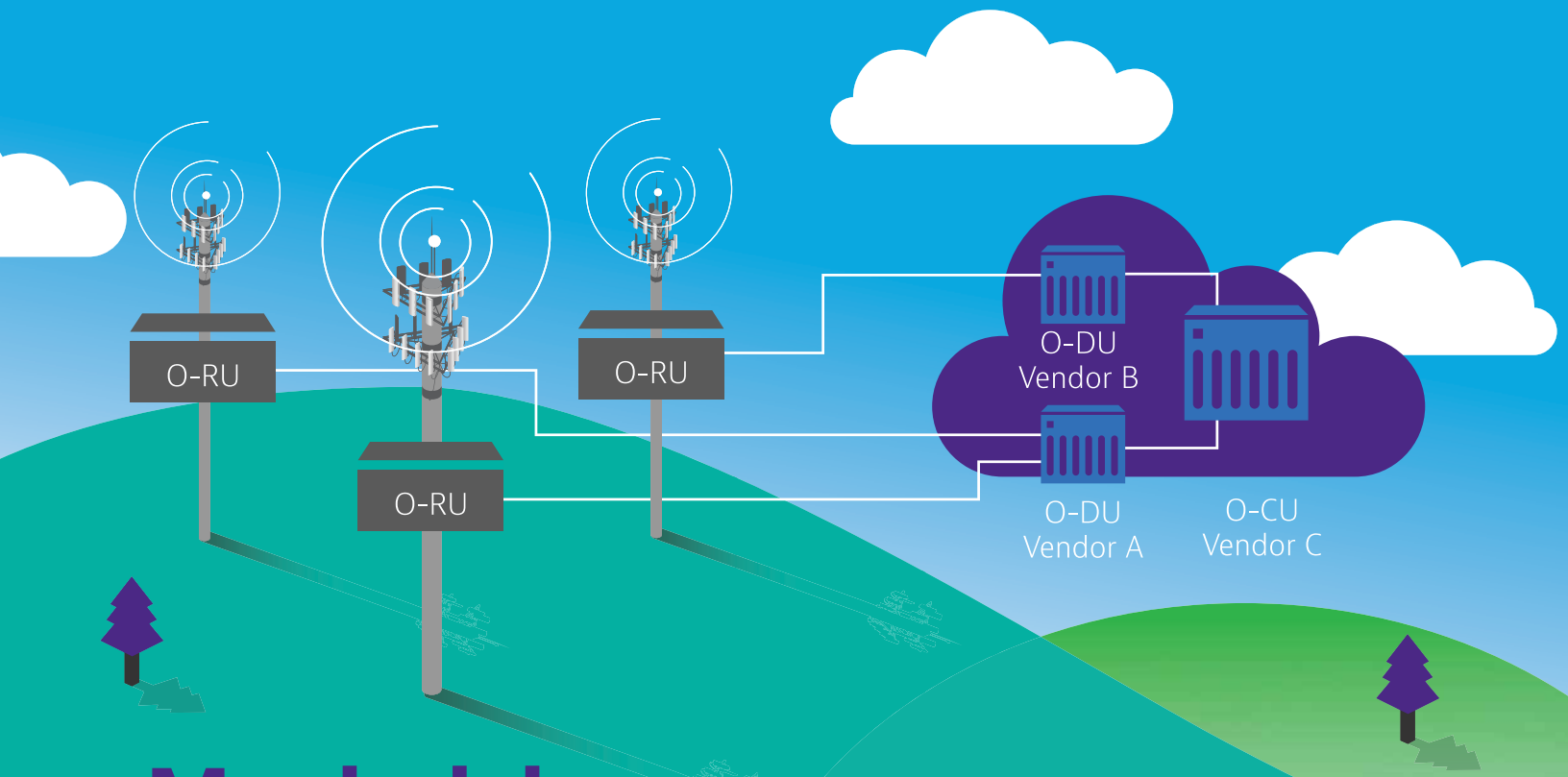
- 5G-powered Remote Racing: Partnering with Formula Square to deliver an immersive, lag-free experience racing remote-controlled cars powered by 5G at Southside, Sentosa.
- 4K live streaming: Working with S.E.A. Aquarium to bring Singapore's first underwater 5G livestream of the S.E.A. Aquarium to UNBOXED, Singtel's unmanned pop-up retail store
- Enhancing the arts and culture experience: Collaborating with the National Gallery Singapore and Esplanade – Theatres on the Bay to deliver cultural and art experiences over 5G, from the Singtel Special Exhibition Gallery and the Singtel Waterfront Theatre when it opens officially next year.
- Co-creating the future of hybrid work: Teaming up with Samsung and Zoom to introduce a Productivity Data Pass plan offering data-free usage of Zoom, enabling customers to connect to family and colleagues seamlessly and lag-free.

"We see next year [2022] as the year for 5G Open RAN. Standalone core is the only option for 5G Open RAN."

Eugina Jordan, Vice President of Marketing, Parallel Wireless

Yuen Kuan Moon, CEO of Singtel said: "With the maturing of 5G technology, we're excited to unlock the benefits of a 5G-enabled reality for consumers and enterprises. Its potential to transform business models and deliver enhanced products and services on a scale like never before, will spur Singapore's digital economy as the country moves into post-COVID recovery. As part of our strategic reset to focus on 5G, we are accelerating our roll-out and the creation of new services."

Jordan said she expects investments in 5G Standalone to pick up in 2022



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Whether your challenges lie in interoperability with legacy technologies, multi-vendor components, or optimizing the performance of your network as a whole, VIAVI delivers a one stop shop, for Open RAN testing.

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Image courtesy of SingTel

and 2023, simultaneously driving investment in Open RAN. "We see next year as the year for 5G Open RAN. Standalone core is the only option for Open RAN. With [Non Standalone] you need to fallback over to your 4G radio vendor. We're deployed in over 50 networks across the globe. Right now with those operators we've been proven. We now have KPIs that are just as good as the legacy networks. We are working on 5G Open RAN. We are delivering software."

Towards 2025: The outlook for Open RAN

Telecoms industry analyst Stefan Pongratz, vice president of the Dell'Oro Group, told attendees to the Open RAN Forum that as operators connect radio site total cost of ownership with savings presented by new Open RAN architectures, revenues derived from disaggregated systems could overtake proprietary revenues in the 2025 timeframe.

Pongratz identified "three broad architecture trends" being addressed by operators and vendors to essentially "do more with less.":

- A shift from centralized to distributed RAN as baseband functionality is moved away from sites;
- a move from custom baseband hardware to general purpose hardware supporting virtualized RAN;
- and a move from closed, proprietary RAN interfaces to Open RAN interfaces.

Pongratz said a big driver here is operators' wanting more vendor optionality as opposed to working with Ericsson, Huawei and Nokia, which control about 80% of global RAN market share. "They want to see more suppliers," he said. "It's not necessarily they want more to work with once they decide…but they want to have a broader selection from the get-go. When it comes to the decision-making then of course there's going to be some collective good kind of thinking, but I also think a lot of the decisions from operators will ultimately boil down to maximizing that TCO over the lifespan of the product."

He also gave a bit of a breakdown of RAN costs noting that wireless

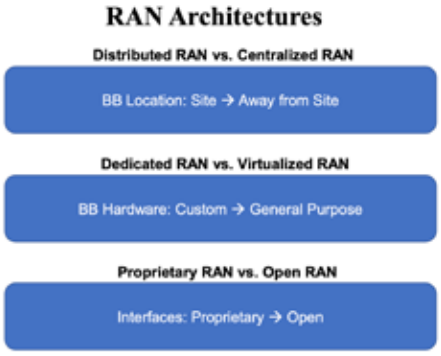

Image courtesy of Dell'Oro Group

capex is around $150 billion to $160 billion per year with RAN representing between 20% and 25% of the capital spend. Drilling down to individual radio sites, this represents between 10% and 20% of total operating budgets. In terms of lowering TCO by switching to Open RAN, vRAN, or a combination of the two, "The likelihood is the majority of [the cost saving]is coming from the non-RAN bucket," things like automation, reducing headcount and improving energy efficiency. "There's a significant non-RAN component to keep in mind."

Pongratz tracked spending on Open RAN solutions showing significant increases from around $100 million in the first half of 2020, to around $1 billion in the first half of 2021. And, "We have just upped short-term and longer-term projections," as more than 80% of the top 20 global service providers by revenue have deployed, committed to deploy, or are otherwise evaluating Open RAN.

"When it comes to how Open RAN will be deployed going forward, I think we kind of envisioned it would be multiple phases," he said. "Some large Tier 1 European operators will say the technology, the architecture, will not be ready for primetime until lets say 2022 or 2025. That's when we see that the Open RAN revenues will actually surpass more traditional solutions. At the same time we now have operators in Japan that have gone from let's say 0% Open RAN to more than 75% or 80% Open RAN in just a couple quarters with 5G. Not all Open RAN is the same; they're doing something different."

Going forward from this initial phase will include increasing focus on multi-vendor deployments, more vRAN, then layering in RAN Intelligent Controller software platforms and white box hardware. "It will take some time to realize the full Open RAN vision," Pongratz said.

Towards 2030: Will Open RAN be foundational to 6G?

Resilient…Critical…Unified…Distributed…Automated

What exactly will 6G be? Given that current research is taking place among academics and technology partners in the private sector well ahead of formalized discussions within standardization bodies like the 3GPP, that's hard to say. It's fair to say it will build on capabilities associated with 6G, straightforward things like less latency, more speed, more embedded intelligence, and so forth, and will tap into new spectrum frequencies, and enable new use cases. But perhaps a better way to understand what 6G could be is to assess the state of currently maturing technologies that will likely inform the answer to the above question.

Below we'll draw on expert commentary from across the telecoms ecosystem to put some stakes in the ground and do a bit of speculation. Let's start with a pragmatic approach courtesy of AT&T Director of RAN Engineering Sinan Akkaya.

"I think when it comes to 6G, the only thing we need to remember here is that every G is created to address certain problems. So the question here is what challenge or what problem we're addressing… As a RAN person, I need to understand if my problem or my client's problem or whatever slice they're on is either latency, capacity or the

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"The industry progress in the last three years has proven that Open RAN will be a critical component to scale 5G deployments, and it is quite clear it will be the foundation of future 6G networks."

Giampaolo Tardioli, VP and GM, Commercial Infrastructure Business, Keysight Technologies

data throughput. Once we know collectively where the challenge is, I think 6G is going to address that."

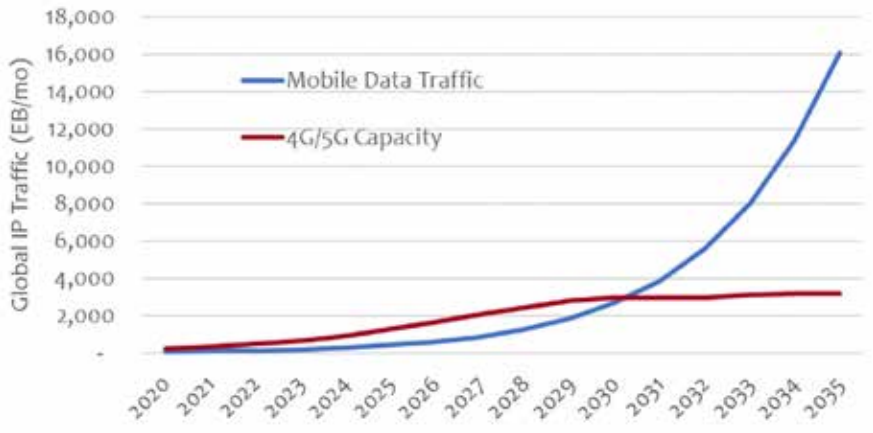
To understand the problem statement, we turn to Joe Madden. Speaking during the 6G Summit held alongside the recent Big 5G Event, Madden, founder and president of analyst firm Mobile Experts, framed the problem: there's a disconnect between the continued long-term increase in demand for mobile data and the available capacity of 4G and 5G networks to handle it. "We're going to see that ongoing growth take place for another 14 years at least," he said, also noting that the vast majority of mobile data is used from indoor locations. "That's a human factor that I don't think will change over the next 14 years. That brings up a conundrum."

To put some numbers to it, Madden pegs current global demand for IP traffic at less than 2,000 exabytes per month. As a reminder, 1 exabyte is 1 billion gigabytes. In the 2029 to 2030 timeframe, he projects global demand for IP traffic exceeding 3,000 exabytes per month. This is in the same general time frame he projects 4G and 5G capacity leveling out in the same exabyte/month range. Going forward to 2035, 4G and 5G will still be delivering approximately that same amount of capacity while demand will have hockey-sticked up to 16,000 exabytes per month. There's your problem.

So, rather than attempting a pre-standard definition of what 6G will be as a whole, let's take a look at some of the characteristics it will likely have.

Orange's Arnaud Vamparys, senior vice president of seamless wireless access, said that when these networks arrive in around 2030, one of his team's goals "is to make sure we have more resilient networks. We all know we are putting more and more stuff for our society on the networks so we need to make sure the next generation increases the resilience. And perhaps, as well, the impact to the lower energy consumption...I see incredible things right now from my research team like zero-energy devices."

Among the private-sector



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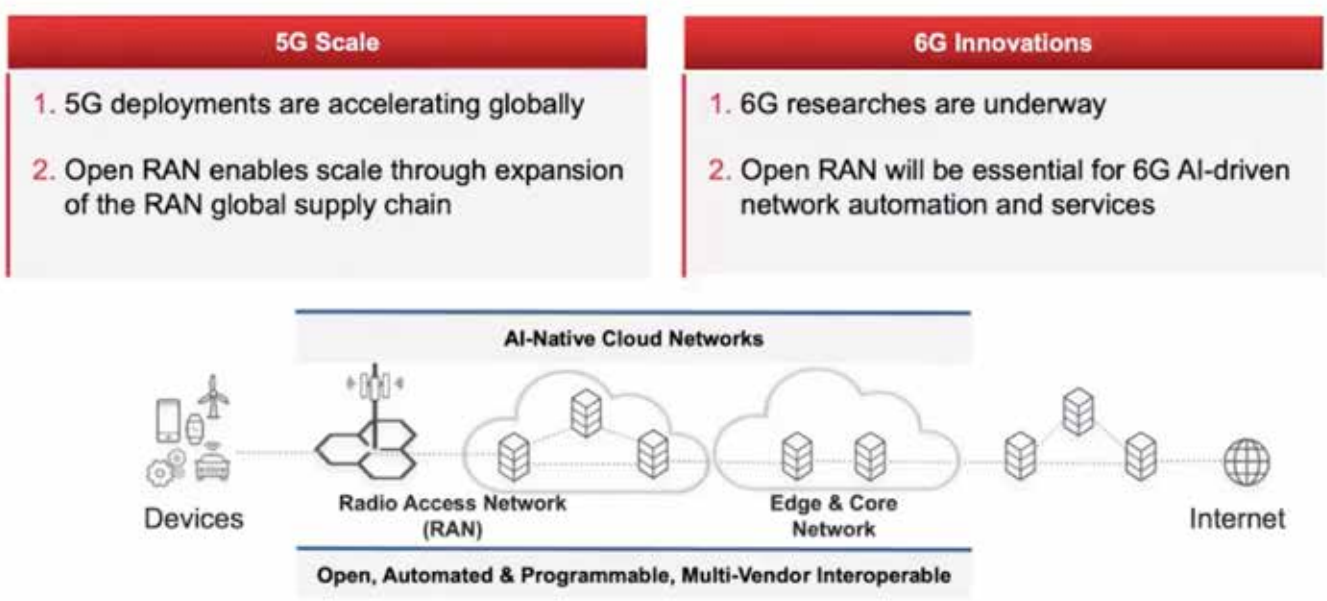

Image courtesy of Keysight Technologies

companies working on framing up 6G, Nokia is viewing this as a "critical network," according to Tanveer Saad, head of edge cloud innovation and ecosystems. "It's more about providing critical services towards our end costumes. We see disaggregation and openness is one of the building blocks for future networks."

This gets us into the role of current Open RAN-related activities in showing a path toward what future generations of cellular will look like--disaggregation, virtualization, distributed intelligence, and other components of current Open RAN study and deployment are poised to roll forward.

"As we add more cloud-based architecture and make it more cloud-native, you're bringing more cloud-native platforms to the edge," according to Sterlite Technologies Limited CTO of Access Solutions Rajesh Gangadhar. "Which just means that the disaggregation that is required between the hardware component and the software becomes even more critical. The radio unit itself can evolve to a highly-intelligent platform." In terms of network and element management systems, "What we see is a sort of unification...That unification is what allows the operator to then have more homogeneous applications across a heterogeneous radio access network."

Keysight Technologies VP and GM of the Commercial Infrastructure Business, Giampaolo Tardioli, described a future where virtualization and openness allow networks to become application platforms, and distribution of AI and ML, combined with CI/CD and continuous testing, enables broad network automation.

"In a 6G future where artificial intelligence-native networks are monitored, optimized and reconfigured automatically...the access to Open RAN infrastructure becomes really a necessity," Tardioli said. "As the Open RAN ecosystem reaches maturity, we will see a significant shift...The industry progress in the last three years has proven that Open RAN will be a critical component to scale 5G deployments, and it is quite clear it will be the foundation of future 6G networks."

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