

SAMSUNG

**Virtualization is the Present
and Future of Mobile Networks**



The future of mobile networks will be software-centric, and Samsung is leading the way to transforming how wireless networks are designed and implemented using virtualization. The hardware-centric approach for network development, using vendor-specific hardware designs, has remained static for decades. That model is unable to keep up with the fast-changing world of today's telecommunication services. Samsung's virtualized Radio Access Network (vRAN) solutions reduces costs, not only for Mobile Network Operators (MNOs), but also for enterprises and government agencies looking to adopt 5G technology for private networks. It increases network flexibility, enables simpler capacity management, reduces Time to Market (TTM) for new services, and improves operator efficiencies.

What is vRAN?

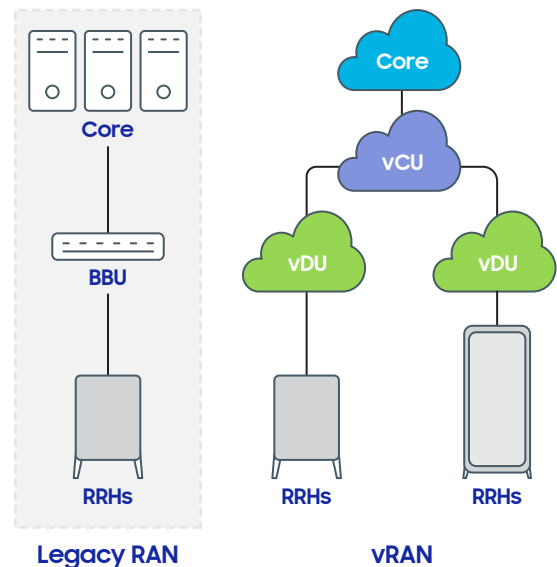
The main elements in a 5G network are the core and the Radio Access Network (RAN). The core runs the complex functionality that allows the highly-anticipated features of 5G to function, such as the Internet of Things (IoT), mission-critical services, high-quality voice application support, and other low-latency, high reliability, and high-speed applications.

vRAN transforms the RAN from hardware-specific to software-based run on general-purpose servers. It is the evolution from vendor-specific, purpose-built baseband technologies to general-purpose platforms run by software.

In legacy RAN systems, each cell site had a Baseband Unit (BBU), which sent data to and from the site's Radio Units (RUs) and the core network. The BBU was a proprietary piece of hardware of fixed capacity.

Disaggregating the functionality of the BBU provides multiple benefits to operators, which has led the industry to develop vRAN, replacing the custom-built BBU with software-based components.

Samsung's vRAN was the first to deliver to the market the virtualized Distributed Unit (vDU) and virtualized Centralized Unit (vCU) that run on general-purpose servers. The vDU sits near the RU and supports real-time processing, including communication between the user and cell site. The vCU can be placed on-site or remotely and handle multiple vDUs, simplifying the network architecture and improving reliability. Both the vDU and vCU run on Common Off the Shelf (COTS) servers, reducing operator dedicated hardware costs. The COTS servers are x86-based, standard components, and are readily available from various suppliers.



With virtualization of the network comes the need for standardized interfaces, which will allow operators to integrate network functions from multiple vendors, assured that they will work together seamlessly. As a member of the Open RAN Alliance, Samsung is committed to virtualized and fully interoperable networks, helping mobile operators improve efficiencies and manage costs. Samsung has already deployed its O-RAN compliant 5G vRAN solutions in commercial networks, offering seamless interoperability between Samsung's vDU and 3rd party's Massive MIMO radio.

Samsung continues to work towards the all-virtualized network, from the edge to the RAN to the core. For its vCore solutions, Samsung has created 5G Open Labs in Samsung's R&D Campuses in Korea and the US to actively lead collaborative development efforts with top-tier companies and run multi-vendor interoperability tests.

A 2021 poll of service providers from [Heavy Reading](#) illustrates the current and expected growth in vRAN deployments. According to the survey 4G-only networks increased significantly over the preceding two-year period, meanwhile 5G-only networks as well as, those that combine 4G and 5G technologies in their networks indicate an exponential growth for the following years.

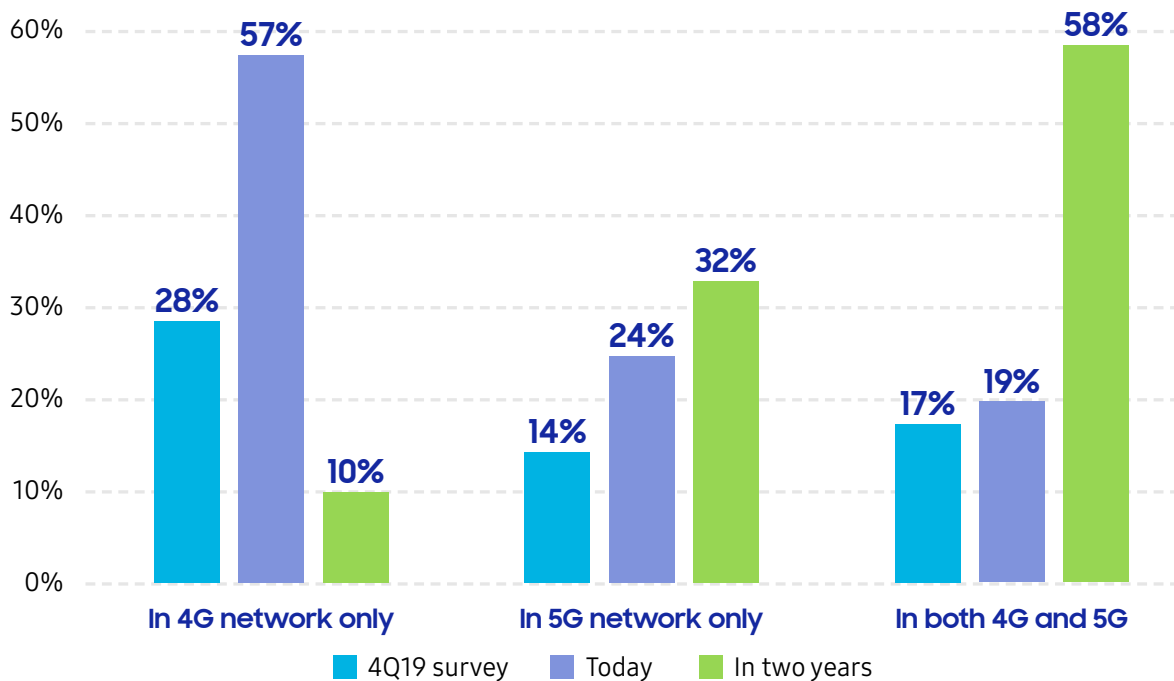
Legacy RAN

1. Vendor specific hardware
2. Proprietary interfaces
3. Upgrades require hardware swaps

Virtualized RAN

1. COTS servers
2. Standardized interfaces
3. Upgrades only require software updates

Do you have a vRAN today?



Source: Heavy Reading, 2019 and 2021

Samsung vRAN is Redefining Mobile Networks

Improved Network Efficiencies

5G networks will operate in multiple frequency bands and handle the far denser networks necessary for new application coverage, capacity, and low-latency requirements. Samsung's vRAN is re-inventing the mobile network with cloud-native virtualization, based on microservices and containers, which provides operators with more efficient operations, simplified network management, accelerated cloud adoption, and improved cost efficiencies.

Samsung's containerized vRAN performs the same baseband functions of allocating, directing, and supervising RAN resources while maintaining equivalent reliability and throughput as a hardware-based baseband unit. This approach creates an environment where functions can be hosted as software services that are dynamically instantiated on-demand.

Simplified Deployments

Networks are poised to become far more efficient than previous generations of technology would allow. The software-only vDU and vCU enable service deployments to be managed in less time with fewer resources. Previous deployments often required hardware changes, in which trained personnel go on-site and perform 'rip-and-replace' operations, physically swapping out new equipment for the old — an expensive and time-consuming procedure. With a virtualized RAN, software upgrades for even the largest deployments can be managed remotely, providing savings on both equipment and travel.

Dynamic Scaling

Samsung's virtualized components can scale as needed, automatically modifying processing power, memory, and connection resources to meet unexpected traffic loads. When spikes in traffic occur, the centralized network can adapt on the fly without manual intervention. During off-peak hours, the same resources can be assigned to support tasks like network analysis and reports or put in power-saving mode. Dynamic scaling allows operators to direct processing resources where needed – a huge cost-savings for vRAN and one that could not be done with legacy hardware-based networks.

Samsung's vRAN supports single band, dual band, and Massive MIMO radios. It works with TDD, FDD, and low-to mid-to high-band frequencies.

Top Six Attributes Carriers Expect in a vRAN Platform

1. Performance
2. Reliability
3. Security
4. Cost efficiency
5. Easy to manage
6. Energy efficiency

Source: Heavy Reading, The Journey to Virtualized RAN: Insights 2021

Better Resource Utilization

In Samsung's vRAN, the pooling of baseband resources allows network demand to determine needed resources. The separation of software and hardware in the vDU and vCU lets new resources be assigned when and where required for local radio real-time processing or centralized for control-related functions. Resource pooling provides operators with cost savings, as they don't need to buy hardware designed for peak loads, knowing that the software will adjust as necessary to maintain optimum performance.

Dynamic Spectrum Sharing for 4G and 5G

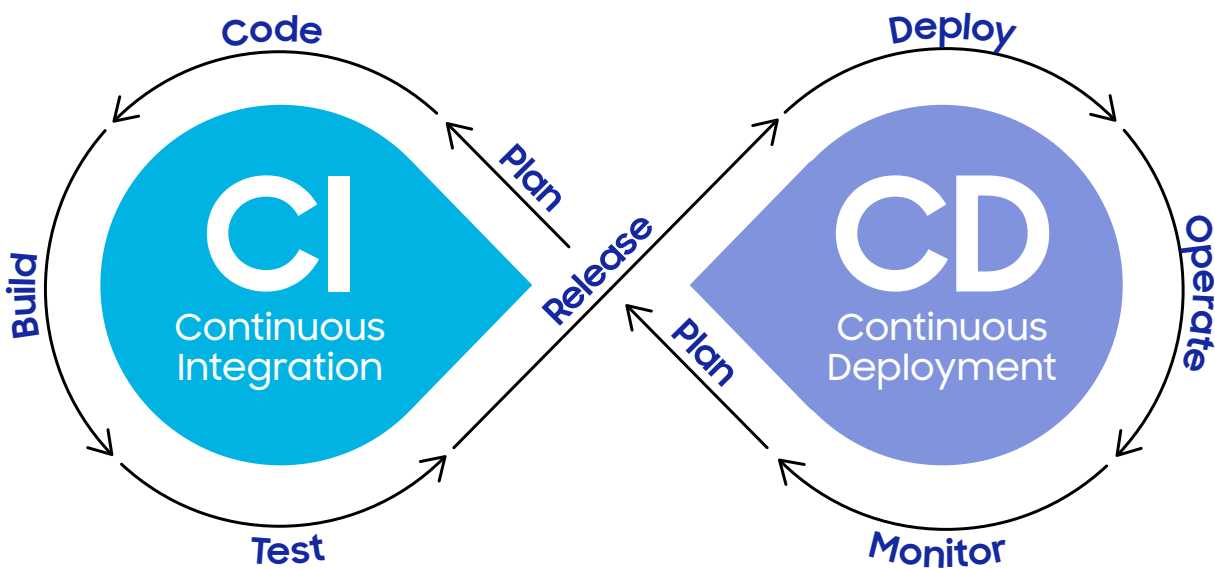
Samsung's vRAN supports Dynamic Spectrum Sharing (DSS), allowing LTE and 5G to run on the same network. DSS allows both 4G and 5G to run concurrently on the same virtualization platform, dynamically shifting frequency resources as needed. DSS will enable MNOs to continue using the same network RAN resources as they upgrade their LTE networks to 5G on their schedule, knowing that their subscribers will stay connected for the duration.

IT Advantages of Virtualization

- No hardware dependency, no vendor lock-in
- Increases new function velocity with CI/CD
- Creates flexible network architectures to meet any need
- Provides dynamic scaling and dimensioning when and where needed
- Efficient resource utilization

Increased Agility with Continuous Integration / Continuous Deployment

Samsung supports Continuous Integration / Continuous Deployment (CI/CD), a methodology that automates building, testing, and deploying software. CI/CD provides operators with near-zero-time upgrades and virtually no impact on existing network abilities.

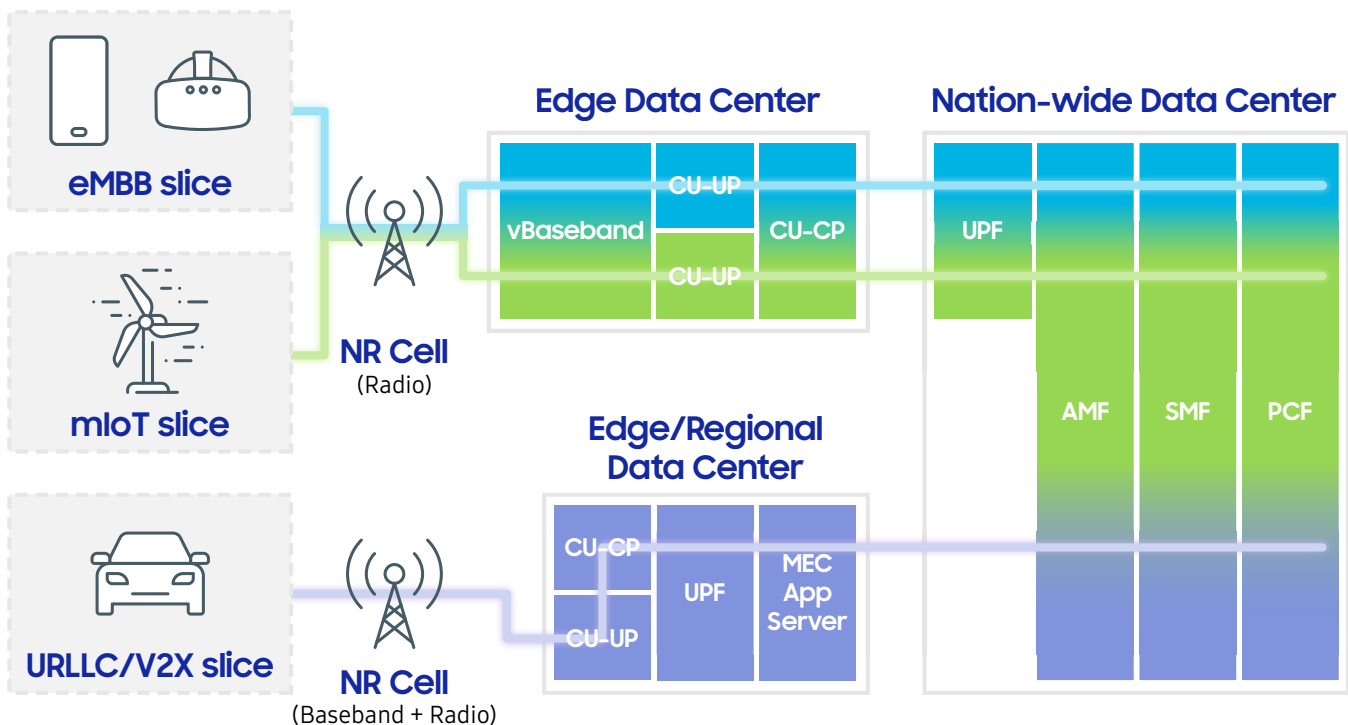


Operators Expand Financial Opportunities with Network Slicing

Network slicing allows operators to provide different network capabilities and services to specific users using the same physical infrastructure. Each network slice comes with its own service and performance requirements, providing operators a powerful way to differentiate their offering to enterprises and consumers and further monetize their network. The Samsung vRAN can efficiently allocate network functions and radio resources for each separate service on a per-slice basis. A slice can comprehensively combine attributes, such as throughput rate, latency requirement, peak data rate, and cell-edge data rate. Furthermore, everything is completely isolated from other slices, simplifying network operations and increasing security.

Examples of typical network slices include:

- Ultra-low latency for factory automation
- Massive machine to machine communication for the Internet of Things
- Enhanced reliability and security for utilities



Enhanced Security Defends Against Cyberthreats

Cyber threats have become a frequent issue, with malware and ransomware infections a constant reminder of the vulnerability of the interconnected world. Samsung employs a multi-phase approach for preventing the introduction of malicious software during various phases of development and deployment and has passed the GSMA/3GPP security assessment standard, Network Security Assurance Scheme (NESAS), for the development processes of vRAN in addition to their analytics, core, and cloud products. NESAS provides an industry-wide security assurance framework and defines the security requirements for product development and lifecycle processes.

Network Deployment Flexibility

The functional independence of the vDU and the vCU allows network planners to manage their systems more effectively than previous hardware-based implementations. The ability of the vCU to be placed on-site with a vDU, in a central location, or around the network edge, connected to multiple sites' vDUs, improves network efficiency and creates fewer chokepoints.

Samsung's vRAN architecture also supports both legacy and new technologies. It can interact with non-virtualized RAN functions, keeping existing equipment as needed.

Accelerating Cloud Adoption

The virtualization of the RAN is hastening the movement into the cloud for some network operators, with Samsung's fully virtualized RAN, containerized network functions are commercially integrated on to the platform of the major telco cloud providers. vRAN provides an automated cycle of provisioning, operation, and optimization for a quick, convenient, near-zero-touch operation. The virtualized network can manage physical, virtual, and cloud-based networks and support multiple cloud services.

Virtualization Pays Off in Many Ways

The increased data traffic demand continues to drive RAN infrastructure needs and spending, as such leading MNO's are looking for ways to contain their infrastructure spend. vRAN systems reduce expenses in many ways, including:

- COTS servers can be repurposed to other uses if they are replaced with newer equipment.
- Operational personnel cost can be reduced with automation efficiency in the workflow and troubleshooting.
- The virtualization and centralization of the BBU lead to fewer hardware servers, which translates into savings in on-site energy costs.
- Training costs and management time are reduced with COTS servers instead of the time needed to learn multiple vendors' equipment.
- vRAN uses Open Sources (e.g., OpenStack, K8s, ONAP, OpenShift) and 3rd party cloud management solutions (e.g., Redhat), so updates can be performed without disrupting services.

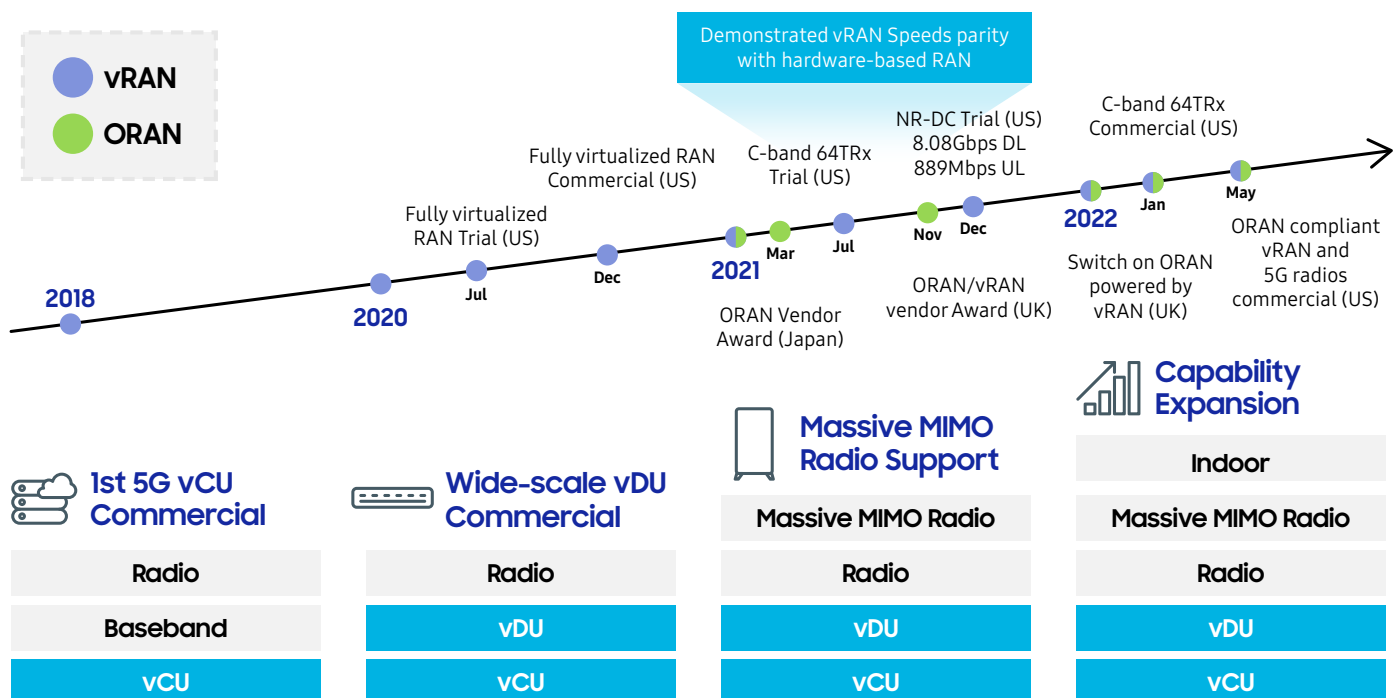
In addition, vRAN provides additional value propositions to operators, such as using shared infrastructure to support multiple enterprises, increased automation, and reduced TTM for new services.

Samsung performed a 5-year TCO analysis to determine the savings MNOs would realize by shifting to a vRAN-based network. The analysis considered the factors listed above and other factors such as transport costs, dark fiber, and the ability of vRAN to perform dynamic scaling. The report found significant savings in the shift to vRAN. A third-party [report](#) from Hewlett Packard Enterprise showed even more significant savings.

Samsung is the vRAN Market Leader

Samsung is the acknowledged pioneer and leader in developing and deploying the vRAN, working with customers, partners, and standards bodies to further the evolution and usage of network virtualization. Samsung developed the virtualized RAN and was the first to bring it to market.

- **2016** - First vCU developed, initiating virtualization in mobile networks.
- **2017** - Provided virtualized baseband capabilities to Verizon in deploying their end-to-end multi-vendor 5G system in the 28 GHz band – a first in the industry.
- **2017** - Demonstrated an end-to-end vRAN trial for 5G NR base stations with SK Telecom in Korea.
- **2018** - Worked with Japan’s KDDI with vRAN and 5G to connect to a 100 km/hour train, achieving a record speed of 1.7 Gbps, showing 4K UHD video.
- **2020** - Announced the first successful commercialization of 5G vRAN with Verizon.
- **2021** - Launched vRAN 2.0, the first fully virtualized commercial 5G RAN delivered end-to-end from a single vendor.
- **2021** - Announced support for 5G C-Band Massive MIMO radios, an industry first.
- **2022** - World’s 1st vRAN + 64T64R Massive MIMO 5G C-band commercial network service deployment in the US.
- **2022** - World’s first 5G SA Open RAN site powered by vRAN in Japan.
- **2022** - First 5G O-RAN site carrying live traffic using Samsung’s 5G vRAN in the UK.
- **2022** - MWC 2022 GLOMO Awards, Samsung’s 5G vRAN Wins CTO’s Choice, and Best Mobile Technology Breakthrough.
- **2022** - Announced first nationwide O-RAN cloud-based vRAN and 5G radios with DISH Wireless.

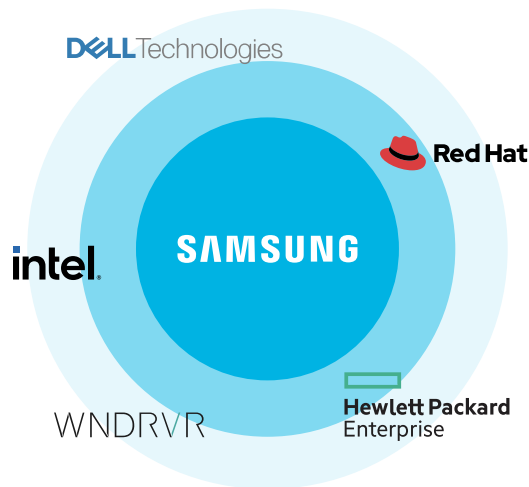


Samsung Helps Set the Standards

Samsung collaborates with multiple standards bodies and organizations to further 5G and vRAN technologies, including the Open RAN Alliance, GSMA, and ETSI. Samsung currently holds multiple Chair and Vice-Chair positions with 3GPP and has been awarded the 3GPP Excellence Award five times, more than any other company.

Leading vRAN Partner Ecosystem

In the design, development, and testing of virtualized components, Samsung continues to work with the industry-leading partners globally, including Dell, HPE, Intel, Red Hat, and Wind River. Samsung is also proud to work with the many MNOs worldwide who trust Samsung to develop the virtualized functionality that will help them efficiently deploy and manage their complex networks.



Network Innovation

More flexible & scalable software-based network

Seamless Integration

Fully-virtualized RAN
Cloud platform
COTS Server
Chipset

Test & Validation

on interoperability to proven vRAN commercial expertise

Samsung Continues to Lead the Way

Samsung is the only equipment manufacturer with vRAN deployments with Tier1 Operators in the US, Japan, and Europe, allowing them to unleash the power of 5G, and is the only manufacturer with commercial deployments supporting massive MIMO with vRAN. Samsung is redefining mobile networks to meet the exponential demands for connectivity and data and meet next-generation network technology requirements, and is the world leader in the 5G marketplace, offering innovative solutions in chipsets, radios, vRAN, and the core network.

Tier 1 Operators using Samsung's vRAN

- U.S.
- U.K.
- Japan



The Samsung **fully virtualized 5G RAN solution** is a GLOMO CTO Choice and Best Mobile Technology Breakthrough winner

For more information about Samsung's fully virtualized RAN offering, please see the links below:

Press release:

- **Samsung Introduces Fully Virtualized 5g RAN for Commercial Availability ('20.7)**
<https://www.samsung.com/global/business/networks/insights/press-release/samsung-introduces-fully-virtualized-5g-ran-for-commercial-availability/>
- **Samsung Expands 5G Technology Leadership with Fully Virtualized Commercial 5G RAN ('21.1)**
http://www.samsung.com/global/business/networks/insights/press-release/0122_samsung-expands-5g-technology-leadership-with-fully-virtualized-commercial-5g-ran/
- **Samsung Achieved a Significant Breakthrough, Increasing the Throughput, Improving User Experience and Showing Our Leadership in Virtualized Technology ('21.6)**
http://www.samsung.com/global/business/networks/insights/press-release/0608_samsung-achieves-industry-first-expands-vran-capability-to-support-c-band-massive-mimo-radio/
- **Samsung's 5G vRAN Wins CTO's Choice and Best Mobile Technology Breakthrough at the GLOMO Awards at MWC 2022**
<https://news.samsung.com/global/samsungs-5g-vran-wins-ctos-choice-and-best-mobile-technology-breakthrough-at-the-glomo-awards-at-mwc-2022>
- **DISH Wireless Selects Samsung Electronics for 5G Open Radio Access Network Rollout**
<https://news.samsung.com/us/dish-wireless-selects-samsung-5g-open-radio-access-network-rollout/>

White Paper:

- **vRAN Vol.1**
https://images.samsung.com/is/content/samsung/p5/global/business/networks/insights/white-paper/virtualized-radio-access-network/white-paper_virtualized-radio-access-network.pdf
- **vRAN Vol.2**
https://images.samsung.com/is/content/samsung/p5/global/business/networks/insights/white-paper/0406_virtualized-ran-vol-2/Virtualized_RAN-Vol.2.pdf

Video:

- **Transition to Virtualized RAN Vol.1**
<https://www.youtube.com/watch?v=DOFcvil8prg>
- **Transition to Virtualized RAN Vol.2**
<https://www.youtube.com/watch?v=A7yGJCXOzeY>
- **Samsung is accelerating the next generation 5G with Virtualized RAN**
<https://www.youtube.com/watch?v=wOZAaw-sg-y8>

Webinar:

- **Radio Access Network Evolution: vRAN**
<https://www.youtube.com/watch?v=sOh3FLTCijQ>

SAMSUNG

6625 Excellence Dr
Plano, TX 75023

Sales: 1.877.556.9469
Service & Support: 1.800.737.7008

samsungnetworks.com