RCR Wireless News
INTELLIGENCE ON ALL THINGS WIRELESS

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Test and Measurement Forum 2023:

KEY FINDINGS REPORT

TEST AND MEASUREMENT FORUM 2023: KEY FINDINGS

5G, Open RAN, millimeter-wave and midband spectrum — networks are evolving faster than ever. Operators must ensure that these rapidly-changing networks are working as expected and providing human users and connected devices with the level of experience and performance that they need. How does testing keep pace, and what are some of the most salient challenges that operators currently face in testing and assuring their networks?

That was the focus of the 2023 virtual Test and Measurement Forum, a daylong discussion of various aspects of current testing issues in modern networks, from timing and synchronization to network slicing and looking ahead to the development of 6G.

This report summarizes those discussions and highlights the primary points made by the participating experts over the course of the event.

HOW ARE NETWORK TESTING AND MONITORING CHANGING IN MODERN NETWORKS?

Right now, 5G testing is by and large focused on the new features and performance of 5G; in time, the main emphasis will shift more toward 5G-specific services, according to Jon Van-Orden, who is the head of engineering for NEC's 5G Center of Excellence. "A lot of the work that we're doing at the moment is really an extension of what we've been doing before," Van-Orden said. "But … there's going to be new services coming in. … [These] are going to require new ways of not only testing the solutions, but also monitoring and measuring how that is actually really performing in the network."

Ian Fogg, VP of analysis for Opensignal, ticked off a number of complicating factors for current testing: Devices that must connect simultaneously to multiple frequency bands across a wider range of airwaves, and in general, the multiplying number of features and capabilities that are available to carriers across both the Radio Access Network and the 5G cloud core.

Ian Fogg

"There's lots of complexity," Fogg said. "And that means that you need to have multiple ways to measure what's happening. … You need ways of comparing not just how your network is doing to make sure it's working in the way you think it is, which is where an outside in methodology is very useful, but also to compare against your competition." After all, he offered, there is a direct relationship between the network quality that people experience and their likelihood to drop their carrier and try another. "The ultimate test, is does the user get a good experience?" Fogg said. "Does [the network] actually do the right thing that you think it's doing?"

Meanwhile, the demands on networks to provide different types of experiences for both humans and IoT devices are changing as well: Massive machine-type communications, Fixed Wireless Access and traditional mobile users—each one with very different needs in terms of bandwidth and latency requirements—are all increasingly being served from the same network. "The operator is still using the same spectrum, the same technology to deliver those services, but now he's got different requirements and different end-users requiring different things from the same infrastructure. That becomes incredibly complicated to manage," Van-Orden said, going on to note that a decision to optimize one particular service can have big impacts on how well another one performs.

Observability is key, Van-Orden said at one point. But how do you balance breadth and depth of testing, when the network can provide ever-more data that may or may not be actionable or relevant to performance and end-user experience? "Clearly you want to go broad, but you also want to go deep. If you try and go broad and deep, you just end up swimming in large amounts of data and not being able to understand what's happening," Fogg said. "If you go super deep without having the breadth, you are going to miss things."

There was some hope, at least, that both time/maturation of various technologies and automation will help the industry to navigate the amount of data. "New features have to be tested to a deeper level than the… pre-existing features. So you've always got this trade off between regression testing of existing features and the depth of the new features," Van-Orden explained. "And that'll be the same for operators introducing a new feature into their network as well. I think the key to it [is] automation. … The collection of data, the automated analysis of that data and then using machine learning to make decisions based on that data is going to be the way to try to address some of these questions about how do you get the best without just drowning in data."

Jon Van-Orden

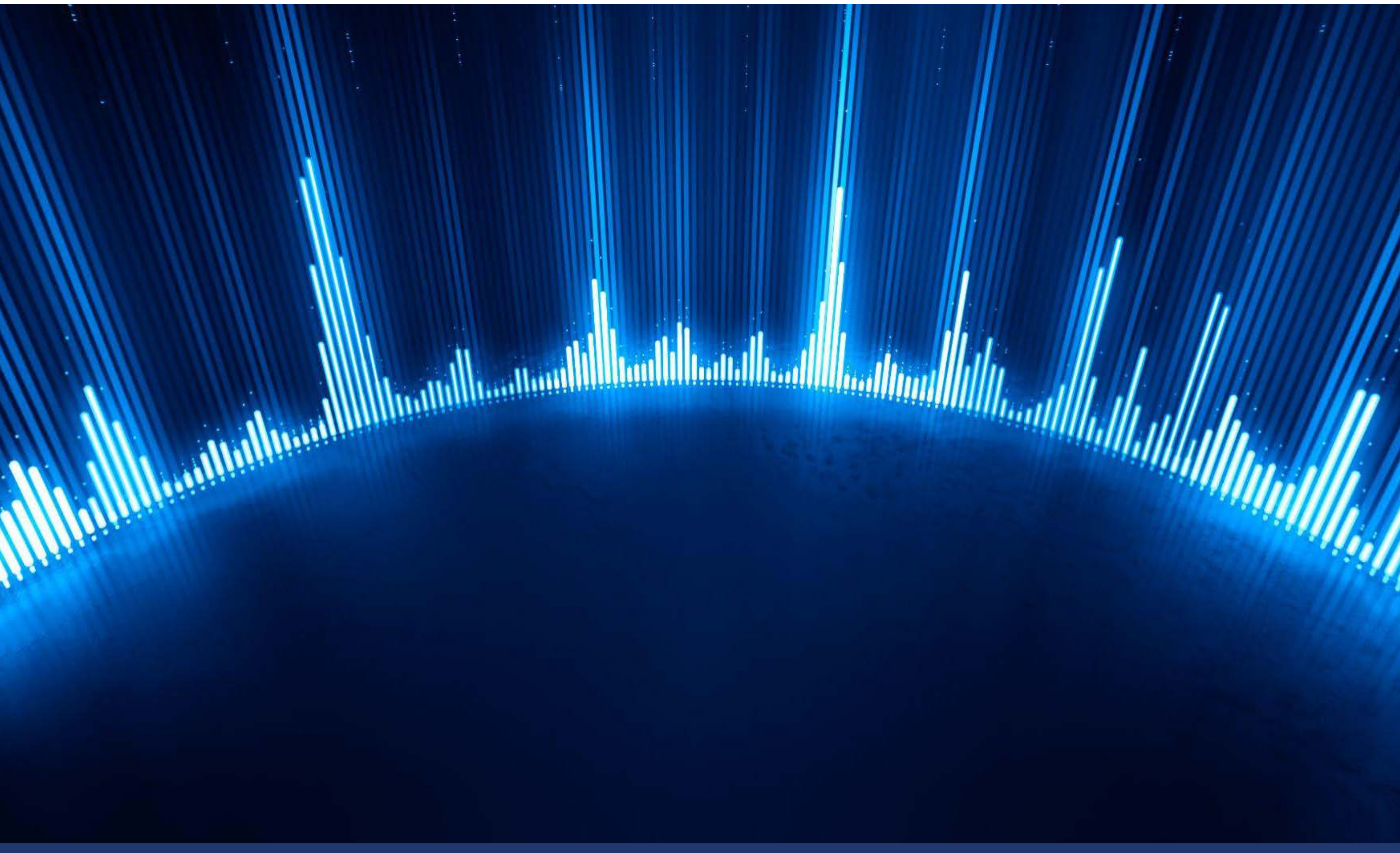
MANAGING A NEW RF ENVIRONMENT

Regis Lerbour, VP of Product, Network Testing and RAN Engineering at Infovista, also addressed how operators can leverage automation, AI/ML and the cloud to cope with the increased demands in RF testing and ensure the successful deployment and operation of their 5G network.

"Given the current RF environment, this means traditional RF testing approaches will need to evolve," Lerbour said. "Demand is increasing, as 5G rollouts are introducing [a] massive amount of new sites and … these sites need validating and tuning. In addition, new services are being introduced through new dedicated slices. And regulators are placing demands on operators to report on subscriber [quality of experience] in specific physical locations. That means that the volume of network testing is increasing and we need solutions for engineers to get more done in the same amount of time."

He also explained that network operators now understand the importance of evaluating the network performance not just based on KPIs, but on how the end users experience the network, especially when it comes to retaining corporate customers and VIP users. "So you need a solution that tests the network as your subscriber sees it, so that you can improve their experience. Also, management needs to be kept up to date with how the rollout is progressing and how the 5G network is performing. You need to have the ability to automatically, in near real time, provide status reports to senior management directly from the solutions," he added. Remote, cloud-based, automated testing capabilities can support more efficient use of tech and engineers' time.

Regis Lerbour



5G FIXED WIRELESS ACCESS CPE TESTING CONSIDERATIONS

Khushboo Kalyani

Arguably the most successful 5G use case thus far has been Fixed Wireless Access for broadband services. Kushboo Kalyani, product manager for test company LitePoint, delved into some of the value propositions of FWA for both the operators and testing considerations for FWA customer-premises equipment (CPE).

Kalyani argued that for operators, FWA allows for improved utilization of available spectrum, as well as the use of the same infrastructure that is being deployed for mobile broadband. For end customers, FWA can deliver higher data rates. However, she also pointed out that consumer adoption is contingent on a CPE device's performance. "If your CPE device is not able to offer you performance … comparable to fiber, then there is not much incentive for consumers to make that shift," she said. Therefore, adequate device testing is key to FWA adoption. For LitePoint, there are four major aspects of FWA CPE devices that should be thoroughly tested: Verifying antenna performance and power calibration, which both relate to range and link stability and reliability; coexistence testing due to the variety of spectrum that must be supported in both 5G and Wi-Fi; and functional verification including measuring the end-to-end throughput, to ensure quality performance.

"All of this testing would have to be accompanied with an automation software tool to ensure that there is minimum engineering effort," she stated, adding that it's important to choose a comprehensive test set up that will simplify the overall test process.

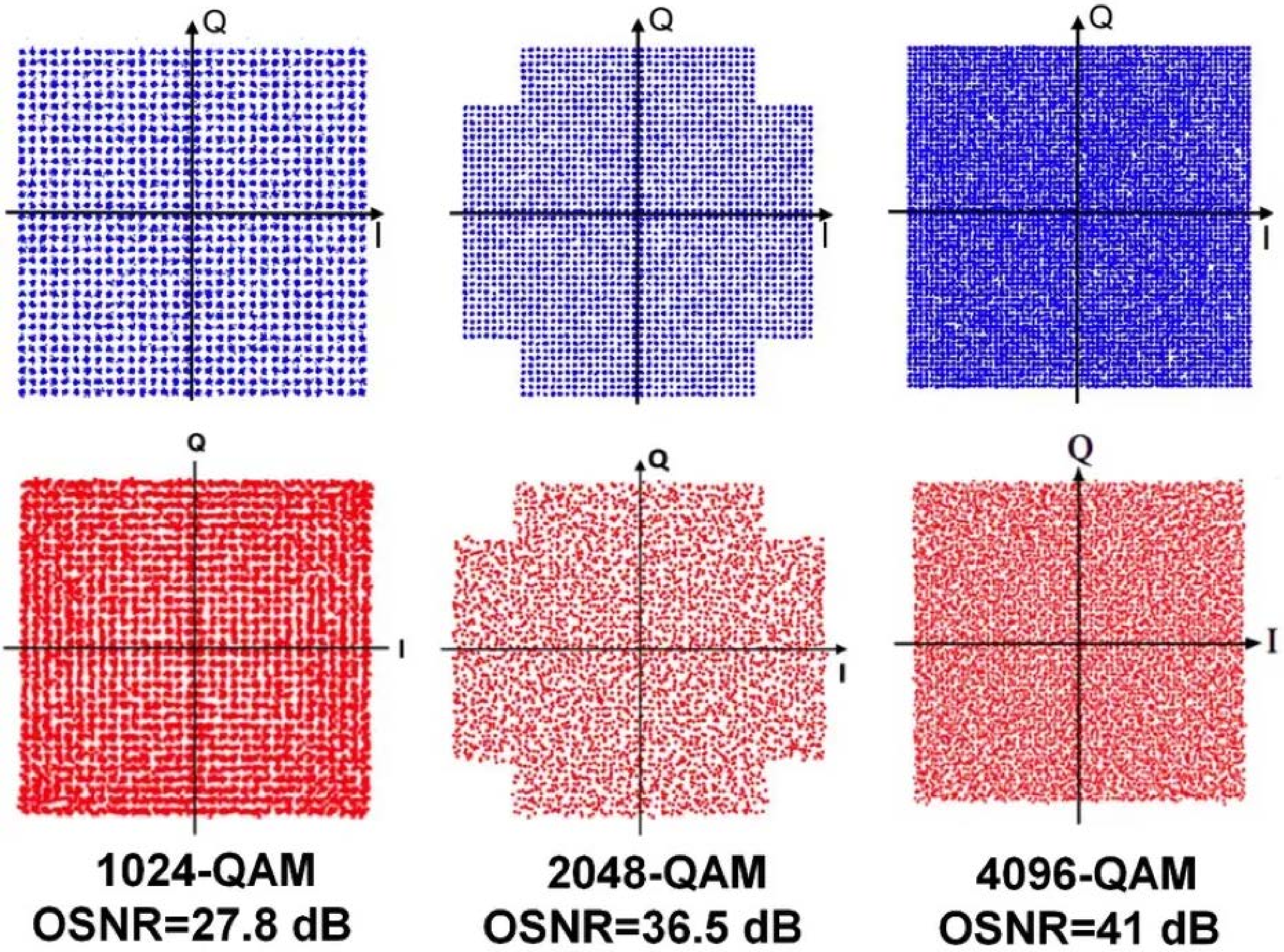
Kalyani also outlined another challenge facing the test and measurement folks at the moment: Test limits that are getting tighter, using Wi-Fi 7's denser modulation scheme 4096-QAM and 320-megahertz channels as examples.

"In order to be able to achieve that higher data rate with such dense modulation, the EVM performance has to be extremely good, and the limits are getting tighter by the specs," she continued. To measure wireless modulation, testing companies use a metric called Error Vector Magnitude, or EVM, which measures the deviation of actual transmissions from their ideal locations in the constellation diagram, capturing the sum of these imperfections to decipher a device's transmit accuracy.

In higher-order modulation, the constellation points are more susceptible to noise and non-linearities because they are closer together, making it more difficult to assess a device's modulation and demodulation capability.

With limits so extreme, explained Kalyani, the test performance must have notable "headroom over the device's performance" to make sure inaccuracies are not being masked and that signal quality is being ensured.

A second area where requirements are tightening up is in timing and synchronization. In part, this is because the "goldilocks" midband spectrum that is prized for 5G deployment is Time Division Duplex (TDD) spectrum, where the uplink and downlink share the same frequency band and must each transmit in the right time slot, explained Sebastien Prieur, solutions manager for mobile and cloud solutions with test company EXFO.



Credit: Li, Si-Ao & HUANG, HAO & Pan, Zhongqi & Yin, Runze & Wang, Yingning & Fang, Yuxi & Zhang, Yiwen & Bao, Changjing & Ren, Yongxiong & Li, Zhaohui & Yue, Yang

Timing and synchronization are also crucial to capabilities such as dynamic spectrum sharing, coordinated multi-point, industrial IoT and other mission-critical applications, according to Prieur, and the importance of timing is becoming more crucial with the move to 5G Standalone.

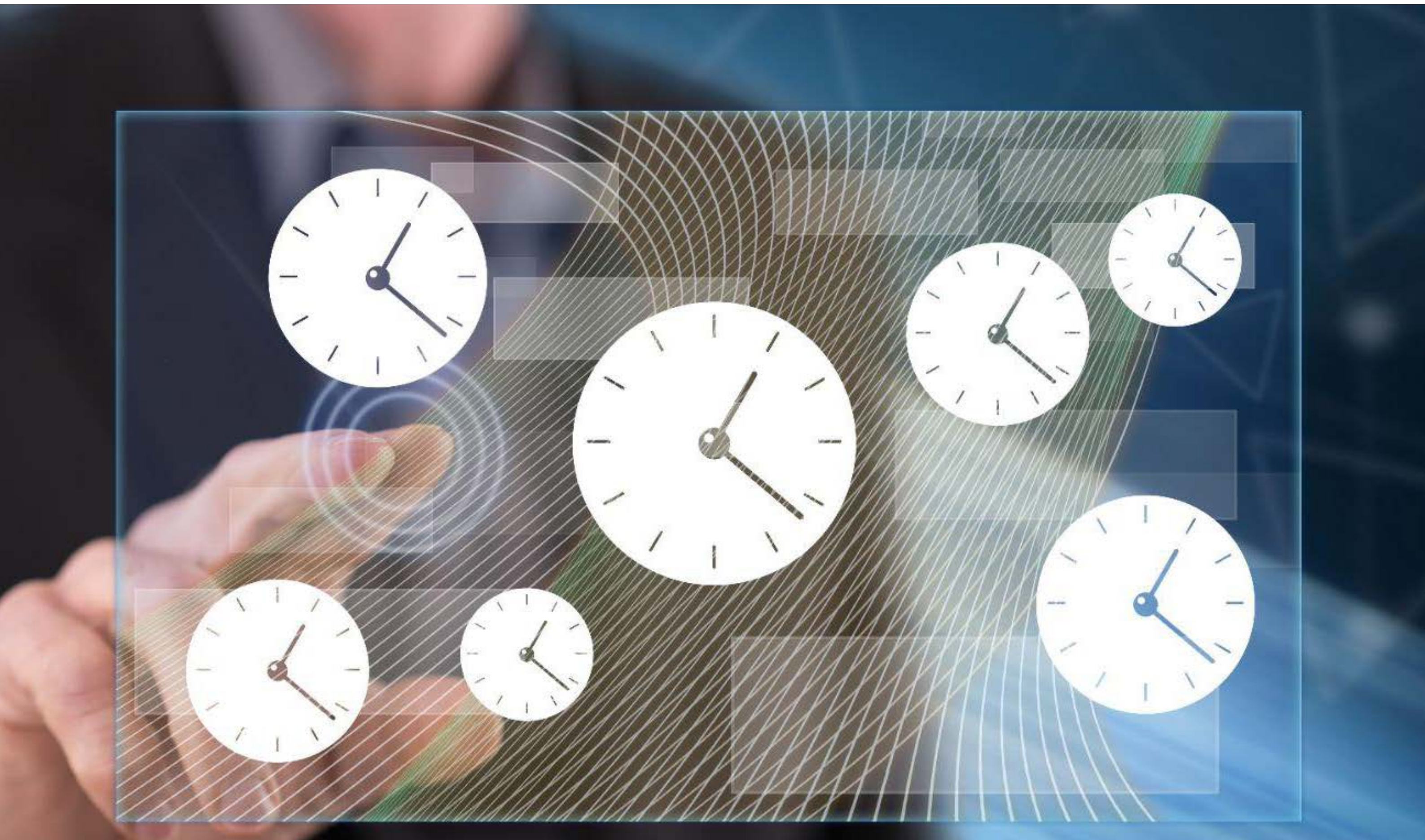
The impacts of timing issues are very similar to symptoms of RF interference issues. A cell site out of sync will create inter-cell interference and have RF performance issues, handover issues, data corruption and overall reduction in transmission performance. The tolerances are tight: An absolute time error of 1.5 microseconds has to be met between the user equipment and the primary reference clock. Because of the dynamic nature of mobile networks, there can be configuration issues, equipment failures, network asymmetry and other problems that increase the time error in the network or cause the 1588 timing protocol to not be delivered correctly.

"You have to be really aware of what is introducing time error," said Kevin Boyle, director of transport solutions at Ericsson, emphasizing that serious consideration has to go into how timing is provided and distributed. "If you're distributing across a network, you have to account for everything. Every node that's in there is adding time error. You have to be aware of that. Building a timing network is not as easy as plugging in a bunch of ethernet cables, and doing some IP addressing, and it'll work. You have to be conscious of this time error that you are getting with each hop and be very thoughtful and precise in how you are building that out." That includes accounting for long fronthaul links in centralized or virtualized RAN set-ups, he pointed out.

Prieur says that timing issues will continue to manifest as 5G networks mature and shift from NSA to SA.

"The reality today is … we are implementing mostly Non-Standalone networks," he said. "The core is still 4G, the evolved packet core, the control, the uplink—we still have the possibility when we are using the 5G network, to fall back on the 4G network. This is, I think, hiding a number of timing issue that we are not currently really seeing currently." Moving to 5G Standalone is likely to reveal timing and configuration issues, he added, and more users and traffic on the 5G network will also make more apparent the impacts of timing on quality of service.

Sebastien Prieur



AUTOMATING THE LIFECYCLE OF THE 5G CORE

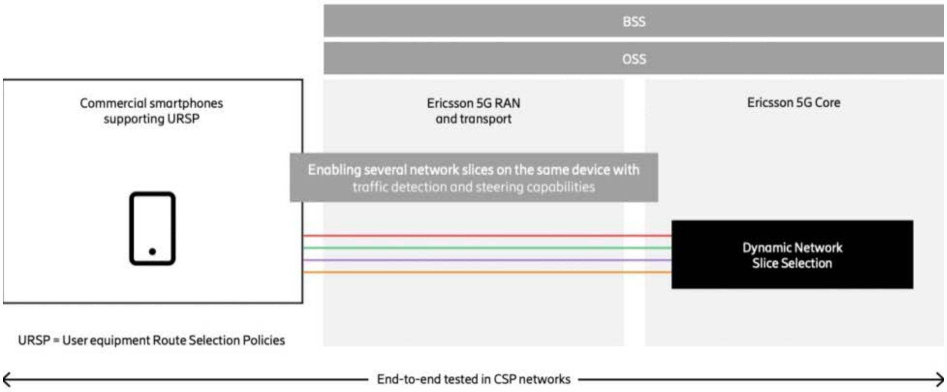
Service providers should think of their networks as a platform that can provide 5G "network as a service" capabilities on which various outcome-based business models and applications are built and delivered across multiple verticals and industries. And at the heart of this "network as a service" platform is the 5G SA core, said Anil Kollipara, senior director of product management at Spirent Communications. Deployment and management of the many virtual functions of a true cloud-native core can be a daunting task for service providers, who are already struggling to keep up with the pace of change in the telecom industry.

"We need to completely automate the lifecycle of the network. Think about a scenario in which specific micro-services need to be updated in the network. They cannot take months or weeks to do that, or even days. This needs to happen in a couple of minutes. And we have examples from the enterprise that this needs to happen in such short timeframes, the only way that that will happen is through complete automation of the lifecycle," said Kollipara.

He went on to give the example that Spanish operator Telefonica estimated that the integration of the Spirent Landslide offering with its 5G core automation platform has led to a significant improvement in the time it takes to test and validate functionality, performance and security throughout the lifecycle of its 5G private network stack.

Anil Kollipara

BARRIERS TO NETWORK SLICING



A logical, virtual, end-to-end network slice that automatically comes into being to serve the exacting requirements of a particular horizontal or vertical use case—that's a big part of the vision of 5G and the monetization opportunities it can support. But network slicing has yet to meaningfully be realized in the real world. So what exactly are the big barriers here, and how is the telecoms industry working to get things sorted?


Mark Watts

"From a technology point of view, we have most of those basic assets to realize slicing," said Ericsson VP of Architecture, Technology & E2E Solutioning Arvinder Anand, noting that Ericsson is involved in around 50 network slicing proofs of concept. In terms of business case and go to market, "I think most of the verticals out there, or enterprises, they want proof points…It's extremely important for us to educate our enterprises on the benefits of slicing, and engage them in trials to develop those proof points."

As for the operational readiness piece, he said, "Slicing is a fundamental shift…there is definitely a strong need for an organizational transformation." This comment applies more broadly than slicing given the ongoing move to software-centric networks being operating in distributed hybrid cloud environments; this approach benefits from an agile workforce organized following a DevOps methodology. "This is one of those key priority areas, and it sometimes takes time," Anand said. "It should therefore be started in parallel with technology and business planning."

Providing perspective from an operator, Verizon Associate Fellow of Global Network and Technology Mark Watts tied network slicing to the ability to "capitalize on the investments we have made within the 5G space." Sketching out the broad strokes of how network slicing could be implemented, Watts called out that a persistent slice would clearly be an easier first step than a dynamic slice. He also said that the all-important assurance aspect of a service running across a slice brings complexities in monitoring and optimizing. But, "Five years ago we may not have had the correct tools or mechanisms to test into the network in multi[ple] directions in faster frequencies of sampling. We can do a


Arvinder Anand

lot more now than we could in years past…The technology is converging."

Elaborating on the test piece, Signals Research Group VP of Network Technology Emil Olbrich talked through the importance of service management and orchestration in aligning different network domains and resources for a slice. "The magic thing that glues this all together is this orchestration that the vendors sell." Part of this is allowing applications to access the network infrastructure. "You're giving a lot of trust to a vendor. …That's a big mind shift."

Olbrich also stressed that before the network slicing conversation matures, operators need to focus on the transition from Non-standalone to Standalone 5G which brings in a cloud-native core. "I think getting SA moving as quickly as possible … the rest will follow suit."

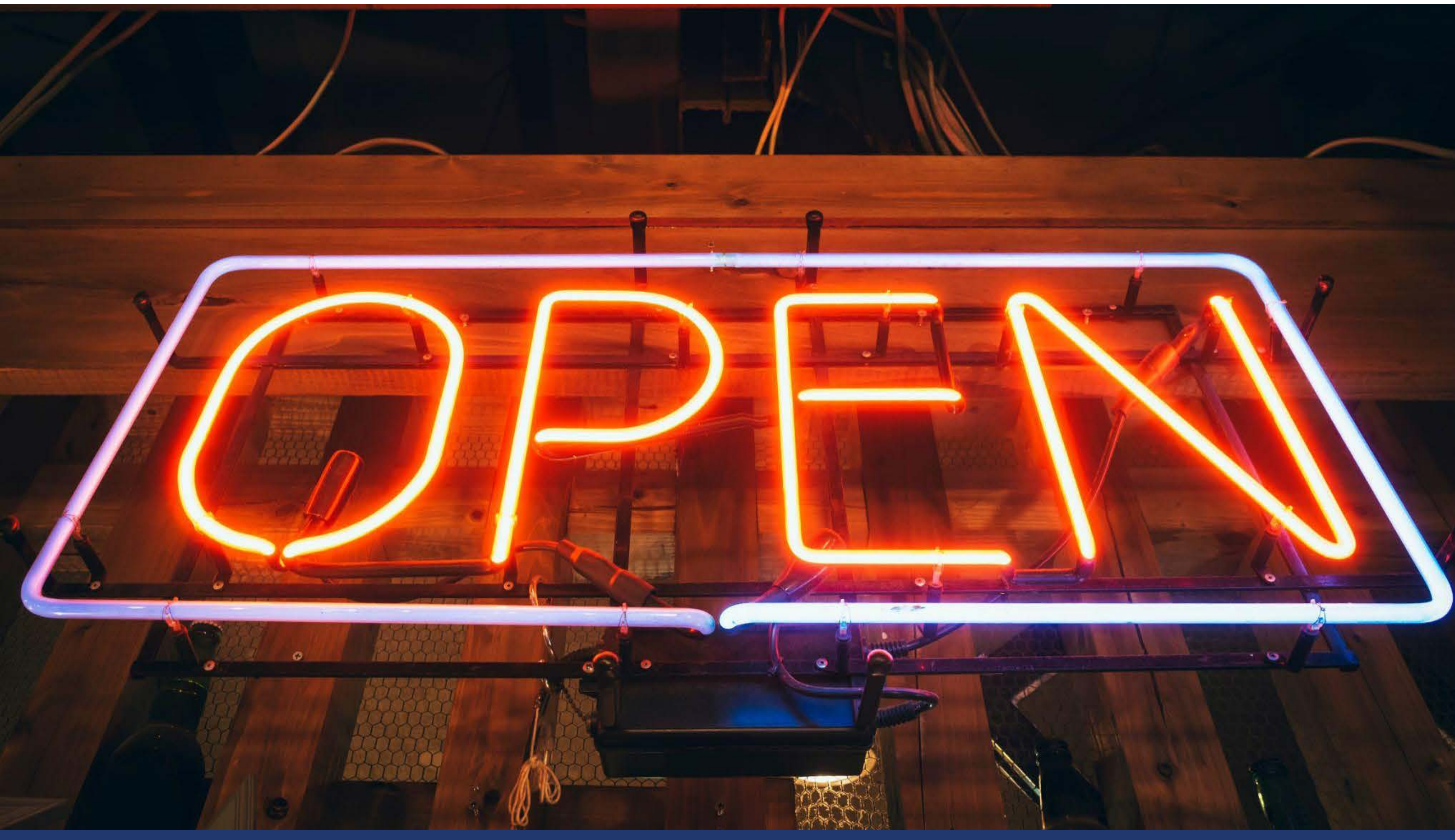

Emil Olbrich

O-RAN AND RIC TEST CHALLENGES

Open Radio Access Networks pose both an opportunity—for new flexibility and agility within the RAN and the ability for network operators to re-set vendor relationships—and a challenge of interoperability among freshly disaggregated network elements. Making sure that new features and functions actually work as anticipated, and play well with solutions from other vendors, is a challenging task, one that test and measurement vendors have been particularly deeply involved with as Open RAN has evolved.

What are some of the specific challenges? Open RAN covers multiple network domains, pointed out James Kimery, VP at Spirent Communications, and the need to validate for conformance and interoperability as well as performance across those domains. "You are dealing with protocols, but you're also dealing with RF, and if you want to validate those network for conformance, for interoperability, you need to make cross-domain measurements, because some implications of protocol issues will only be visible on the RF side," Kimery said, later adding: "Conformance is table stakes. You have to make sure that you have performance, but you also have to really understand how it operates in the field."

There is also more potential for variation across operators for deployments. While the implementation of standards has always involved vendors making choices about how those standards are implemented to establish their own unique "flavors", and MNOs ultimately establishing what features and functions will be live in their networks and at what cadence, Open RAN provides a standardized foundation but with a far wider variety of potential implementation points. "When it comes to Open RAN, we actually opened up everything. Operators can test RU separately, DU separately, and CU separately and then integrate it together to make it a complete ecosystem which is best suited for the use cases that networks deploy," said Sandeep Sharma, VP and global head of Tech Mahindra's 5G/RAN/O-RAN portfolio. "For example, for enterprises there might be different set of requirements, for cellular networks there might be different set of requirements."



Energy efficiency has also emerged as one of the driving reasons that mobile network operators are interested in applying O-RAN to their network, because it offers potentially faster realization of energy savings—but it has its challenges, said Jean Manuel Dassonville, strategic planner at Keysight Technologies. The best way to save energy within the network, he explained, is to add elasticity: Turn resources off when they are not needed. "From a test point and measurement point of view, what's interesting is, that one of the first challenges is the metrics," he continued. "At the system level it's pretty straightforward to characterize the energy efficiency of the network. … But as you zoom into the different components of the network, the metrics become a little bit more challenging. How do you test the energy efficiency of a virtual network function? How do you test a radio's energy efficiency? Is it data per energy or is it data per distance per energy? How do you incorporate the spectral efficiency there? We realize that there are a lot of interesting challenges to properly characterize each component of the network for energy efficiency." Again, this means still more cross-domain testing by adding measurement of the energy domain.

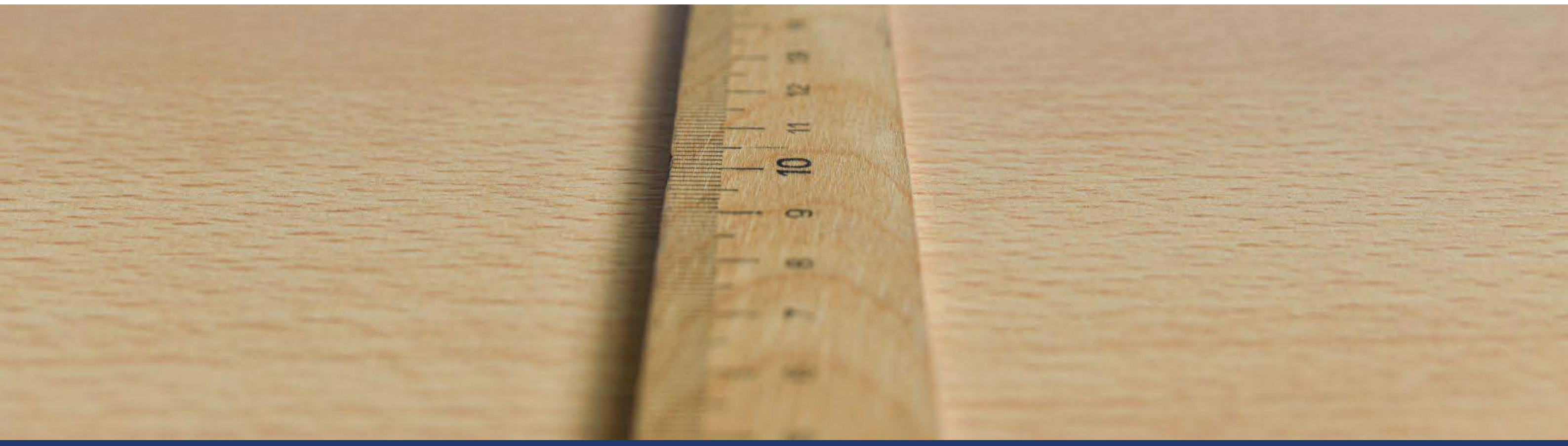
While there are numerous aspects of O-RAN that have to be tested, one of the most challenging is that of the RIC. This came up in multiple sessions but was most deeply explored by Owen O'Donnell, marketing manager for TeraVM and the wireless business unit at VIAVI Solutions, in a discussion of RIC benchmarking.

He laid out the basic questions that testing must answer: How will operators know for sure that decisions made by the RIC and the resulting changes will benefit the RAN and not cause degradation to performance? How will they make sure that artificial intelligence and machine-learning models which have been trained in a certain network environment will also perform well in different network environments?. Operators also want to know how to port and combine components and solutions from different O-RAN vendors, xApps, rApps and RICs and feel confident that network performance and operation will be improved rather than negatively impacted.

Benchmarking the RIC is the strategy for answering those questions, O'Donnell said, and three types of benchmarking are currently being discussed. Those are app benchmarking to compare apps for the RIC, or how the RIC performs under network scenarios such as rural use versus urban. All of that benchmarking needs to take place in the lab with emulated users, emulated traffic and emulated RAN scenarios being used to test out the workings without affecting real subscribers, O'Donnell noted.

Perhaps more intriguing is testing known as conflict mitigation or collision management. When a RIC has to handle conflicting priorities, what will it do? "When it comes to a real network running tens of apps, making changes, who's to say one change in one direction won't be undone by another app reversing the change?" O'Donnell offers. He gave the example of an app that seeks to maximize coverage/boost antenna power, versus an energy-saving app. "These two apps are in conflict, and if running together at the same time in the same region, could either cancel each other out or cause a flip-flop of changes going up and down continuously," he said. Operators should have (and test) a policy that determines which app takes precedence, but that might depend on time of day, location or specific events, O'Donnell said. Testing various scenarios in the lab will help identify such situations and mitigation strategies.

Owen O'Donnell



FROM REAL TO LAB TO LIVE—CONTINUOUS TESTING IN THE ERA OF AI

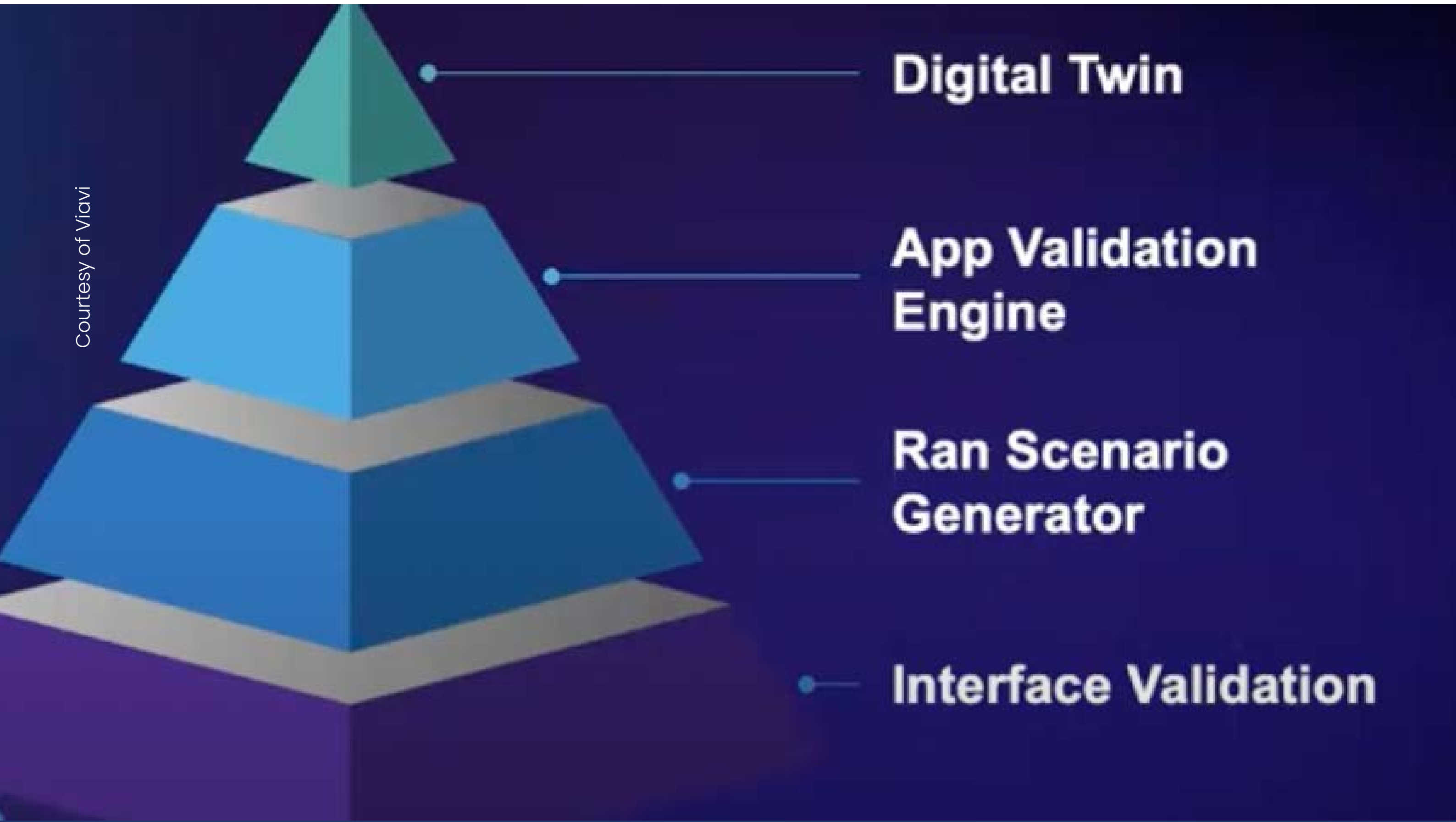
Operators need a new, more real way of understanding network performance in order to fully leverage the speed and agility of the networks being built; the answer, according to Viavi CTO Sameh Yamany, is to use real-world network data to build a digital twin of the network, then train artificial intelligence to conduct continuous testing.

Yamany sees an important role for digital twins, continuously fed with real-world network data, and AI engines in this new test, measurement and service assurance paradigm. He acknowledged operators have long used emulation tools loaded with synthetic data to hit network KPIs and adhere to service level agreements, but highlighted that synthetic data has led to disconnects between what was observed in the lab and what's happening in the field.

Going forward, he said, "You really need to bring in the expertise from the field. You really need to train a model of the digital twin with this data so it can actually understand what realistic use cases you'll have… You have to have this continuous feedback loop from real to lab to live, and back again."

If operators pursue this approach to continuous testing, Yamany emphasized the need to tie network and application performance to operational cost, customer satisfaction, ARPU, customer loyalty/retention, and return on capital investment.

Sameh Yamany



Courtesy of Viavi

5G DEPLOYMENTS, 6G R&D AND MORE: A Q&A WITH ROHDE & SCHWARZ

Test and measurement companies have a unique perspective on the deployment and development of the latest network technologies and features. Andreas Roessler, technology manager at Rohde & Schwarz, provides some insights on terrestrial and non-terrestrial networks—what is happening now, and what is coming down the line. This interview was conducted via email and has been edited and condensed for length.

Let's start with a refresh on the state of 3GPP standards and development. Where do you see the industry in terms of adoption of Rel 16 and 17 and work on Rel 18 of 5G New Radio?

Before we discuss deploying Rel-16 and 17 features, we need to assess the overall deployment status for 5G New Radio. According to industry sources, we have today 249 5G networks "on air" in 97 countries. From 2009 to 2013, we had 317 LTE networks live in 111 countries and territories. This is roughly 20% less compared to 4G LTE in the same time span since the initial launch of the first 4G LTE network and 5G network, respectively. I believe the reasons for that are manifold. For one, no clear "killer application" is yet identified, at least from a consumer perspective. We also see a slower-than-expected adoption rate for the market verticals, automotive, and the Industrial Internet of Things (IIoT). One reason is most likely the current state of the global economy; another is the complex deployment situation and the low number of current 5G standalone deployments. The latest stats show that worldwide 41 networks are using a 5G core, and thus an LTE signaling anchor is not required anymore. Only with 5G SA do we get access to all the bells and whistles that 5G New Radio offers, including network slicing, which, to a certain extent, is the foundation within 5G for use cases and applications that require a certain quality of service profile. Regarding individual 3GPP features, the industry's focus for the last 12 months was to transition to Standalone Mode and introduce Rel-16 feature sets that help with power consumption. From our understanding, the first chipsets with Rel-17 support have just been officially announced at Mobile World Congress Barcelona 2023, with expected shipments in the fall of this year. From that perspective, we don't anticipate any Rel-17 features going commercial before mid-2024.

What new features or capabilities are you seeing high levels of interest in?

At the moment, it seems that RedCap, short for Reduced Capabilities, is one of the hot features that are currently the focus of the wireless industry. With RedCap, standardized as part of 3GPP Release 17, the device complexity will be significantly reduced to enable the Internet of Things (IoT) across a 5G network. It requires a Standalone Mode operation, which, as discussed, is not yet widely available. Some vendors promote the use of RedCap not only for IoT but also for Augmented Reality (AR) applications, integrating 5G modem capabilities directly into AR glasses.

Another major topic coming with Release 17 is Non-terrestrial Networks (NTN). The primary use case is network coverage via satellite for emergencies in remote rural or offshore areas as well as for global tracking and positioning. Several service providers worldwide recently announced partnerships or showcased early demonstrations of NTN capabilities, including emergency messaging in areas without coverage. The testing of such critical features is of course imminent, and Rohde & Schwarz support the industry already with test solutions for NTN, as demonstrated in a collaboration with MediaTek and Bullitt at MWC Barcelona in March 2023.

What are the technical challenges you see with testing and deploying NTN?

There are a couple of challenges related to the entire protocol stack, and I will briefly address only a few of them; but this is the fascinating part of NTN, as it starts with a new dimension in the wireless world. First, the paradigm change we face with NTN; we now have to talk about a moving "base station", a satellite-based or airborne node, which is moving with respect to the receiving UE. This results in a time-variant carrier frequency change, aka Doppler shift. The second big challenge is the long delay or latency due to the large distance. It is not only the absolute latency, but what is more critical is the time-variant latency. For example, when the Low Earth Orbit (LEO) satellite is at the far end of the orbit, rising above the elevation angle to become available or leaving the edge falling below the elevation angle, the latency is at its longest. The satellite in the nadir position perpendicular to the UE faces the shortest latency. In other words, we face a dynamic delay over the time of the connection. A third challenge is the large path attenuation, resulting in a low Signal-to-Noise Ratio (SNR). The good news is that communication is still possible under those conditions. Besides such RF challenges, there are a couple of signaling aspects. For example, the timing advance adjustment in NTN is much more complex than it is in terrestrial networks. In addition, there are impacts on several higher-layer protocol parameters like timer values, sequence numbers, and buffer sizes, to mention a few. And don't forget about mobility. With NTN, we discuss several handover scenarios, including satellite-to-satellite handovers or satellite-to-terrestrial gNB handovers. Last but not least, coexistence aspects are important, especially with RF interference contemplations like terrestrial bands adjacent to satellite bands or, in the future, the incorporation of higher frequencies like Ku- or Ka-band into the terminals, which requires directive antennas.

To switch gears and look a little further forward—what observations can you make about 6G development so far? Where do you see R&D focusing, and are there any specific tests or demonstrations that Rohde & Schwarz has been part of that you think are exciting?

Many researchers and industry players believe that a future 6G standard will natively support AI/ML on the air interface. One idea is to replace signal processing blocks, specifically on the receiver side, with trained machine-learning models for channel estimation, channel equalization, and demapping. This concept is understood as a neural receiver. Rohde & Schwarz teamed up with Nvidia to demonstrate and validate a neural receiver concept in a hardware-in-the-loop test bed.

Although AI/ML is one of the hot buzzwords within 6G research, it is not the only essential focus area of current 6G research. Joint communication and sensing (JCAS), sometimes also referred to as Integrated Sensing and Communication (ISAC), will enable new use cases while providing the network and devices with a sixth sense combining wireless communication with radar capabilities. Furthermore, a paradigm change applies, as researchers use metamaterial to actively modify the propagation channel with reconfigurable intelligent surfaces (RIS) instead of taking the propagation channel as it is. All these technology components will require adapted or new measurement techniques, which we at Rohde & Schwarz are actively working on.

CHALLENGES IN SPACE

The first IoT Non-Terrestrial Network (NTN) devices are starting to enter the scene and are expected to launch commercially next year or so, but Thierry Berisot, the director of IoT/telecom, standards and spectrum at Novamint, said there remains a lot of work around certifying these devices. "The 3GPP perspective is… reflecting only IoT [from a] satellite perspective and not the fact that the device will support… both… cellular and satellite connectivity," he continued. One of the biggest challenges, he added, is the development of test cases to support commercial launch. "Without [a] test case, there will be no commercial launch."

Berisot also highlighted the challenge around supporting different satellite orbits. Support of LEO [Low-Earth Orbit satellites] is more challenging than GEO [Geostationary satellites], Berisot said, explaining that LEO constellations have a high-rate Doppler effect that contributes to complex handovers, requiring greater complexity in the radio resource management (RRM) system as well as scheduling issues.

Looking ahead, Berisot expects further integration of NTN and 5G, as well as with 6G. "You will have more complex architecture for satellite; you will have dual connectivity, real-time communication, more network selection aspect, more roaming between satellite[s], more high-frequency bond[s]." He added that by the time 6G comes around, this will be fully integrated and so you won't think about satellite as a separate network from terrestrial cellular networks, but instead as just another way to connect.

KEY ASPECTS OF THE 6G VISION—AUTOMATION, SPECTRUM, SPACE

6G systems are expected to be commercially launched by 2030, while the first phase of standardization will likely start from 2025, leading to the first 6G specification in 3GPP Release 21 by 2028. Test & measurement companies are key supporters of early 6G research and development.

There is an initial vision that terahertz communication, joint communication and sensing (JCAS), artificial intelligence and machine learning, reconfigurable intelligent surfaces (RIS) and photonics/visible light communication (VLC) will likely be among 6G technologies.

Stéphane Téral

Stéphane Téral, chief analyst at LightCounting, said that future 6G systems will likely realize many of the use cases initially promised to happen in the 5G era.

"So far, we haven't seen any of the use cases that were presented ten years ago. So basically, 6G will be all the stuff we have been talking about and we have not delivered yet," Téral said.

Sandeep Sharma, VP and global head of portfolio 5G/RAN/ORAN at Tech Mahindra, believes that centimeter wave (cmWave) spectrum will play a key role in 6G. The cmWave spectrum in the frequency range 7-15 GHz holds the promise of combining good coverage, especially at the lower edge, with reasonably large bandwidths.

Both Teral and Sharma agreed about the need of a unified standard for future 6G systems to enable economies of scale and lower costs for end-users."In order to have economies of scale, right use of the spectrum, I think having a unified global harmonized standard will be required for 6G, rather than having regional views," said Sharma.

Sandeep Sharma

"If you don't have [a unified standard] you're not going to have economies of scale. From a consumer standpoint, they will pay more for service and the handset will cost more because the handset manufacturers are going to have to accommodate the different demands, needs and requests coming from all these multiple standards. So this is not where the world should be going by any stretch," Téral said.

Arden Media and RCR Wireless News hopes you found this recap of highlights from the 2023 Test and Measurement Forum to be useful, and that you will join us for next year's event.