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Opportunities and Challenges of Open vRAN in a Global Market

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Summary

This white paper introduces the concepts of virtual radio access networks (vRANs) and open RAN and explains how these new approaches help transform the way networks are designed, built, operated, optimized, and maintained. It presents the key benefits that service providers can expect from the adoption of virtual RAN or open RAN, which include flexibility, scalability, agility, innovation, vendor diversity, lower cost of ownership, and simplicity of operations.

The second part looks specifically at the perspectives and drivers in different regions: North America; Latin America; Europe, the Middle East & Africa (EMEA); and Japan, where service providers are particularly keen to leverage open vRAN to build and maintain more resilient and secure networks and to facilitate a more competitive ecosystem and foster innovation.

It also highlights some of the key government initiatives, especially in North America and Europe, that aim to reduce reliance on Chinese suppliers by promoting open vRAN and encouraging the development of a wider ecosystem of vendors via government funding, the creation of labs, and trial deployments.

Omdia forecasts that open vRAN will represent a market of $5.9bn in 2026 or 15.9% of the total RAN market. Open vRAN will be the fastest-growing segment within the RAN market, driven by greenfield deployments in large markets such as the US, Japan, and Germany and by brownfield deployments by service providers around the world.

Early deployments are an opportunity for Red Hat and Intel to validate and demonstrate the solutions and capabilities they offer to support a service provider’s RAN transformation.

A brief introduction to vRAN, open RAN, and RAN functional disaggregation

Service providers around the world are continuously investing in their networks to augment their capacity in order to address the rapid increase in traffic and support new applications and scenarios. However, the traditional approach where mobile networks are built using dedicated equipment presents some limits in terms of scalability, flexibility, and agility.

This is why telecom service providers have been looking for new approaches and ways to modernize their network. Network functions virtualization introduced the concept of deploying network functions on virtual machines (VMs) running on general-purpose infrastructure instead of dedicated hardware. This trend started about a decade ago in the core network domain, and because many service providers are now well advanced in that transition, they are moving into the next phase: the virtualization of the RAN domain.

Virtual RAN creates an opportunity to disaggregate the base station hardware and software and to run the baseband software function on generic commercial off-the-shelf (COTS) servers. A further evolution is to run RAN functions as microservices on containers instead of VMs and to adopt cloud principles such as development and operations (DevOps) and GitOps, which describes and observes systems such as the RAN with declarative specifications.

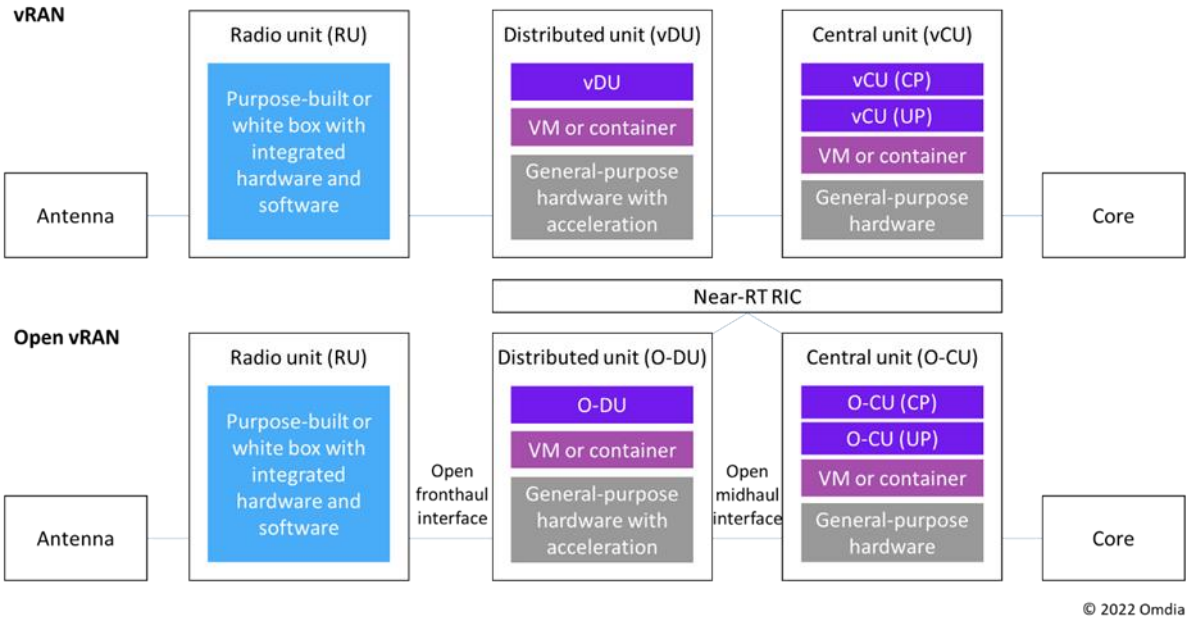
Recently, service providers have also shown a lot of appetite for open RAN. *Open RAN* describes the opening of interfaces within the radio access network domain and, in particular, the interface between the two main elements that constitute the base station: the radio unit (RU) and the baseband unit (BBU) or digital unit, known as the fronthaul interface. Opening interfaces enables buyers to separately purchase the RU and the digital unit and mix and match products from different vendors.

A third trend is the functional disaggregation of the RAN. The O-RAN Alliance and 3GPP release 15 define functional disaggregation of the baseband unit into a central unit (CU) and a distributed unit (DU), offering new architecture options and more possibilities in terms of disaggregation and distribution or centralization of resources.

Cloud RAN, open vRAN, and RAN functional disaggregation will transform the way service providers build and operate their mobile networks. Though they are still at an early stage, Omdia observes that these trends have gained significant momentum in the past few months with many service providers around the world committing to adopting these new approaches and many others evaluating and testing them.

It is also important to understand that vRAN can be implemented regardless of open RAN, and conversely, open RAN and open interfaces can also be implemented without virtualization. Effectively, open RAN is often associated with vRAN because the two are complementary, as summarized in **Figure 1**. The convergence of the two into open vRAN will enable service providers to maximize the benefits of the transformation.

Figure 1: vRAN and open vRAN simplified architectures



Source: Omdia

The expected benefits of RAN virtualization

The key benefits of opening interfaces, including the possibility of introducing new vendors, selecting best-of-breed solutions, and fostering price and technology competition, are well understood by the telecom community.

Virtualization and hardware/software disaggregation facilitate the introduction of different vendors of hardware, the virtualization layer, virtual network functions (VNFs), and cloud-native network functions (CNFs). In addition, vRAN brings other benefits in terms of flexibility, scalability, efficiency, and time-to-market reduction. These are summarized in **Figure 2**.

Those benefits are known by service providers that have already virtualized their core network, but because of the sheer size of the RAN, virtualization in this domain can potentially be more transformational. Service providers believe that the open vRAN approach is promising, but they also realize that RAN virtualization will be complex and potentially more challenging than virtualization in other network domains. This is primarily because of the specificities of the RAN, including the need for real-time processing and timing and synchronization requirements.

When vRAN was first introduced, vendors themselves acknowledged challenges—particularly around latency, performance, feature parity, and energy efficiency—in comparison with integrated purpose-built RAN solutions. However, vRAN offerings have developed very fast in the past few months, closing the gap. In terms of performance improvement, for example, RAN-specific hardware accelerators, which complement generic processors and handle some of the most demanding workloads, play a key role.

Figure 2: Key benefits expected from the adoption of vRAN

Expected benefit	How is it realized?
Flexibility, scalability, and optimization of resources 	• Scale in and scale out easily via the addition of VMs or container-based resources, enabling the capacity of the network to be precisely adapted to actual demand in real time. • A horizontal cloud platform across access, edge, and core will play a critical role, ensuring consistency and reducing integration efforts.
Easier and faster innovation 	• Installation, configuration, updates, and upgrades are software based so can be introduced to the market faster and in a continuous manner. • It is possible to benefit from innovation from the broader IT/cloud community in terms of both hardware (including silicon) and software (including open source).
Greater vendor diversity 	• A larger choice of suppliers is available with new entrants. • Disaggregation enables the supply of different components from different vendors and the selection of best-of-breed components from specialists in each area (COTS hardware, acceleration, virtualization, vRAN software), instead of having to buy an end-to-end integrated system from a single supplier.
Lower total cost of ownership 	• The use of COTS servers and of common infrastructure across domains (RAN, core, OSS/BSS) reduces capex. • The pooling and sharing of hardware resources enables increased resource utilization and the simplification of cell sites, which in turn means a small footprint and rent and fewer site visits. • Automation is necessary to deploy and maintain vRAN. A zero-touch approach to automation is the desired state to realize the reliability and resilience and for self-healing and scaling of a highly distributed system.
Simplify operations and improve operational agility 	• Automated service provisioning reduces human intervention and associated costs. • Service providers are able to manage and maximize the lifecycle of their RAN. • Simplified workflows reduce complexity and ensure reliability.

Source: Omdia

Omdia’s view: The global perspective

Though open vRAN is still in its early development, Omdia observes that service providers around the world are increasingly interested in it and in how it can benefit them. There is a strong and undeniable open vRAN momentum, seen in the membership of and participation in organizations such as the O-RAN Alliance and the Telecom Infrastructure Project (TIP), the number of trials and deployments, and service providers’ announcements of their commitment to adopting open RAN.

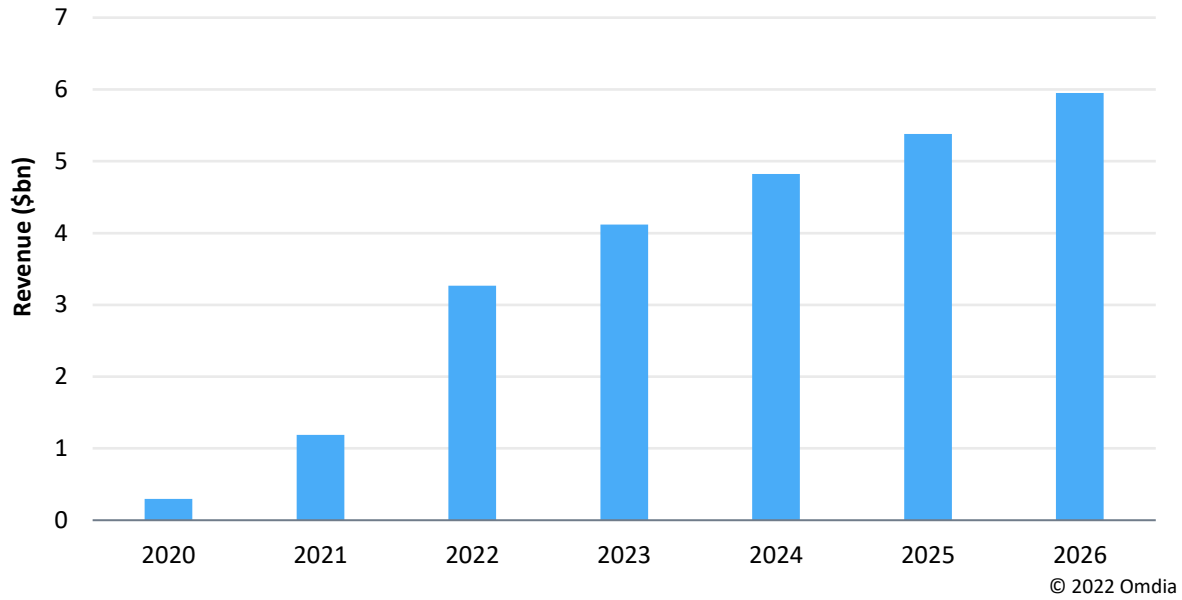
The open vRAN concept was initially championed by the greenfield service provider Rakuten Mobile (Japan), but it has also been adopted by other greenfield service providers such as DISH Wireless (US) and 1&1 (Germany) and by brownfield service providers, noticeably not just in the most technology advanced markets but in all types of markets and on all continents.

While most initiatives are small scale, the size of trials and deployments tends to grow from a few sites initially to dozens or sometimes hundreds. There is also an increasing variety of scenarios and use cases considered, including rural, suburban, and urban deployments; outdoors and indoors; and on public and private networks.

Open vRAN is actively promoted by vendors including a few market pioneers, pure players, and new entrants, but some of the RAN incumbents are now also adding vRAN offerings to their portfolios and opening their interfaces as a response.

Omdia believes that while purpose-built integrated RAN will continue to be dominant for years, open vRAN deployments will play an increasingly important role, and this segment will grow faster than the rest of the market. Omdia forecasts that open vRAN deployments will represent 15.9% of the $37.5bn RAN market globally by 2026.

Figure 3: Open vRAN revenue forecast, 2021–26



Source: Omdia

Drivers vary by region, but service providers everywhere have reasons to adopt open vRAN

North American policymakers are keen to support the development of a local ecosystem of suppliers and to bring connectivity to rural communities

Over the last few years, in an effort to reduce dependencies on China-based suppliers and vulnerabilities in telecom infrastructure, the US government has taken a series of initiatives in collaboration with the private sector for the promotion and the development of open RAN:

- In 2019 the US Department of Commerce ban placed Chinese-based vendors and a number of their affiliates on the Bureau of Industry and Security's "entity list."
- In May 2020 the Open RAN Policy Coalition was formed with the intention to advance the adoption of open and interoperable RAN solutions. Today it has 55 members.
- In December 2020 the US Congress passed the USA Telecommunications Act as part of the National Defense Authorization Act (NDAA), making $500m available to encourage and finance the deployment of open RAN in replacement of Chinese equipment.
- In June 2021 the Senate passed the US Innovation and Competition Act setting aside $250bn to increase technology innovation in the face of growing competition from China. Of this, $1.5bn was set aside to boost innovation in wireless technologies such as 5G and 6G.
- In October 2021 Congress passed four more bills related to telecom security and open RAN.

Another key reason for service providers in North America to adopt open vRAN is to bring connectivity to underserved territories:

- In the US, a quarter of the population in rural areas (14.5 million people) have no access to any broadband services (FCC).

- In Canada, 18.4% of the population (7.1 million people) live in rural areas, and 63% of those households do not have access to broadband speeds of 50Mbps/10Mbps (Policy Options).

Lack of access to good broadband services not only prevents economic growth and distance learning but also discourages companies from moving from larger urban areas to rural geographies where they could reduce costs and help increase prosperity. In the age of COVID-19, limited connectivity has also proved to slow productivity, because people cannot work effectively from home.

The large service providers are continuing to expand their 4G and some 5G footprint to deliver both mobile-only and fixed wireless access (FWA) broadband services in rural areas to meet demand, but the economics of many of these areas impede the service providers from deploying sufficient coverage and capacity to meet the needs of all the inhabitants. Open vRAN's economics are different and present service providers with the opportunity to deliver services using infrastructure that could enable a lower total cost of ownership (TCO).

Find out more about open vRAN in North America.

In Latin America, service providers look for innovative solutions to deliver services more efficiently

Latin America is a diverse region with a population of more than 670 million, where the mobile industry plays an important role in both delivering connectivity and contributing to socioeconomic growth. COVID-19-related lockdowns have exacerbated the customer demand for connectivity and reliable mobile broadband (MBB) services. This demand led to significant growth in mobile data traffic on most service provider networks in the region.

However, bringing MBB services to the millions of unconnected people in rural and remote villages in the region is both challenging and costly. The terrain often consists of mountains and dense forests, and access to high-quality fiber for backhaul (and fronthaul) connectivity is limited. Furthermore, given the lower ARPU in these areas, it takes longer to achieve a return on investment.

To reap the full benefits of cloud-native solutions, service providers need to acquire competencies and implement organizational changes. By deploying cloud-native networks and using DevOps environments that use continuous integration / continuous delivery (CI/CD) and GitOps-based methodologies, they will be able to accelerate service delivery and mitigate risk through consistent and compliant configuration management and automation.

Red Hat is working with its partners in the region to assist with the technology, cultural, and organizational transformations required and to support service providers on their open vRAN TCO analysis ahead of trials and rollouts set for the 2022–23 timeframe.

Find out more about open vRAN in Latin America.

In EMEA, service providers are willing to diversify their supply chain, and countries have committed public funds to support open vRAN development

As in North America, many service providers in EMEA are trying to reduce dependencies on China-based suppliers and, more generally, to reduce their dependence on a small number of incumbent vendors. In this context, several European governments have become supporters of open vRAN.

The UK's Department of Digital, Culture, Media and Sport set out three main targets: support incumbent suppliers, attract new suppliers into the UK market, and accelerate the development and deployment of open interface solutions. UK national initiatives include

- Public funding of £250m ($340m) to support telecom diversification
- A national target of 35% of UK's mobile network traffic carried by open RAN by 2030
- The Future RAN Competition (FRANC) to discover and fund talented new vendor specialists

Motivations are essentially similar in Germany where funding and trials were announced:

- Funding of €300m ($402m) over the next 10 years to support the establishment of an open RAN lab to develop and test open RAN technologies
- Open RAN trials in two testbed cities: Neubrandenburg and Plauen

Though it is not a public initiative, it is also notable that Germany's fourth service provider 1&1 is building Europe's first fully virtualized multi-vendor mobile network using open RAN.

Also in Europe, the open RAN memorandum of understanding (MoU) group, formed by Deutsche Telekom, Orange, Telefónica, TIM, and Vodafone, is working to define and develop open RAN solutions.

In the Middle East, an MoU group similar to the European one was formed by five service providers: du, Etisalat, Mobily, Saudi Telecom (STC), and Zain, later joined by Batelco and Omantel. These service providers opened the first regional community lab in collaboration with TIP and Intel.

In Africa in March 2022, the MTN Group announced a collaboration with Rakuten Symphony to carry out 4G and 5G open vRAN trials in South Africa, Nigeria, and Liberia. Vodacom SA, which conducted open RAN lab trials with Vodacom in South Africa as early as October 2019, is also looking to follow suit in Mozambique and the Democratic Republic of Congo.

Find out more about open vRAN in EMEA.

In Japan, the favorable market environment and appetite for innovation explain early adoption of open vRAN

Japan offers a favorable environment for the development of open vRAN, and it is no surprise that it was the first country to adopt the open vRAN model at scale. First, Japan is a mature and advanced telecom market and an early adopter of the latest technologies such as 5G and virtualization. This is also a quality-focused market where service providers invest in the best available solutions and the most advanced functionalities rather than being low-cost oriented. Japan is also an increasingly competitive market, particularly since Rakuten Mobile entered as the fourth service provider, and competition is based not just on price but also on technology and network quality.

Japan is also special because of the quality of its transport network. The fiber infrastructure is widely available and connects a majority of cell sites, which has enabled Japanese service providers to use a centralized RAN (C-RAN) architecture since the early stage of LTE. Japan is one of the few countries to have had the fiber resources to support the capacity and latency requirements of fronthaul links between remote radio units and centralized baseband units for many years. This will serve as the foundation for the deployment of vRAN.

By pooling baseband resources in baseband hotels or data centers rather than distributing the resource at cell sites, service providers can realize savings in terms of rent, electricity, and cooling. They can also achieve faster deployment and reduce the need to visit cell sites.

Find out more about open vRAN in Japan.

Early adopters around the world

North America

In North America, investments in open vRAN will grow from $0.3bn in 2021 to $1.7bn in 2026, driven initially by spending from greenfield service provider DISH Wireless and then by adoption by multiple-system operators (MSOs) and service providers.

Open vRAN offers an alternative to equipment from nontrusted vendors and a way to lower the total cost of deployment and ownership. This in turn enables providers to bring coverage and capacity where previously investment was not viable, and it also opens the market to new entrants.

The business case is also improved thanks to access to more affordable spectrum. In July 2020 150MHz of spectrum in the CBRS band, a band used by the US Navy mainly in coastal areas, was made available at a significantly lower cost than in traditional spectrum auctions. Affordable spectrum combined with the new open vRAN infrastructure has changed the market paradigm and made it possible for nonservice providers to enter this market.

MSOs that acquired CBRS spectrum can deploy their own 4G and, later, 5G networks and deliver coverage and capacity in different scenarios including rural areas and venues such as malls and sports stadiums. MSOs that are also mobile virtual network operators can utilize CBRS to deliver their services and offload customers onto their own networks, thereby reducing their wholesale costs. CBRS also allows MSOs to become neutral host providers and to lease their infrastructure to other service providers that lack coverage in certain environments.

Finally, MSOs can leverage their existing cable infrastructure as backhaul connectivity to serve their strand-mounted (the small cells are attached to the metal strand between two utility poles) small cells. MSOs will leverage small cell deployments to address the mobile broadband market as the initial use case, but they plan to target industrial and enterprise segments as well.

Latin America & the Caribbean

In Latin America & the Caribbean, Omdia forecasts that service providers' investment in open vRAN will grow from $40m in 2021 to $0.7bn in 2026, driven primarily by the investment from Tier 1 service providers such as Telefónica.

In the early years, service providers are expected to deploy the technology primarily in rural areas as well as for private networks. According to Livio Silva, chief solutions architect at Red Hat Americas, "While many service providers in the region are in the race toward 5G, they are also validating the

benefits of open vRAN and the different deployment options that are available that can address challenges around the lack of backhaul fiber availability in rural areas."

Since networks are becoming more applications based, service providers can differentiate themselves by evolving their RAN to be more disaggregated, open, and programmable with cloud-native and container-based platforms that will support multiple RAN functions. A common platform will develop new revenue-generating services and shorten time to market.

EMEA

EMEA is a vast region with more than 110 countries that are at different stages of economic development and different levels of technology maturity and adoption. Omdia's latest open vRAN tracker forecasts revenue in EMEA will reach $1.5bn in 2026 from $0.2bn in 2021, driven primarily by deployments by Tier 1 service providers in Western Europe and the Middle East.

In Europe, Tier 1 service providers are leading the pack:

- Vodafone announced plans to deploy 2,500 4G and 5G O-RAN sites in the UK by 2027 and switched on the first live site in January 2022. Vodafone also plans to have open RAN in 30% of its masts in Europe by 2030.
- Deutsche Telekom has been piloting a multi-vendor open vRAN network in Neubrandenburg, Germany (also known as O-RAN Town) since June 2021, and the service provider plans commercialization in 2023.
- Telefónica announced a target of "50% radio network growth" based on open RAN by 2025, which Omdia interprets as 50% of new radios deployed to be O-RAN compliant. The service provider announced the first live sites in 2022 and precommercial trials in Brazil, Germany, Spain, and the UK.

Japan (Asia & Oceania)

Asia & Oceania is the largest RAN market in the world, and Omdia expects it to also be the largest market for the open vRAN segment. Omdia forecasts service providers in the region will spend $2.1bn on open vRAN in 2026, from $0.6bn in 2021, with Japan the first country in the region to adopt open vRAN at scale.

Rakuten Mobile is the undisputed pioneer in open vRAN. It was the first service provider in the world to deploy open vRAN at scale and, as a matter of fact, nationwide. Rakuten Mobile's network ticks all the boxes: it is virtualized, disaggregated, and open.

But Rakuten is not the only Japanese service provider embracing these new models. NTT DOCOMO has a long history and is well established, but it is nonetheless one of the most innovative service providers in the world. It was one of the founding members of the O-RAN Alliance back in 2018 and in February 2021 announced the creation of its own initiative, the Open RAN Ecosystem (OREC), an alliance with 12 companies including Red Hat and Intel that aims to cooperate on the development of 5G open RAN.

NTT DOCOMO was one of the first service providers to introduce multi-vendor RAN at site level with open fronthaul in 4G and then again in 5G using an O-RAN-compliant fronthaul interface. The service provider publicly said that the next stage of its network evolution is the introduction of vRAN with vCUs and vDUs.

Finally, KDDI has also recently announced the adoption of vRAN in its 5G network, with commercial deployment expected in the second half of 2022. The service provider had previously revealed its desire to introduce O-RAN-compatible radio units in its network from 2021, and it will therefore effectively be an open vRAN service provider from 2022.

Red Hat and Intel enable the transition to open vRAN

Red Hat joined the O-RAN Alliance in 2018 with a primary focus on the working group 6 (WG6): Cloudification and Orchestration and is now one of O-RAN Alliance's top 10 voting members. Red Hat is one of the world's leading providers of carrier-grade open source solutions, using a community-powered approach to deliver high-performing Linux, cloud, container, and Kubernetes technologies. Red Hat integrates key technologies from open source communities and is one of the top contributors to OpenStack and Kubernetes, among other projects. It provides a telco-cloud platform and automation framework that allows the disaggregation of hardware and software and the running of virtualized RAN functions on top of generic servers.

Red Hat has been working with its service provider partners to support their journey toward cloud-native platforms, helping them understand how these together with automation tools can help to reduce network TCO and deliver advanced capabilities. The migration to 5G is a good trigger for investments into open vRAN. Service providers should take advantage of this partnership to start with rural environment use cases and null spots, which are ideal for early deployments and learning because these have no existing infrastructure and can be treated as green fields. Service providers that engage with a wide ecosystem of partners and embrace cloud-native platforms will be in a good position to take deployments to the next level. This includes urban and dense urban environments as soon as the open vRAN infrastructure, such as massive multiple input, multiple output (MIMO), becomes commercially ready from late 2022 or early 2023.

Red Hat's portfolio for vRAN includes Red Hat® Enterprise Linux®, Red Hat OpenStack® Platform, and Red Hat OpenShift® Container Platform®, which makes network functions run in a cloud environment. Together these solutions enable service providers to design, deploy, and orchestrate DU and CU VNFs or CNFs.

Red Hat collaborates closely with Intel to provide a preintegrated open platform for vRAN and cloud-native RAN combining Red Hat's virtualization layer with Intel's silicon and software. Intel supplies several critical components including its Xeon processors for general compute, hardware accelerators including its vRAN dedicated accelerator ACC100 (ASIC) and FPGA Programmable Acceleration Card, and the FlexRAN reference architecture used in most open vRAN deployments around the world today. Such a preintegrated solution enables service providers to start from an existing framework when designing and implementing their vRAN, thereby reducing the amount of effort and time required as well as the complexity of the project.

Conclusion

Open RAN and vRAN will change the way service providers supply, design, build, operate, and maintain their mobile networks. They represent an opportunity for service providers to innovate and reduce their costs, but this transformation also represents a major endeavor. Open vRAN is not just about introducing new vendors: it is about introducing new architectures and new ways to deploy and operate the RAN, working with cloud-native principles, new processes, and new methodologies. A horizontal cloud platform will allow service providers to manage their RAN components in a consistent and efficient manner, driving benefits that include increased agility and reduced costs. This is a fundamental transformation and a multiyear journey.

Service providers need to start, and for that they should first clarify their expectations and define their requirements. They should talk to platform vendors and RAN vendors and organize tests in labs and then in the field. Service providers should, naturally, also verify the business case and when doing that consider the specificities of the market where they operate, their existing assets, and their internal capabilities, because there is no such thing as a standard or guaranteed level of savings. Once they have done all that, service providers will be well positioned to decide when and where it makes sense to deploy open vRAN.

Some will start with virtualization and others with opening interfaces. Some will try to do both in parallel, but what is probably common to all except greenfield service providers is that they will start in pilot areas or with pilot scenarios before progressively expanding to their entire footprint.

Finally, even if they plan to rely heavily on partners, service providers should try to acquire a minimum set of skills and internal capabilities to remain in control of their transformation and manage the relationship with their technology providers and partners.

Appendix

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