

TAKING THE LEAP:

Testing, RF and automation in cloud-native networks



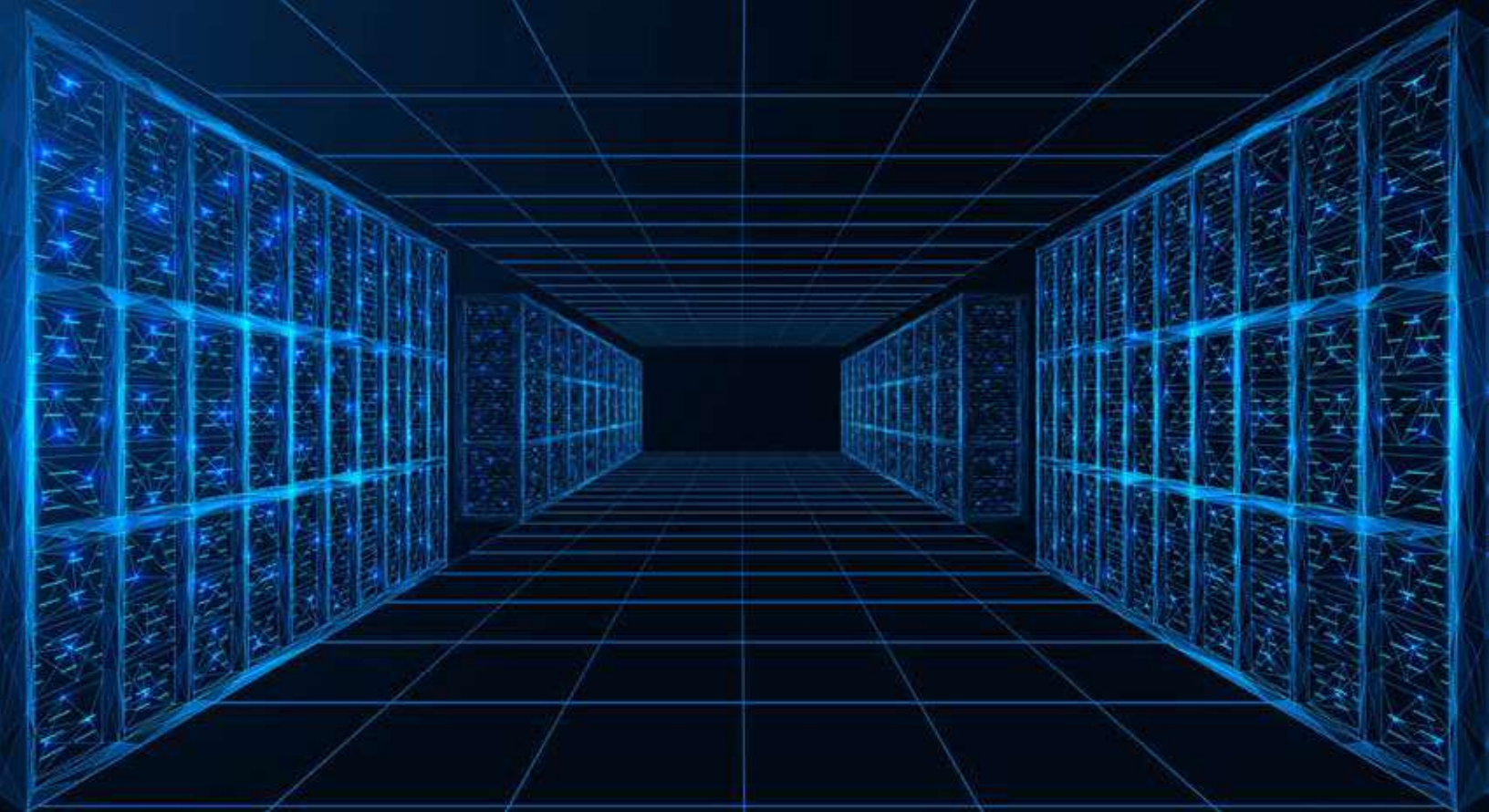
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The cloud transformation of telecom networks is well underway. Nearly half of network capacity—46%—is expected to be “entirely cloud-native” in the next 3-5 years, up from around 31% of telco 4G/5G network capacity currently, according to a recent report by Capgemini Research Institute. The investment is significant: The report estimated that on average, telcos will probably spend about a billion dollars each (on the order of \$200 million a year over the next few years; or an average of \$348 million per year for large telcos with more than \$30 billion in annual revenue) on their cloud-native transformation. But so is the expected pay-off. Telcos anticipate being able to reduce Total Cost of Ownership (TCO) by 13%, reflecting savings up to \$260-\$380 million per year per operator, plus an additional \$110-\$210 million in additional revenues,

particularly if they capture “early mover” status. Capgemini’s survey of 270 telecom executives (of which 170 were from CSPs) found that telcos which had already initiated their move to cloud in the past 3-5 years already report “notably increased” customer lifetime value and improved customer experience.

“Cloud transformation is a fundamental change in the evolution of the network, that has been dominated by physical devices and infrastructure. It represents a significant change of mindset for telcos,” said Jacques Assaraf, global head of telco industry at Capgemini. “Early adopters will reap the most benefits in markets enabled by cloud-based platforms, not just financially but also from a business and sustainability perspective.”

However, that same report found that only about one in 10 telco executives

said that their organization has a comprehensive telco cloud strategy. The shift to cloud-native networks is only one of multiple technology shifts that CSPs are currently navigating. That shift has enormous implications for testing, validating and verification: No matter what, telco networks have to work. Operators wanted a software-centric environment for agility—now that they’re getting it, what does that mean for ensuring service reliability and continuity?

This report examines the evolution of network testing in a cloud-native world.

Multiple, simultaneous tech & architecture evolutions are happening

While this report focuses specifically on the impacts of cloud and network disaggregation, that transformation

isn't happening in a vacuum. It's one of a number of simultaneous shifts in telecom networks that are all happening in roughly the same timeframe, increasing the overall complexity of already complex networks.

Those additional shifts include:

The widespread and rapid deployment of 5G. This one is perhaps the most high-profile evolution, that of the next “G” of mobile networks. 5G is seeing “astonishing” growth, says 5G Americas, and is “scaling faster than any other previous generation of mobile wireless.” In India, the pace of deployment was reported at around 3,500 sites per week in late 2022. 5G connections are expected to reach 1.9 billion by end of 2023 on a global basis; 5G penetration in North America

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grew 78% between the fourth quarter of 2021 and the fourth quarter of 2022, according to figures from Omdia. “It seems like 5G is being deployed much faster than the other technologies. The scale of the work required is a lot and that’s the key area where we’re seeing challenges,” said Gavin Hayhurst, product marketing director



Image courtesy of 5G Americas & Omdia

at Infovista. “Customers are saying, we don’t have enough people to go and drive every site we’re turning on, but we can’t afford to turn them on without checking that they’ve been built correctly and are working correctly.”

The 5G NonStandalone to Standalone jump. The majority of 5G networks thus far have been NSA, linked inextricably to LTE as an anchor. But the true performance gains of 5G—and features like ultra low latency, ultra reliability and network slicing, which are hoped to be the key to substantial new revenues—won’t be realized until the network includes a 5G core. While network virtualization, the precursor to cloud-native, wasn’t specifically tied to a “G,” 5G SA is seen as inherently cloud-native.

New, higher spectrum bands and larger bandwidths. With a dearth of spectrum available in suitably large swaths below 1 GHz, mid-band spectrum (particularly around 2-4 GHz) has been pegged as the “goldilocks” airwaves for 5G. Those bands do require more site density

than lower bands, meaning that more 5G sites have to be deployed (and tested, optimized and integrated) to achieve coverage parity and scale 5G. This problem is compounded at higher mmWave frequencies, which can deliver very high speeds and capacity but over a limited distance, hence why the deployments have largely been limited to large venues, transportation hubs and other high-capacity hot spots.

Multi-access edge computing. Separate but related to cloud and disaggregation trends is the effort to bring computing resources closer to end users in order to reduce latency and improve overall reliability, availability and performance for not only telecom network functions themselves (or certain disaggregated elements of them) or enterprise or consumer applications, with an IT environment at the network edge. Operators are turning to hyperscaler partners for this and pairing it with 5G deployments, such as Verizon’s partnership with AWS Wavelength and AT&T’s announcement in



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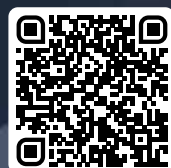


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late 2022 that it would launch a dozen localized “5G edge zones” by the end of the year.

Private networks and services beyond best-effort. One of the ways operators and other players hope to realize new 5G revenues is via private networks, which are also often tied to/include edge computing. But the vision here isn’t simply to provide run-of-the-mill connectivity, it’s to enable use cases such as industrial automation with support for dense IoT deployments and use cases such as computer-vision-based inspection and robotic command-and-control. That means mission-critical connectivity, for a telecom ecosystem that has historically been one of establishing

best-effort service for consumers. “You could be providing a private network to a customer, maybe in the form of a slice, in which case the customer is, I would assume, paying a premium and expecting some sort of service level, a minimum service level. And that quickly starts to go beyond what mobile networks have ever been,” explains Hayhurst. “Mobile networks, ever since they started, have always been a best effort, and if you drop a call, you re-start the call, and if your YouTube video stalls, you close the app and restart it or wait for a few minutes and try again. But as we go into private networks, and there’s production line robots being run over the network, it becomes much more critical to deliver

some sort of minimum service. And the consequences of not meeting that are much greater if production lines stop or accidents happen.”

Open Radio Access Networks.

The shift to cloud and disaggregation is going all the way to the RAN itself, as telcos seek the ability to implement best-of-breed features across disaggregated RAN elements. While they want to avoid vendor lock-in, telcos still want the convenience of a pre-integrated solution, which means that new players are having to work closely and test their solutions and that system integrators have an expanded and newly critical role. As with edge partners, it also raises new questions about who is responsible for the integration, validation and performance of disaggregated network elements.

As networks evolve, so must measurement

Innovations in software and software disaggregation are evolving telecom change on two levels, according to Per Kangru, technologist and business development expert in the CTO’s office at Viavi Solutions. Carriers can either do new things to drive automation or efficiencies within their own network; or, there are innovations going on beyond the network level that require new flexibility to support. It’s a matter of both adapting to a new environment and making sure that you can add value in that environment.



When it comes to the toolsets that are the necessary backbone of software environments, enterprises and cloud players have often turned to open-source options, Kangru says. Telecom players seeking to leverage the cloud may also want to do so, but they face a “scale difference in complexity”, he says, which means those tools only get them so far.

His go-to example for this is the disaggregation of the familiar and basic Policy and Charging Rules Function (PCRF), which is instrumental to the type of service a customer receives and how it is charged for. In legacy networks, a PCRF would have some ingress and egress, 3GPP interfaces that would be monitored, Kangru explains. In the cloud, however, a single PCRF might be made up of 20 individual micro services, each potentially providing data.

“In order to really understand the performance of that PCRF and what may

limit its scale or functions, you have to look at all of those micro services, how they compose themselves together, to form that [cloud-native network function, or CNF],” Kangru says. You still have the 3GPP interfaces to monitor, he continues, but if you just take your methodology from the legacy world of using a virtualized packet monitor or probe that is only monitoring those interfaces, “you’re actually now going from seeing almost everything that there is to see in the legacy world, into seeing maybe 5% of the information in the cloud world.”

Accomplishing holistic, end-to-end visibility in this realm is a major challenge that operators often try to achieve by stitching together point solutions, he explains. “You need to both have the traditional visibility ... coupled with the new visibility of the decomposed microservices role, plus obviously the visibility of your cloud

infrastructure,” Kangru continues.

Multi-cloud or hybrid operations present yet another potential hurdle. That may be the right choice for supply chain security or reining in costs, as well as making a network more failover-resistant and potentially, portable between clouds: All good and valuable reasons to pursue a multi-cloud or hybrid strategy for telecom networks, Kangru acknowledges. But it’s also one where relying only on open-source tools will make it “relatively hard to manage,” he says. “You need to have that end-to-end visibility ... and it grows significantly more complex than ... in the legacy world.”





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But the level of control is also in flux—which is not an easy thing for telecom operators to navigate, but is integral to the very nature of the cloud. Just look at service-level agreements, Kangru says. Asking a hyperscaler for on SLA on their compute or to do an apples-to-apples SLA on a cloud-native function in their cloud that is measured the same way as telcos have done with telecom NEMS and on-prem equipment comes with what he says is the “painful revelation” that either the hyperscaler simply won’t provide it, or that it comes with such onerous and static conditions on configuration and mapping to specific hardware (CPU pinning) that it throttles the benefits of moving to the cloud in the first place. Hyperscalers

are selling availability of resources, which is not necessarily reflective of exposing the actual hardware availability. “If you are truly in the cloud world, you don’t care. You care that you get the right output, but if you measure that in the traditional SLA, you are most probably going to shoot yourself both in the foot and in the head at the same time,” Kangru says.

Kangru compares this transition to the jump to Ethernet IP networks, where it took a number of years for people to trust a shared medium to get information from point A to point B rather than a defined resource.

“It really then boils down to, are you ready to take the leap and let go of those legacy SLAs? Procurement

departments often spend years and years negotiating ... and people’s salaries or bonuses are based on that. Are you ready to let go of them and go into measuring it in a new way, where you truly look at, how would my new 5G SA core deliver a good enough experience?” That should be the focus, he says: The outcome. The output. “If you’re not ready as an operator to change how you’re measuring yourself [and] measuring your vendors, then it’s very easy to get fundamentally lost in the cloud and spend an awful lot of money on something that you could do much more efficiently—or measuring your own organization in ways where it’s not measuring something toward a more





“If you’re not ready as an operator to change how you’re measuring yourself [and] measuring your vendors, then it’s very easy to get fundamentally lost in the cloud.”

Per Kangru, Technologist & Business Development, Viavi Solutions

successful outcome, but potentially to a worse outcome,” he warns.

But how does an operator get to that point? How do you build trust in new systems that don’t necessarily have a perfect analog with the old ones? What exactly are you placing your trust in? Kangru’s answer is reflective of the much-talked-about mindset shift that so many people say that telcos have to make as they move to cloud.

First, he says, you have to essentially trust that you have infinite compute available to handle traffic loads. You

have to trust that your CNFs are disaggregated in such a way that they can horizontally scale (taking into account whether they are stateless functions that simply relay information, or stateful ones that track and respond—which are more difficult to scale up and down), and that you have early stateful indicators of performance thresholds so that you can tell when functions are at 60-80% of their capability and new ones can be spun up. Then you have to trust that your orchestration is capable of managing that infinite resource with the right ability to scale up and scale down (because budgets for cloud spend are not infinite). You also need enough skilled people to build the right orchestration patterns for that system to use, which Kangru says is either solved by having an army of consultants (which itself can become difficult to manage) or by intent-based orchestration models where, as he puts it, you “put trust in that the model plus the computer science will figure out how to go between a current state and desired state.”

The goal is to get to a point where you present a data model of the type and scale of a service—say, 10 million subscribers in a 5G Standalone environment—and the disaggregated, intelligent cloud network can figure out what that means and how to get there, then deploys the necessary functions across compute resources without manual specification and

orchestration. Kangru says that telecom as an industry isn’t capable of that just yet. just yet. But he sees it on the near-term horizon. Viavi, he says, is already working with some individual companies capable of achieving that level of automation, but at this point they are small and their technology may only be validated for a few use cases and scenarios. He sees those capabilities developing over the next two to three years to the point where they could be available across the industry from multiple vendors.

RF challenges in cloud-native, disaggregated networks

Impacts to radio frequency isn’t the first aspect that comes to mind amid the ongoing shift toward cloud-native, disaggregated networks. But that’s not to say there aren’t any, and according to Regis Lerbour, VP of product for network testing and RAN at Infovista, it’s important to talk about RF in the context of the ongoing evolution of testing and disaggregation of networks. After all, one of the focal points for development is disaggregation in the RAN itself.

“The shift to cloud native and disaggregated networks brings a software-centric environment and such an agile environment means a high volume of changes to the network—and all of these changes have the possibility [of effecting] service reliability, service continuity ... in a negative way,”



he said. “So testing is essential to ensure that the network changes do not impact the end customer experience.”

He lays out three ways that increasingly software-centric networks put pressure on RF testing:

Expanding demand. This plays into Lerbour’s comment about the many more changes, and more frequent changes, which become routine with a cloud-native network. But all of those changes still need to be validated to ensure that nothing breaks and that end-user experience is only improved. That means that as changes increase, there is also an exponential increase in the testing demand, he said. Infovista’s customers are seeing challenges mainly around the expanding need to test 5G deployments, new service deployments, private network deployments on top of their existing networks and regulators demanding testing.

Operational pressures. Lerbour describes this as adding a layer of complexity into already-complex telecom networks. “Cloud-native networks will add another layer of complexity in your network on top of everything—2G, 3G, 4G, 5G, etc.,” he explains. “But the headcount for network optimization will not increase. That’s due to the general lack of available skills in the market, and the fact that operators are looking to reduce on costs and pushing every single department to make cost savings.” This means finding ways for people who are not highly skilled telecom engineers to support testing.

Management oversight. Operators are spending billions of dollars on shifting their networks to the cloud and disaggregation—and management, including senior management, wants to keep close track of roll-out progress and network performance. Greater visibility is being demanded by

a wider audience within the carriers, on a near-real-time basis. “They want up to the minute information at their fingertips, whenever they need it, and it’s not acceptable to just send a report ... on a monthly basis, on the status of the network,” he said.

“With cloud-native, and specifically with disaggregated networks, testing becomes more challenging. But,” Lerbour goes on, “the key outcome remains the same. We are still looking to validate that the end-customers receive the quality of service they expect, and the quality of experience they expect.”

Lerbour sees test evolving in several ways to meet those three challenges. The cloudification of network test, so that testing benefits from the cloud in the same ways that the network itself does, through increased availability, scalability and agility through centralizing the management of network testing. “If the burden of field testing is removed from the field engineers, they can manage many more testing projects, and the testing can be successfully scaled with the same amount of RF experts,” he said.

Infovista is also using smartphones as the primary testing device for the network, which allows a reduction of complexity of testing a disaggregated network and produces test results “that align with how an end-user would use the network,” he notes. Its TEMS testing app additionally relies on automation and artificial intelligence for very

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practical applications in the field: Guiding users to strategic test locations, including intelligent selection of drive-test routes, then automatically running tests and notifying the user when tests are complete and the tester can move on, which allows more tests to be conducted in more locations even when additional RF engineers are not available. Smartphones can also be deployed proactively as automated test probes at key locations in order to monitor RF conditions 24/7, with remote access and control by telecom engineers so that they can be used to validate the more-frequent network changes that come with disaggregated and cloud-native networks. “You can run regression testing before and after a planned network change. That means you can validate network changes without deploying any field testing teams,” Lerbour says.

Are automation and AI the solution? Possibly, in part.

Every “G” brings new complexity, and 5G is no exception, as outlined in the first section of this report. The number of combinations and scenarios that could be tested is far beyond the time or expense that any operator could devote to it, and the sheer amount of information coming out of networks is already beyond human ability to sift through. As network elements are disaggregated, an already complex system only gets exponentially more complex.

The hope is that automation and artificial intelligence will be the key to assisting humans in the deployment, testing and management of cloud-native networks.

“The demands being placed on service assurance, experience measurement and insights into customer



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Regis Lerbour, VP of Product for Network Testing and RAN, Infovista

expectations are enormous - and the communication service provider (CSP) will need every part of their business working together towards this goal to succeed,” summarized Ericsson in a recent assessment of the impact that AI will have on networks.” By leveraging

O-RAN Testing Progress

One measure of the progress of testing evolution as networks become further disaggregated, is to look at the trends in the testing and focus of Open RAN development as reflected in O-RAN Alliance plugfests. The alliance has established a cadence of spring and fall plugfests at regional Open Testing and Integration Center (OTIC) labs in Asia-Pacific, Europe and the United States.

Let's look at the recent European events as an example. In the spring of 2022, Telefonica hosted the plugfest at the European OTIC in Madrid, Spain, with five companies participating in testing focused solely on aspects of open X-haul transport, including data plane functional and performance testing as well as syn-

chronization. There were three set-ups with different transport equipment, two instrumentation vendors and one transceiver vendor; according to a plugfest report, more companies were interested in participating, but there were resource limitations.

The fall O-RAN plugfest event in Europe was far larger, with Deutsche Telekom, EANTC, EURECOM, Orange, TIM, Vodafone and BT teaming with the Telecom Infra Project (TIP) to host a joint event across four European labs. Twenty-eight test scenarios were in play, including conformance testing of the open fronthaul interface of the O-RU and O-DU, end-to-end multi-vendor integration with functional and performance testing, xApp/rApp integration

with Near/Non-RT RICs and xApps/rApps functional verification, O-Cloud platform performance testing. In total 41 companies and organizations from all over the world participated in the PlugFest.

"Testing and integration at O-RAN PlugFests show increasing maturity of O-RAN technology in all regions," said Linsheng Liao, O-RAN TIFG Co-chair and Senior Project Manager of CMRI. "Comparing the PlugFest results year to year, we are pleased to see major progress made by the O-RAN ecosystem in conformance and interoperability tests, as well as more advanced end-to-end and network automation scenarios. O-RAN PlugFests greatly contribute to developing commercially available O-RAN networks."

AI, communication service providers (CSPs) can manage increased complexity, improving the customer experience while maintaining high network performance."

But what does that actually translate to in the real world, both now and in the near-term? In an interview at Mobile World Congress Barcelona, CEO Igor Leprince of Boldyn Networks (formerly BAI Communications, including the infrastructure companies Mobilitie and Transit Wireless) said that his company has seen firsthand how network architectures and edges are evolving. In New York City, for example, he said that as Transit Wireless has nearly doubled the footprint of its network, the number of infrastructure "boxes" that it has to deal with has been vastly reduced due to implementation of virtualization, and less data center space is needed even as the

footprint of the network expands further away from the data centers in the area. Meanwhile, "There is a lot of automation coming into play," Leprince added, particularly in the ability to access and manage equipment remotely—which has changed how the company manages its field teams, and ultimately results in less disruption in a transit environment like the New York City subway, where trains have to be stopped when tunnel equipment needs to be accessed physically

In some cases, leveraging AI may mean integrating capabilities that seem simple. AI doesn't have to be able to autonomously manage a network in order to bring value. Lerbour offers up the example of an Infovista solution that leverages AI for optimized drive-testing routes and directions to specific locations (an application of AI that many of us take for granted), automated

conducting of testing once there, and notifying the tester to move on once the tests are complete, with near-real-time, cloud-based, centralized reporting.

"Engineers can manage 100 people in the field doing the testing, instead of needing 100 RF engineers in the field to be able to scale verifying thousands of 5G sites," Hayhurst explained, calling this approach to scaling a "midway step" between highly manual testing processes and networks that may someday be fully automated. "The niche in which AI truly thrives is in automating repetitive tasks, acting quickly and efficiently, and freeing up staff or resources to be used in other areas," says Ericsson.

AI, then, leads inextricably to automation. The Capgemini Research Institute survey showed that, following the shift to telco cloud, around two-fifths



(41%) of the work of network engineers, architects, and administrators has the potential to be automated.

Does this mean that AI/ML and automation will put RF and telecom engineers out of work? The survey suggests that instead, those experts be shifted from field work into managing lower-skilled workers and cloud-based systems that tie into their expertise. Hayhurst of Infovista is also skeptical that telecom engineers will be any less needed, for several reasons. For one, there has been a persistent shortage of RF experts in the industry for years that operators still have to work around; and for another, technology advances often take longer or have different workforce impacts than expected. He

points to the example of Self-Organizing Networks (SON).

“I think what happened is, everybody thought that SON was going to come in and in five years’ time the networks ... would just turn on and they would just run and you would never think about it,” Hayhurst says. “So there wasn’t a big drive to expand the pool of people to operate them, because well, that whole area [was] going away and we won’t need these people. And it hasn’t gone away. It’s probably not going away for awhile. ... I don’t think the autonomous network is going to happen for a very long time.” Those industry expectations, though, influence people’s areas of focus and education—no one wants to be out of a job in five or 10

years, in an industry that is notoriously fast-moving. And paradoxically, those expectations mean that individuals and companies don’t plan for what they’ll need if such things don’t happen, or don’t happen as quickly as they anticipate. In a world of changing test requirements and scale, the combination of relying on human and machine intelligence will be key to managing the complexity of networks.

Key takeaways:

- The shift toward cloud native and disaggregated networks is not tied to any particular technology or “G”, but is one of multiple simultaneous evolutions happening in telecom networks that add complexity to testing, measuring and assuring networks.

- As they move to cloud, operators have to adjust their expectations, requirements and mindset to a radically new environment where end-to-end visibility is a challenge and outcomes need to be the focus rather than specific SLA requirements.

- Testing tools and strategies should take advantage of the cloud themselves, for centralized reporting, wider availability, flexibility and automation.

- Artificial intelligence and automation hold promise in reducing the amount of manual work and simplifying test, but the point at which AI and full autonomy might come to telecom networks on a large scale is still highly uncertain. (())

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