Intel

Network Programmability Jumpstart with VMware's RIC SDK

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PRESENTATION

Lilian Veras

Welcome everyone to the Intel Network Builders Webinar program. Thank you for taking the time to join us today for a presentation titled Network Programmability Jumpstart with VMware's RIC SDK.

Before we get started, I want to point out some of the features of the BrightTALK tool that may improve your experience. There's a Questions tab below your viewer. I encourage our live audience to please ask questions at any time. Our presenters will hold answering them until the end of the presentation.

Below your viewing screen, you will also find an Attachments tab with additional documentation and reference materials, including a number of websites and documents mentioned in this presentation.

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Intel Network Business partners have been working to accelerate network innovation by optimizing their solutions on Intel technologies. These industry leaders are recognized in our Winners' Circles program and VMware is a Titanium partner. Learn more about our INB Winners' Circle program by clicking on the link in the Attachments tab.

Today, we're pleased to welcome Rakesh Misra from VMware, Art King from Cohere Technologies, Anand Parikh from AirHop Communications, and Ravikanth Pasumarthy from Capgemini Engineering.

Dr. Rakesh Misra is Director of R&D Engineering in VMware's Service Provider and Edge business unit where he leads the development of VMware's RAN Intelligence product portfolio. Prior to joining VMware, Dr. Misra had co-founded Uhana Corporation that commercialized an observability and optimization platform for mobile RAN. Uhana was acquired by VMware in 2019. He has a Ph.D. from Stanford University in electrical engineering.

Art King brings three decades of wireless, enterprise, and IT experiences to Cohere Technologies. Prior to joining Cohere in September 2021, Mr. King led the development of enterprise services definitions and business case propositions at Corning Optical

Communications. He also spent five years with SpiderCloud Wireless, a company acquired by Corning in 2017. And 10 years at Nike where he was a leader in Nike's IT infrastructure architecture and operations where he held various global roles.

Anand is the Vice President of Strategic Partnerships for AirHop. In this capacity, he is responsible for building a robust ecosystem of business partners for AirHop, focused on accelerating the adoption of Open RAN.

Ravikanth is working as Chief Architect at Capgemini Engineering having over 26 years of experience in developing wireless and satellite-based systems. He is also leading the Open RAN-related solution initiatives at Capgemini Engineering. His area of expertise involves solution engineering, system architecture, and realization for 4G/5G systems and RIC apps based on O-RAN architecture, application of AI/ML concepts to RAN, and solutioning of NTN systems.

Welcome, Rakesh, Art, Anand, and Ravikanth. And thank you again for joining us today. I will hand over to Rakesh to start off. Thank you.

Rakesh Misra

Great. Thanks a lot, Lilian. And thanks for inviting me to speak in this webinar today. Good morning. Good afternoon. Good evening to everyone in the audience. I'm very excited to speak today about how the radio access network is opening to developers and share more about how VMware is building the RAN Intelligent Controllers, which enable developers to program the radio access network and to bring that innovation to the radio access network.

As you may all know, the radio access network is part of a telco network that provides last-mile wireless access to our user devices, our phones, and tablets. And how well the radio access network performs directly impacts what quality of service operators are able to deliver to their subscribers. The radio access network is also the only part of a telco's network that touches their most valuable asset, which is the spectrum. And therefore, how well the RAN performs also directly influences the spectral efficiency, which is how well an operator is able to utilize its most valuable asset. And how well a RAN performs in terms of delivering good quality of service and good spectral efficiency is dictated by how intelligent the RAN is.

If you think about the RAN software stack, the software logically consists of a data plane, which is a set of data processing functions to process user data. It's essentially a set of protocols, standardized by 3GPP. But the RAN software also comprises of what is known as the control plane and the management plane. And the control and management planes contain the intelligence in the radio access network. The control plane is the set of control algorithms that operate in either real-time on the order of milliseconds, or near-real-time on the order of tens of milliseconds. And these algorithms drive the data plane in how it processes user data.

So, these algorithms could range from Layer 3 control plane functions like admission control, mobility control, load and traffic control, and so on, to Layer 2 scheduler functions like beamforming control and MIMO-related control, precoding control, and so on.

The software stack also consists of a management plane, which consists of all the analytics, configuration, and policy functions for the control and data planes. So, this could be analytics on cell KPIs, subscribers KPIs, this could be configuration of cell parameters, bearer parameters, slice parameters, or setting policies on these parameters.

And together, the control and management plane drive, or define, or dictate the performance of a radio access network in terms of what kind of quality of service they're able to deliver to subscribers, and what kind of spectral efficiency an operator is able to see of its spectrum.

And traditionally, the management plane and control plane have been tightly integrated with the data plane. Traditionally, the traditional RAN has followed a closed monolith vertically integrated architecture, where the control plane and management plane comes from the same vendor that provides the data plane and there is very little programmability that is exposed externally.

Over the last few years, you might have heard about how we are bringing network function virtualization, NFV, into the RAN architecture to create what is known as virtual RAN.

In virtual RAN, only the software is decoupled from the hardware. But within the software, the control plane and management plane are still very tightly integrated with the data plane, still provided by the same vendor, and there's still very limited programmability that is exposed externally.

In parallel, very recently, we are also bringing in – the industry is bringing in software-defined networking principles into the RAN architecture. And software-defined networking is about decoupling the control plane and management plane of a network from its data plane. And this is where the O-RAN Alliance has defined and they're standardizing what is known as a Near-Real-Time RAN Intelligent Controller, which is a platform that allows external developers to program the near-real-time control plane of a RAN. The near-real-time control plane is the set of control algorithms that operate on the order of tens of milliseconds or hundreds of milliseconds.

And now, third parties can provide what are known as xApps, which are implementing various control plane functions. So, they can bring intelligence, they can program intelligence in the radio access network control plane.

Similarly, O-RAN Alliance is also defining what is known as the Non-Real-Time RAN Intelligent Controller, which is part of the larger service management and orchestration framework, which provides a platform for external developers to program the management plane intelligence in the radio access network. And third parties can now bring their innovation in management plane functions via what are known as rApps.

VMware is leading the charge in the industry when it comes to productizing and operationalizing these RAN Intelligent Controllers. It is probably the only company right now which has made the RAN Intelligent Controllers commercially available. VMware's RAN Intelligence portfolio consists of the VMware Centralized RIC, which is VMware's commercial-grade offering of the non-real-time RIC. It consists of the VMware Distributed RIC, which is VMware's commercial-grade offering of the near-real-time RIC. It also consists of SDKs and APIs for app developers who can now use these SDKs and APIs to build various intelligent innovative applications for the radio access network. And depending on specific scenarios and specific requests from the customers, VMware is also making some in-house xApps and rApps available to operators along with its Distributed and Centralized RIC Platforms.

And since I'm speaking at an Intel webinar, I also wanted to call out that we work very closely with the Intel FlexRAN team to pre-integrate our distributed RIC with the Intel FlexRAN stack. And what this pre-integration enables is that developers get access to very fine-grained and rich APIs to program the Intel FlexRAN stack. And this really opens up a wide variety of innovation in radio access networking.

Our mission with the VMware RIC – our vision is to create an open platform that enables the ecosystem to innovate in the radio access network. And we are on a mission to create a vibrant ecosystem of vendors and operators who are innovating in RAN. And as part of this mission to create an open platform that encourages innovation, we are providing open APIs and SDKs for developers, we are creating an open data repository of real-world radio access networking data, so app developers can use for building various AI/ML-based algorithms. We are providing open APIs to operators for FCAPS management, for all configuration, accounting, performance, security management of RIC platforms and the apps, the xApps and rApps that run with our RIC platform.

We are building a RIC platform in a very extensible manner, using service-based architecture, which means that the VMware RIC platforms, after being deployed in production can be extended by third-party services that could bring in additional functionality to the RIC platform. And we are designing our RIC platform to be multi-RAN and multi-cloud because we want to make sure that the VMware RIC acts as an abstraction layer across any mixture of RAN vendors and any mixture of cloud that an operator may be using in its network.

In order to accelerate the process of developing and deploying new xApps and rApps, VMware is making available software development kits, SDKs, for developers.

The software development kits essentially include a set of developer resources that really simplifies the process of building and packaging new xApps and rApps for the VMware RICs. The SDKs contain APIs for developers. These are based on O-RAN specification and standards, many of which are still work-in-progress, and we are making sure that we are supporting the latest APIs as part of the development kits. The SDK also includes reference apps and starter code, so that app developers can quickly get started with prototyping their application. Specifically, for xApp developers, the SDK also contains transport libraries, which implement the transport between the xApps and the near-real-time RIC platform. And this is important because latency is very critical for xApps. And the transport is a significant contributor to the latency, so we have already built libraries that optimizes the transport between xApps and the near-real-time RIC platform for low latency. So, xApp developers don't have to worry about it. They simply use these libraries to build their applications.

The SDK also includes a bunch of testing and debugging tools. The SDK also provides custom resource definition, which is a Kubernetes construct for describing the requirements of an application. So, along with providing the container images for the xApps and rApps, app developers can also provide the requirements for orchestrating, or for deploying their xApps and rApps in the form of a custom resource definition which essentially tells a Kubernetes orchestrator how to orchestrate these xApp and rApp functions. And the SDK also provides a developer guide with instructions and best practices for using the SDK and APIs to build xApps and rApps.

I'm very excited to share that last month, VMware formally launched a RIC SDK Partner Program, which is an open program for developers, for partners to help accelerate the development, deployment, and monetization of their applications.

So, through this partner program – we have designed this partner program so that we can help our partners accelerate the RIC app development through our SDK, through our self-service training videos, through developer guides, and VMware technical support. They can increase their market reach by leveraging VMware RIC's multi-RAN and multi-cloud support, and all the 100-plus CSPs, customer base that VMware has. We are designing very carefully how we can help our partners reduce their time to revenue with the VMware RIC. And we also allow our partners to foster technical collaborations with VMware experts and our growing partner ecosystem.

So, if you are interested to learn more about the program and to join the program, the link is on this slide and it's also available in the attachments. If you have a VMware contact, please also reach out to them to learn more about how you can make the best use of this partner program.

So, with that, I would like to pass the baton onto Art King from Cohere Technologies, and then AirHop and Capgemini. And I'm very excited to hear what they have to share in terms of how they are using the VMware RIC SDK to build various innovative use cases that their respective companies specialize in.

So, over to you, Art.

Art King

Thank you, Rakesh. So, I'm going to talk a little bit about our Universal Spectrum Multiplier xApp.

It's an xApp that we built that plugs into a near-real-time RIC to greatly increase spectral efficiency via a new channel model, the Delay Doppler channel model. And it's really used to drive precision beamforming in MU-MIMO infrastructure.

So, what we've got with this technology is we're doing, essentially, innovation at the DU level. And this is the kind of innovation that just wasn't possible before with the legacy technologies. You really couldn't innovate at the PHY and MAC level within the existing technology frameworks that were available.

And we're leveraging the Intel FlexRAN and also the ACC100 processor card that does the FEC processing for all the packets, essentially forwarder or control processing. And our xApp uses an E2 interface to talk from the software to actually talk to the DU. And we've got a very productive relationship with Capgemini on the use of their stack to essentially build a trial-grade base station that we've used to demo our software.

Our Delay Doppler channel process is really at the heart of the Spectrum Multiplier, and it tolerates latency up to 50 milliseconds, which enables us to have the xApp and the RIC to be located in an edge data center instead of within the actual site where the base station is. And it changes the dynamics by moving quite a lot of the infrastructure to the cloud and a lot of the processing intelligence which – the cloud is a lot more elastic and scalable.

And longer-term, we see changes within the base station world where CUPS, the control user plane separation, really exposes a lot of controls and a lot of interfaces on the base station itself, such that outside people can, essentially, add value to what's actually been shipping with the base station itself. So, it opens up the gNodeB like never before.

And for us, the RIC is very important because we look at the RIC – imagine that you want to move into a house and you've got all your furniture, and with the old way of doing things, you'd have to essentially build the whole house and then move in. And the RIC essentially provides a house to move into. A lot of the essential infrastructure and heavy lifting that every software developer has to do is accomplished within the RIC, such that we can focus on our value-added application instead of doing a lot of blocking and tackling, building a lot of the lower infrastructure. So, it really allows us to focus.

When we're able to reach into the MAC and PHY level to innovate, we also have the ability to gradually provide statistics and information longer-term. And for companies like AirHop who build the non-real-time apps like an rApp, we've got O1/A1 interface, places to feed information and stats to someone who wants to track and monitor things long-term and do trending, and statistics that we don't feel which is in our remit.

And then finally, as we look towards the cloud and moving to the telco cloud and having a lot more things in the data center, we look at the Kubernetes pods and horizontal scalability as very important technologies. And because we're moving the channel models into the cloud, we're also improving the economics of the system. There's less equipment in huts, that means less space and less power consumed. There's less wasted capacity. It's extremely scalable both up and down. And we see a lot of ways that the telco cloud is going to allow inter-gNodeB innovation that really wasn't possible before.

And finally, it's greener. There's less electricity required, less CapEx on systems, and less e-waste to be thrown into the waste chain after doing system and processor upgrades. And this is kind of all made possible by O-RAN just making innovation possible in previously locked places.

And as we head towards 6G, we believe that O-RAN, RIC, and a lot of computational power is going to be in the cloud instead of where it is today.

And with that, I will pass the baton.

Anand Parikh

Well, thank you, Art. Very warm greetings to all of you attending this webinar. My name is Anand Parikh and I am the Vice President of Strategic Partnerships at AirHop.

Before I start my comments, let me first thank VMware and Intel for organizing this webinar, and inviting me to participate in it.

So, just a bit of background on AirHop. AirHop, we have been providing network intelligent solutions for several years. Our solutions are fully cloud-native, Kubernetes container-based with microservices architecture that provide real-time automation and optimization of the RAN. Some of our solutions have been deployed in some of the most innovative Open RAN networks, including Rakuten Mobile in Japan and Reliance Jio in India where these solutions manage over a million macro and small cells, so very large-scale deployments.

Using the same software that's been deployed in these networks, we have created a very broad portfolio of xApps and rApps for the Open RAN Alliance based on Open RAN O-RAN architecture.

Our portfolio of automation and optimization xApps and rApps, which we call Auptim, span a variety of use cases that you see on this slide ranging from spectrum optimization, handover optimization, interference mitigation, to QoE optimization, anomaly detection, and energy savings, resulting in a reduction of total cost of operation, TCO, for the RAN.

So, one question that comes up is how does a RIC help us, AirHop, to accomplish what we do as an xApp/rApp provider?

So, the answer is actually fairly simple. First of all, one cannot succeed without the other. rApps and xApps have a very symbiotic relationship with the RIC, and you need the RIC for the xApps and rApps to do their job. And you need xApps and rApps for the RIC to deliver the value to the Open RAN, to the network operator. So, they have a very symbiotic relationship. Normally that – and Open RAN itself, frankly, cannot succeed without both the RIC and the xApps and rApps. Together, the RIC and the xApps and rApps form the – what we call the Central Nervous System of the Open RAN, and are really critical for its operation.

So, for us, as a vendor of xApps and rApps to be successful, we need the RIC vendors as our key partners and Open RAN needs both of us. For AirHop, RIC vendors are a critical part of our partner ecosystem. And of course, VMware is a very key RIC partner for us.

So, let me comment on some specifics about our experience of working with VMware as a RIC partner and how the integration of some of our Auptim rApps have gone so far with VMware.

We began our partnership with VMware last year, and we couldn't be happier with the way the partnership has gone thus far. The integration of Auptim rApps with VMware Centralized RIC, which is what we have done so far, was performed very quickly with minimal support needed from the VMware team. The VMware SDK that Rakesh talked about before is very well prepared and everything worked as advertised.

One more specific in terms of why this made – this was made very easy for us as the integration partner was the use of OpenAPI specifications by VMware. It made the process very simple and easy, and the OpenAPI specifications are very easy to understand, interact with remote services, with minimal amount of implementation logic, and removing the guesswork in calling a service.

And the one important part also is the development and integration platform provided by VMware for this integration. We have significant experience in deploying our solutions on several Kubernetes environments including, of course, AWS EKS, Robin.io, OpenShift from Red Hat, et cetera. Some are easier than others. And in the case of VMware, their Centralized RIC deployment and our rApp integration were done on AWS EKS Kubernetes environment. And it really was very simple.

So, those are my comments. Very happy to be here. And again, thank you VMware for being a partner. I'm going to invite Ravi to make his comments next.

Ravi, over to you.

Ravikanth Pasumarthy

Yes, thanks, Anand. So, I'm going to probably use the next few minutes to provide our experiences in building a reference solution in O-RAN part and especially how we collaborate with VMware and integrating the CU/DU with the RIC and also bringing some xApps and onboarding onto the RIC platform.

Before we get into the specifics of the RIC and SDK integration. So, this provides a high-level overview of Capgemini's vCU/vDU framework, which is based on the O-RAN architecture. So, the green components, as you can see, are something which we offer, these are based on 3GPP and O-RAN-based deployment model architecture specifications wherein our CU/DU runs as containers and is highly scalable architecture. And it supports multiple deployed models and supports all the necessary interface as defined in O-RAN, for example, the E2 interface for the RIC, the O1 interface towards the SMO FCAPS. So, it supports both these interfaces and also kind of an O2 -kind of an implementation, I will say your network is not standardized for a cloud infra and cloud management part .

So, we do support all of these capabilities. And in this particular case, we have integrated our CU/DU with VMware RIC and also onboarded some of Capgemini xApps itself onto the platform and integrated and demonstrated end-to-end part .

Now, why this is important is to show that while we have apps is one part, the RIC is another part, open interface programmability is a critical piece. What is also important is that what is supporting capability available in the RAN to the CU/DU, to be able to demonstrate the use case, and that's very important. That's also a role where we play to enable this ecosystem of trying to ensure that the necessary interfaces and the RAN functions, which are needed to demonstrate and build these use cases are available as well. And then help the overall ecosystem to integrate and build and demonstrate xApps in an end-to-end environment.

So, next slide gives a little more detailed view of the architecture, a very high-level view is what I'll try to explain. So, for example, in the RAN case CU/DU. So, we have this concept of RAN function, which is running in CU, as well as in the DU. Based on the deployment model, for example, it could be an integrated model, in which case the CU/DU is running on a single server and then it could be E2 interface exposed to the RIC. But in case, you could have a typical deployment model of centralized CU and DU at the cell site, then each of the DUs could be exposing an E2 interface back to the RIC. And the CU interface to the RIC itself over the E2 interface. Based on the use case deployment once again, the kinds of use cases which is usually supported, the necessary functionality on the E2 side, which is the E2AP and E2SMs. And the corresponding RAN functions, which has to be handling that code is very important, and that's something which we provide.

And as I said, xApp is something which we also offer, apart from providing the O1 interface as an interface back to that FCAPS model, which – but that can be leveraged by the non-RT RIC modules as required from an overall O-RAN functionality perspective.

Moving to the next slide, which specifically talks about the experience we have using the VMware RIC and SDK. This provides a high-level view of some of the use cases which are done allowing the Capgemini CU/DU and xApp built on top of VMware RIC and SDK.

As you can see in this particular case, this is an example of a particular xApp which is done, which is integrated with the RIC/SDK, further integrated to the RIC platform. And then we have these RAN functions, which are exposing based on the E2AP. What is more important is two things, one the interoperability of the E2 spec across the RIC and the RAN is one aspect, which is validated. Item two is actually passing on the APIs from the RIC to SDK to the app, so meaning the app is able to consume those APIs. And then any commands which are sent from the app going back all the way from the RIC to the CU/DU and the action being taken back in the RAN is a critical piece to ensure that the end-to-end flow is demonstrated. And that is something which has been done. So, the integration, interoperability, and validation of some of the evolving specifications, E2 specifications, and also integration of the app with an SDK is something which was demonstrated and is a part of the partnership with VMware.

And in this particular case, the key aspect is making the RAN programmable via the interface, that's a very important aspect. As the programmability will add ease of adding the RAN functions and ability to extend the interfaces is one key aspect interfacing with the RIC.

And then third part is being able to build and develop an xApp. As Anand also mentioned, ease of actually using the VMware RIC/SDK in developing the xApp is also one of the critical factors to build an application. And that's something which you also experience, like ease of developing an xApp using the SDK provided by VMware that's I think one of the key aspects of this overall exercise.

Moving another slide. So, a few factors which differentiate an acceleration of the O-RAN. So, Capgemini is also one of the proponents of actually the O-RAN kind of an ecosystem in these kinds of deployments.

So, a few things which we think are very important is actually identifying the use cases and developing the apps, and demonstrating them. That's a very important aspect. The second is support for SDKs to be able to build apps. While we identify the use case, and then the use case can be translated to certain kind of logic, or an app which can be onboarded. Now, how do you actually make sure that that app which you've developed is integrated to the overall system and to the RIC. It is very important and this is where the SDKs play a very important role in helping the application developers to be able to develop their applications, on-board it to the platform, and then make sure that further integration is done.

And there are two roles here, so Capgemini plays as an app developer, and where we port this to the SDKs, for example, VMware in this case, and ensure that the apps can be onboarded. So, that's another key thing. Application of the apps, development of the apps, and SDK support, ease of building the apps is a very critical thing.

The third factor is while we have the app and SDK, the programmability in RAN, flexibility to add and on-board these new apps and ensure that "Okay, in the end-to-end case, you are able to demonstrate it". That's pretty important.

Now, this is where the programmability of the RAN comes into the picture, and ease of actually able to provide that flexibility to adapt and enhance the RAN, further the use cases and apps being developed is a very important item and that's something we believe is also important apart from the use case, apps, SDK, and the programmability.

And finally, building the ecosystem of partners. So, each one has a role to play. It's a combined ecosystem of all these partners. It will be developers, platform, RAN, end-to-end providers, so this is an ecosystem of partners. We believe these are the multiple four factors, which will help in acceleration of the O-RAN development, not to mention the specification and standardization, which is also important and ongoing activity.

Now, where we play a role is actually ensuring the CU – the RAN solution is actually compliant with the 3GPP specifications with O-RAN. Able to support the new RAN functions, to be able to help build new use cases. And then working with, as I said, ecosystem partners is very important. We work with VMware in ensuring that "Okay, the interoperability between the RIC and the RAN estate is ensured". And also, interfacing with the app, so onboarding of the apps to the RIC is another key aspect. So, that's very important. That's where we also work with VMware.

And then most importantly, all of these learnings, this is a journey which is actually we are going through, making sure that the feedback and learnings from these trials and some of this experience is actually – we close the loop. And it goes back, once again, to the various modules. And we have ensured that this is a journey going forward, and as Art said, probably from the 5G and 5G transition to 6G. So, this could play a very important role in ensuring that how we build this robust system and interfaces in the platform is going to be very critical.

That's all I have, and back to Rakesh if you want to say something.

Rakesh Misra

Thanks, Ravi. I think back to Lilian. I think, Lilian, you might be on mute.

Lilian Veras

Yes, my microphone was on mute, I'm sorry about that.

Thank you to the four of you for the great insightful presentation. We do have a few questions that have come in while you were presenting, so let's get started on our Q&A.

First question I have here. "Why are the RIC xApps and rApps critical for building the Open RAN?"

Anand Parikh

I'm happy to provide my perspective and I'm sure my co-panelists have theirs as well. So, in my mind, frankly, the answer is very simple, which is as I mentioned in my comments, the RIC along with the xApps and rApps form the central nervous system for the Open RAN. And so, they provide the intelligence needed for the Open RAN to operate efficiently and cost-effectively in an optimal way.

RIC, as Rakesh has described, provides the programmability necessary for the various xApps and rApps to run, and these xApps and rApps, in turn, make use of the services provided by the RIC or through the RIC to interact with the RAN to automatically optimize various things as optimized operation, enhance the performance capacity, coverage, optimize the quality of experience for the end user, et cetera.

So, without the central nervous system comprising of the RIC and xApps and rApps, you don't have an efficiently functioning RAN. You would have a RAN, but it would not be efficiently functioning.

Rakesh Misra

Yes, and just to add to that, like I mentioned during my presentation. How well a RAN performs is largely dictated by how intelligent the RAN is. In other words, how well the control and management planes of the RAN have been architected. And like I presented, in the traditional RAN architecture, which is the architecture we have followed for the 40-plus years that radio access networks have been in commercial existence, this control and management plane intelligence has been very tightly integrated within the radio access networking stack. It comes from the same vendor, so there has been very little competition in this space. And as a result, the pace of innovation has been really slow.

And what is now happening is that this intelligence is opening up to the larger industry ecosystem. And the RIC is enabling that. And it's allowing anyone and everyone who wants to play in this space to bring their innovation, their intelligence in the form of xApps and rApps. And this is truly taking the competition to a new level, and that is breeding innovation.

Eventually, it will all come back to making the RAN better in how it operates, and how well it provides quality of service to its subscribers, and how well it utilizes an operator's spectrum.

Lilian Veras

Great, thank you. Question number two. "What are the impediments for a wide-scale adoption of Open RAN?"

Rakesh Misra

Anand or Ravi, do you want to go first?

Anand Parikh

Sure. I'm happy to provide my perspective. So, in my mind, there are three things that come to mind. One is what, in fact, Rakesh mentioned just a few seconds ago, which is a robust multi-vendor ecosystem. Without a very robust multi-vendor ecosystem, you won't have wide-scale adoption of Open RAN. We've got to get away from the monolithic architecture, the monolithic deployments from a few vendors.

Second is maturity of standards. This is with anything new. It always takes time for the standards to mature. And without robust, mature standards, you would not have the ecosystem which, by definition, requires different components from different vendors to work together properly.

And the third relates to our experience of integrating with various RIC partners, including VMware, which is the standardization of APIs and SDKs for integration of RIC, and xApps, and rApps.

Today, for example, we work with several RIC partners, and each one has different ways for integration of rApps and xApps, and we adopt. But it slows down the process, the progress towards providing a complete solution.

So, in my mind, that standardization of the SDKs and APIs would also play an important role for wide-scale adoption of Open RAN.

Ravikanth Pasumarthy

Just to add one more aspect as to what what Anand mentioned is also about ease of – ability to extend the specification part itself, the ability to bring in apps is also very critical. Because one, we have an app, and then how do you make sure that you're demonstrating an end-to-end? There could be certain bottlenecks in the whole chain of the things, for example, are the SDKs standardized as one option, is E2 standardize is another option, does RAN has programmability is another option.

So, I think that also is an important factor to play as to how many use cases or how generic can the specifications can, firstly, evolve to be able to bring in more apps and demonstrate. And an open interface is very important rather than going for specific proprietary interfaces to demonstrate the use case of an Open RAN network.

Rakesh Misra

I think, Art, you might be speaking on mute.

Art King

Am I there?

Rakesh Misra

Yes.

Art King

Okay, well, one other thing I would add is the need to bring in the IT disciplines, the system management, system maintenance that maybe underlies the computers within the operator that need to be brought into the RAN infrastructure now too. That's something that is extremely important. And it brings a whole new supply chain to the table.

You have whole different people, the Dells and HPs of the world are potentially able to participate in the RAN infrastructure now, in addition to the other players in the market.

Lilian Veras

Great, thank you. Another question we have here. "What are the differences between developing an rApp versus an xApp?"

Rakesh Misra

Yes, I can take that. So, as an rApp developer versus an xApp developer, the main difference is that they are programming different parts of the stack. Like I mentioned here, as an rApp developer, you are programming the management plane intelligence. So, the kinds of use cases that you are bringing in the form of these rApps are the management plane functions, monitoring, analytics, configuration, policy kinds of functions.

As an xApp developer, you're programming the control plane intelligence in the RAN. This is bringing all the L3 and L2 control plane algorithms to the RAN. So, that's the essential difference.

From a development experience point of view, what this boils down to is that the way you are using the APIs from the RIC are different. The non-real-time RIC exposes RESTful APIs, REST APIs. As an rApp developer, you would just program using those REST APIs. With the near-real-time RIC, the APIs are still being standardized. Currently, VMware RIC offers an SDK API integration, so you'll be using an SDK to integrate with the near-real-time RIC. So, that is a slight difference in how you would build your applications.

And the other big difference is how you would optimize the performance of your application. With the near-real-time RIC, if you are building an xApp, latency is very critical. So, you need to design your application, so that it can execute with very low and predictable latencies. Scale or throughput of messaging is typically not as big of a concern as it would be for an rApp. If you are developing an rApp, latency requirements are very relaxed. You don't have to optimize to the extent that you need for xApps, because rApps typically operate at timescales of seconds or even longer, sometimes minutes or hours or even longer.

But as an rApp developer, you have to keep an eye for throughput, because your rApp may be deployed in a very centralized location, there might be tens of thousands of cell sites aggregating up to a single instance of your rApp, as opposed to maybe only hundreds of cell sites, for example, for xApps. So, you need to design your rApps to be very throughput efficient, to be able to handle such a large scale.

So, those are, I would say, some of the key differences when it comes to developing an rApp versus developing an xApp.

Lilian Veras

Excellent. "And can the app developers program legacy RAN too using the VMware RIC?"

Rakesh Misra

Oh, that's a great question, and the answer, surprisingly, is yes. This is, in fact, a key part of VMware's strategy with the RICs.

And just to give a little nuanced answer, the VMware Centralized RIC, which is the non-real-time RIC can be used to program even legacy RAN. And the way we have achieved that is if you see this picture, I mentioned that even legacy RAN, traditional RANs, or virtual RANs, which are not software-defined still expose limited vendor-specific APIs.

So, what we have done is we have built adapters for these different vendors, for the different legacy vendors. And these adapters, essentially, terminate the vendor-specific APIs that exist from the legacy RAN, and translate them into the standard interface that app developers can use. And rApp developers can use – still continue using the R1 interface to build management plane intelligence, even for legacy RAN within the constraints of what kind of programmability is exposed by a legacy RAN.

So, yes, you can use the VMware Centralized RIC to program legacy RAN to the extent that there are these limited vendor-specific APIs available.

The near-real-time RIC is not applicable to legacy RAN because there is nothing like the near-real-time interface, the E2 interface that exists, that is supported by legacy RAN. So, that would not be possible.

But non-real-time RIC and rApps, yes, that's possible.

Lilian Veras

Great. Another question for you, Rakesh. "Does VMware RIC come bundled with VMware Telco Cloud Platform?"

Rakesh Misra

Great question. No, it does not. The VMware RICs are standalone products, meaning – and like I mentioned, we have designed the VMware RICs to be cloud-native and Kubernetes-native, meaning they can run on any Kubernetes platform. So, no, the answer is the customers can choose to buy just the VMware Centralized RIC or just the Distributed RIC and run them on another cloud platform, which is not VMware Telco Cloud.

We, in fact, support multiple Kubernetes platforms. Of course, we do a lot of pre-integrations and testing with VMware Telco Cloud. But we have customers who are currently trialing the RICs on native AWS EKS, on OpenShift. We have a recent request to trial the RIC on Azure Kubernetes service.

So, we have designed the RICs to be Kubernetes-native and cloud-native, and they can run on any cloud platform that supports Kubernetes.

Lilian Veras

Awesome. Next question. "Is the RESTful API for rApps standardized? Is there any plan to support the standardized R1 interface?"

Rakesh Misra

I can take that quickly and Anand or Ravi if you want to chime in.

The short answer is that it is in the process of getting standardized. There are some aspects of R1 that have already been standardized. But I would say that there is a lot more to be done than has been done. So, it's very much a work in progress.

And just to tie it back to the VMware non-real-time RIC, the centralized RIC, what we support today is a combination of standard R1, and other R1 aspects that have been standardized, but also some pre-standard R1. The R1 aspects that are still currently being standardized or are yet to be standardized. But we have made a pre-standard version of those APIs available, so we can really get the process of creating that rApp ecosystem going, so that the rApp developers don't have to wait for the standardization to be complete, which can take several years.

So, we already support a rich set of capabilities over R1 standard and pre-standard R1. And that already is allowing partners like AirHop and others to build various innovative, intelligent applications.

And over time, as and when several aspects of R1 keep getting standardized, we'll make sure that our support is also conforming to the latest standards.

Anand Parikh

Let me just echo that from AirHop's standpoint. What Rakesh said has been very critical for us at AirHop as well, that as these APIs and these interfaces get standardized, in order to make progress, vendors like us, all of us here on this panel have to continue to develop pre-standard interfaces, pre-standard ways to integrate products and then adopt them as the standards become available. And at the same time, contribute to the standards organization, so we are very active on that front in the O-RAN Alliance different working groups. And I know all of the people here are as well.

That effort is really critical to accelerate the adoption of Open RAN. So, not only creating the pre-standard work but also contributing them to the standards organization and getting them adopted.

Lilian Veras

Awesome. Next question, again, for VMware. "O-RAN WG1 is currently working on a decoupled SBA SMO architecture. Will this be supported by VMware?"

Rakesh Misra

Oh, yes, absolutely. VMware has been an advocate for moving the entire control plane and management plane of the RAN to a service-based architecture. And like I mentioned in one of my slides, we have built our RICs to be service-based from day one. So, yes, we totally support the effort. We are actually actively contributing to the efforts in Working Group 1 to come up with the specifications of a service-based SMO. And we would absolutely support it in our products.

Lilian Veras

Great. One more question here. "What are the unsolved technical challenges within this ecosystem?"

Rakesh Misra

We can keep talking for the rest of the day. Maybe, Art, do you want to go first?

Anand Parikh

It's not that bad, Rakesh. Let's be positive. Sorry, Art.

Art King

There's a lot of work we've done around performance and around getting a lot of different formats developed that are fast to process for us. And what we're doing with Capgemini and VMware is fairly ground-breaking. So, it's really working on performance, and scale, for us, is job one.

We can get the – the user plane performance is fantastic and we're just working on scaling up the performance of our own xApp.

Rakesh Misra

I can add a couple of challenges, specifically from the perspective of an xApp and rApp developer. So, I think Anand has already talked about one, which is the pace of standardization and the fact that a lot of the APIs that an xApp or rApp developer would want to use are still not standardized, meaning they have to work with pre-standard implementations by vendors.

Beyond that, a couple of things which, in my experience, has been slowing down the process of xApp and rApp development, one is the lack of a standard testbed, or a standard way to test the end-to-end function and performance of xApps and rApps. Testing is very piecemeal. Different apps come up with their own ways to test their end-to-end function and performance. It would really help if we can come together as a community to create some standard testbeds and standard test suites, and create some standard performance templates to evaluate these xApps and rApps. So, that is one thing where I think we can do better.

The second thing where xApp and rApp development is being slowed down, and this is especially to apps, which rely on AI and machine learning is the lack of any real-world large-scale data set. Because to build any machine learning-driven algorithm, you need data. If you look at other domains like videos and images, there are a lot of large open data sets that is available out there that app developers can use to build various sophisticated, complex machine learning-based algorithms.

I've heard people building 128 layer deep neural nets, 256 layer deep neural nets, that is possible because there is so much and so rich data that is available in the open. The same is far from being true in the radio access networking world. And that has really hindered the development of AI/ML-based applications.

And therefore, one of the things that VMware is striving to do is to collaborate with operators, because operators typically own this data from the network. Collaborate with operators to create large real-world RAN data sets that we can make available to xApp and rApp developers to build various data-driven ML/AI-driven applications.

Anand Parikh

Yes, if I may add to that, Rakesh. The last point about operators is very key. We are also working with some of the operators for this.

The good news is that the operators recognize that this is one of the key requirements for all of us to go forward. So, operators are very interested in working with vendors like us, all of us to provide these data sets. That's, at least, what we are hearing.

Lilian Veras

All right, thank you. That was our last question. I would like to take the time here to thank you, Art, and Anand, and Rakesh, and Ravikanth for sharing such great information with us.

I'd like to ask our audience to please not forget to give our team a rating for the live recording, so that we may continuously improve the quality of our webinars.

Thank you once again. And this concludes our webcast today.

Rakesh Misra

Thanks everyone for joining us.

Lilian Veras

Bye for now.

Art King

Thanks.