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North America: Delivering Coverage and Capacity with Open vRAN

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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 service providers can expect from the adoption of vRAN 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 North American market. North America is a diverse and large region, with very dense urban areas with very good mobile broadband services, but there are also rural areas where broadband market competition has been limited. This has led to underinvestment in both mobile and fixed broadband services.

Over the last several years, in an effort to reduce dependencies on China-based suppliers and reduce vulnerabilities in telecom infrastructure, the US government has become a big supporter of open RAN. The US Congress and Senate have passed a number of bills and made funding available. In particular, Congress passed the USA Telecommunications Act in December 2020, through which the purchase and deployment of open RAN equipment could be financed.

The availability of lightly licensed spectrum such as the citizens broadband radio service (CBRS) band has improved the business case for new players. Multisystem operators (MSOs) and companies that provide wireline services can now enter the wireless market and deploy their own mobile services to deliver coverage in areas where it was limited. The spectrum will further enable these providers to plan new revenue-generating networks in the enterprise or private networks' segments using their own 5G core.

These deployments are also an opportunity for Red Hat and Intel to validate and demonstrate the solutions and capabilities they offer to support service providers.

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 (NFV) 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 host RAN functions as containerized applications instead of VMs and to adopt cloud principles such as development and operations (DevOps) and GitOps, which allows the deployment and provisioning of the RAN in an automated and declarative way.

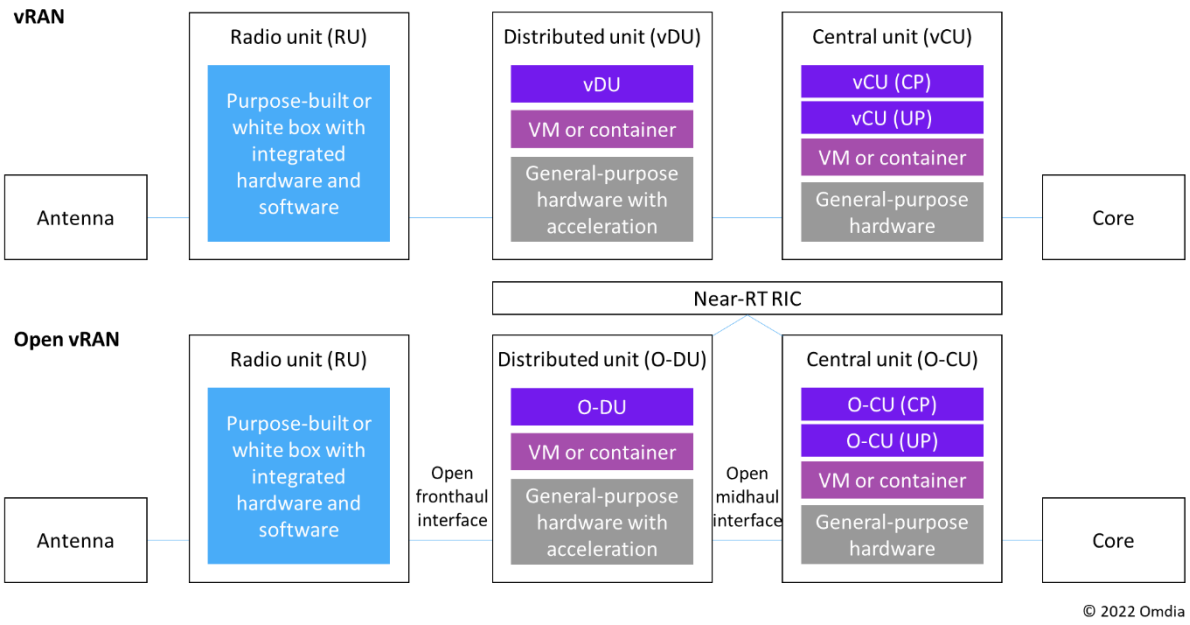
Recently, service providers have also shown a lot of appetite for open RAN. *Open RAN* describes the opening of interfaces within the radio access network domain and, in particular, the interface between the two main elements that constitute the base station: the radio unit (RU) and the baseband unit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

A third trend is the functional disaggregation of the RAN. The 3rd Generation Partnership Project (3GPP) release 15 and the O-RAN Alliance 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 best-of-breed 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 through 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 TCO	• 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. • Operators 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 early development, Omdia observes that service providers in North America and many other parts of 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, 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 been rapidly adopted by a number of 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 often 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. In the North American market, a sizable percentage of the population do not live in urban areas and are limited in the number of service providers available. This lack of choice is a result of reduced competition in the broadband market and has prevented good access to digital services in many rural areas. As in many countries, open vRAN has benefited from political support in the US over the last several years. While the transformation to open vRAN would likely have happened anyway, external factors can contribute to accelerate adoption in some cases.

Open vRAN is actively promoted by vendors including a few market pioneers, pure players, and new entrants, but 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. In its current forecast, Omdia estimates that open vRAN deployments will represent approximately 14% of the $7.5bn RAN market in North America and 10% of the $36bn RAN market globally by 2025.

Government support for open vRAN is strong and will help deliver coverage and capacity to more North American areas

Policy and lawmakers are keen for US-based 5G open vRAN suppliers

Over the last several years, in an effort to reduce dependencies on China-based suppliers and reduce vulnerabilities in telecom infrastructure, the US government has become a big supporter of open RAN. Following the US Department of Commerce ban that placed Chinese-based vendors and a number of their affiliates on the Bureau of Industry and Security's "entity list" in 2019, the Open RAN Policy Coalition was formed in May 2020, with the intention to advance the adoption of open and interoperable RAN solutions. The Open RAN Policy Coalition membership is currently made up of about 57 global technology companies.

The US Congress passed the USA Telecommunications Act in December 2020 as part of the National Defense Authorization Act (NDAA), through which $500m was made available to encourage the purchase and deployment of open RAN equipment, paving the way for service providers to replace equipment from Chinese-based vendors. The Senate later passed the US Innovation and Competition Act in June 2021, 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. This fund is managed by the National Telecommunications and Information Administration and comes from spectrum auction proceeds, the main beneficiaries being US-based open vRAN vendors.

In October 2021 the US Congress passed four other bills related to telecom security and open RAN. The ultimate goal is to ensure open RAN is widely developed and not only meets but exceeds service providers' security and performance requirements.

Lower traffic demands make rural areas a perfect use case for open vRAN deployments

The North American market is a large region. In Canada, according to the World Bank, 18.4% of the population (7.1 million people) live in rural areas. Policy Options reports that approximately 63% of those households do not have access to broadband speeds of 50Mbps/10Mbps, which is considered a standard threshold. The FCC's "Eighth Broadband Progress Report" found that in the US, one-fourth of its population (14.5 million people) that live in rural areas have no access to any broadband services. In the US, there is also a lack of service provider choice in many rural areas known as census blocks. Census blocks are "statistical areas bounded by visible features such as roads, streams, and railroad tracks, and by nonvisible boundaries such as property lines." A census block is said to have broadband service available if just one property within the block is covered by a service provider.

Furthermore, in many locations where fixed broadband services are available, these are delivered using older technologies such as ADSL rather than fiber or co-axial cable, delivering significantly lower speeds than the standard threshold required for a developed market in 2022.

Lack of access to good broadband services not only prevents economic growth and distance learning but also limits 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 proven 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 lower total cost of ownership (TCO).

Many of these locations do not carry the high levels of mobile data traffic seen in dense urban environments to warrant the same multicarrier and multisector radios, so RU and DU complexity is reduced. The lower traffic demand in these regions further eliminates the need for complex massive-MIMO antennas, a technology that is still maturing within the open vRAN domain. This makes rural regions a good use case for open vRAN in its current state of maturity and will help reduce the digital divide in these areas. Until massive-MIMO technology for open RAN is matured, it will be unlikely that open RAN will fully substitute fixed broadband.

Open vRAN vendors have been trialing and deploying their solutions in many parts of the world, including rural regions and difficult-to-reach terrains, to deliver coverage and network capacity where little existed previously. Both rural Canada and the US would benefit from the experiences gained by such vendors to roll out network capacity and deliver much-needed services in these locations.

CBRS opened up the spectrum arena to new players

Spectrum obtained during auctions is expensive, and that together with the special skillsets required to run and manage a mobile network has made service providers the main beneficiaries of the spectrum auction processes for several decades. About 150MHz of spectrum in the CBRS band, a band used by the US Navy mainly in coastal areas, was made available through an auction process in July 2020 at a significantly lower cost than in traditional spectrum auctions. The CBRS spectrum availability and new open vRAN infrastructure has changed the market paradigm and made it possible for non-service providers to enter this market.

A number of MSOs acquired CBRS spectrum blocks and intend to utilize these assets to deploy their own 4G and, later, 5G networks to deliver coverage and capacity. This spectrum will be used for rural areas but also for indoor venues such as malls and sports stadiums. Access to CBRS spectrum allows MSOs to expand their business model by, for example, becoming a neutral host provider, leasing their infrastructure to existing service providers that lack coverage in certain environments.

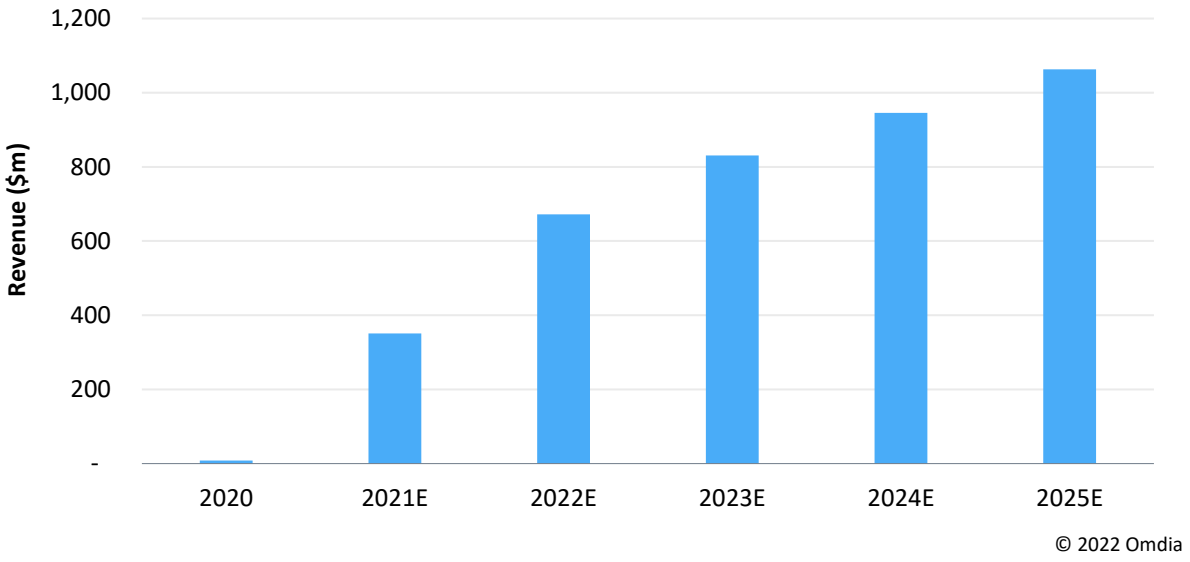
Some of these MSOs also hold mobile virtual network operator (MVNO) service agreements with one of the large service providers. These MSOs can utilize the CBRS bands to deliver services and offload customers onto their own networks, thereby reducing their wholesale costs.

The low power of CBRS makes it a valuable asset to utilize together with small cells. Some service providers are already deploying CBRS-based open RAN in rural regions. 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.

In the North American market, Omdia forecasts service providers will spend $1.1bn on open vRAN in 2025 (see **Figure 3**) and will deploy most of these in the rural regions and private networks in the early years.

Red Hat has been working with both service providers and MSOs in the North American market to support their journey toward telco cloud-native platforms. Red Hat is helping them understand how these reduce network TCO and deliver advanced capabilities for open vRAN workloads that support mobile services for both 4G and 5G.

Figure 3: North America, open vRAN forecast, 2020–25



Source: Omdia

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 network functions virtualization infrastructure (NFVI) platform and is now one of its top 10 voting members. Red Hat is one of the world's leading providers of telco-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 for OpenStack. It provides a horizontal cloud platform and automation framework that allows the disaggregation of hardware and software to run virtualized RAN functions on top of generic servers.

Red Hat's portfolio for vRAN includes Red Hat® Enterprise Linux®, Red Hat OpenStack® Platform, and Red Hat OpenShift® Container Platform that 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.

Both Red Hat and Intel are working with service providers and MSOs to support open vRAN activities in North America.

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

Further reading

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