Cloud RAN: Unlocking the power of 5G for a smarter, connected future

NOKIA | e&

Cloud RAN

The catalyst driving the transformation of cloud-native 5G RAN and beyond.

"It is a privilege to lead a visionary team in the UAE, dedicated to transforming the landscape of connectivity and unlocking the comprehensive benefits of 5G technology for a smarter, more interconnected future. Our commitment to pioneering advanced technologies and setting global benchmarks underscores our focus on enriching consumer and business experiences.

At e&, our 5G network is central to driving societal and industrial prosperity in the digital era, reflecting our broader techno transformation. Upheld by our relentless pursuit of excellence and the UAE's progressive mindset, we have propelled the telecommunications sector beyond global standards. Boasting the fastest mobile broadband network and leading global FTTH penetration rates, e& UAE exemplifies how cutting-edge technology can revolutionize connectivity and foster innovation.

In partnership with Nokia, e& UAE is driving 5G network evolution with the first Cloud-RAN deployment in the region, emphasizing openness, sustainability and an AI-driven network. Our focus on cloud-native technologies is a significant step toward an AI-native network. We are at the forefront of innovation, constantly pushing the boundaries of what is possible in connectivity."

Khalid Murshed
Chief Technology and Information Officer (CTIO), e& UAE

Through our close Cloud RAN collaboration, Nokia is supporting the visionary strategy of e& UAE in pioneering advanced technologies. Together, we are setting a benchmark for enabling an enriched 5G experience for both consumer and business users.

At Nokia, we leverage our extensive R&D competencies and technology expertise to transition from Cloud RAN trials to commercial deployment, marking a pivotal evolution for our industry. To help make Cloud RAN a success for our customers, we embrace an open model that leverages strategic collaboration with leading technology partners.

Our customers are at various stages in their cloud evolution journey. We design and develop our RAN solutions to deliver reliable high performance, consistent features and optimized energy efficiency across hybrid networks. These networks encompass purpose-built, cloud-based and open environments, empowering customers to choose deployment and architecture options that best suit them while enhancing TCO.

Additionally, in collaboration with e& UAE, we are looking into the monetization opportunities with Cloud RAN, 5G edge slicing and enterprise private networks. This initiative underscores our commitment to helping our customers build a future-proof foundation for their business.

Mark Atkinson
Head of Radio Access Networks, Nokia

Introduction

The telecommunications industry is undergoing a significant transformation. Amidst a complex landscape, the shift of Radio Access Networks (RAN) towards cloud-based architecture is becoming increasingly prominent. It's anticipated that radio networks will progressively transition into hybrid configurations, integrating cloud-based solutions alongside established purpose-built networks and, depending on the business strategy, potentially incorporating open radio network models.

e& UAE, a leading Communication Service Provider (CSP) in the United Arab Emirates, is spearheading this transformation by leveraging virtualization and cloud-native technologies to redefine its network transformation strategy. Renowned for its prominence in the telecom sector, e& UAE's commitment to innovation and sustainability, aligns perfectly with the evolution towards Cloud RAN, reinforcing its position as a pioneer in the industry.

The core concept of Cloud RAN involves separating the RAN baseband software from the baseband processing hardware. This is achieved through the virtualization or cloudification of baseband functions, specifically the centralized unit (CU) and the distributed unit (DU). It utilizes commercial off-the-shelf (COTS) hardware alongside a Containers-as-a-Service (CaaS) software layer, a process known as the vertical disaggregation of RAN.

Open RAN involves the disaggregation and standardization of RAN interfaces, especially the Open Fronthaul interface between the RU and the baseband. Standardized interfaces are crucial for ensuring interoperability and seamless integration, promoting supplier diversity. This process is known as the horizontal disaggregation of RAN.

The concepts of RAN vertical and horizontal aggregation are illustrated in the figure below:
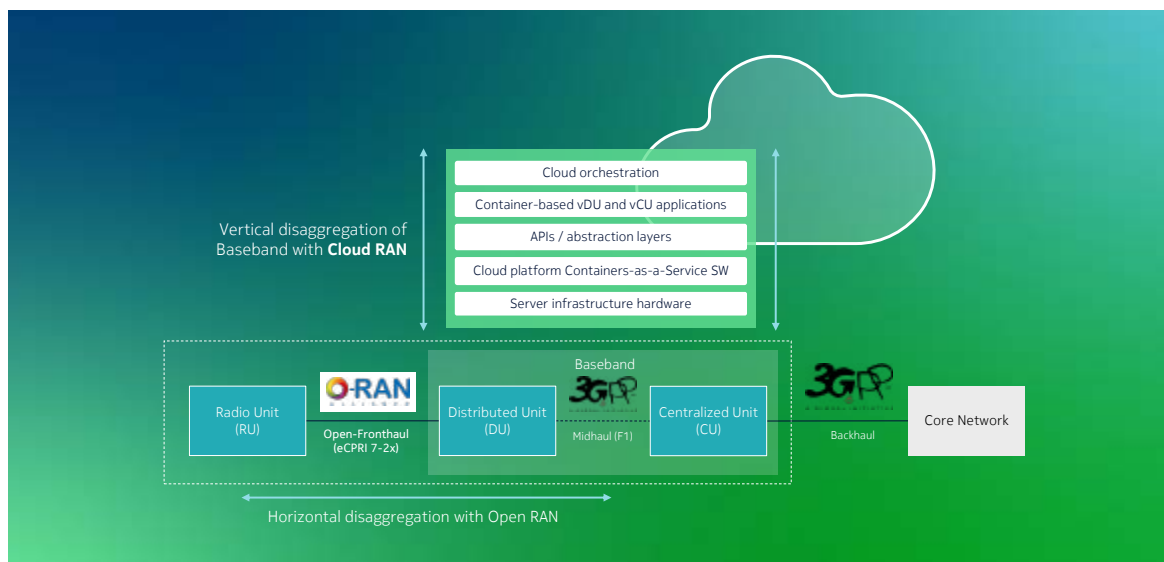
Nokia, as a leading supplier of network technologies and solutions, comprehensively understands the business drivers of its customers. Through Nokia's anyRAN approach, it forges strategic alliances with top technology firms to customize solutions that meet the unique requirements of each customer. Moreover, Nokia collaborates closely with standardization bodies and industry organizations to shape the future capabilities of radio networks, ensuring its solutions are interoperable and future-proof.

In the following chapters, we will delve deeper into the evolution towards Cloud RAN, the pivotal role of key players like e& UAE and Nokia and will also explore the opportunities and challenges that lie ahead. In fact, this journey has already started with the completion of the first **Cloud RAN trial,** jointly conducted by Nokia and e& UAE in Jan 2024.

Value Proposition of Nokia anyRAN

Cloud RAN provides flexibility, agility and openness to drive the RAN evolution.

Most operator networks are anticipated to gradually evolve into hybrid networks, featuring a combination of purpose-built RAN, Cloud RAN, and, based on business strategy, Open RAN.

Nokia develops its Cloud RAN solutions through its innovative anyRAN approach. By working closely with industry-leading technology partners, Nokia anyRAN offers the broadest range of strategic options to make Cloud RAN a commercial reality for customer networks.

Nokia anyRAN solution approach is illustrated in the picture below:

anyRAN – Cloudification, Open Fronthaul and Open management
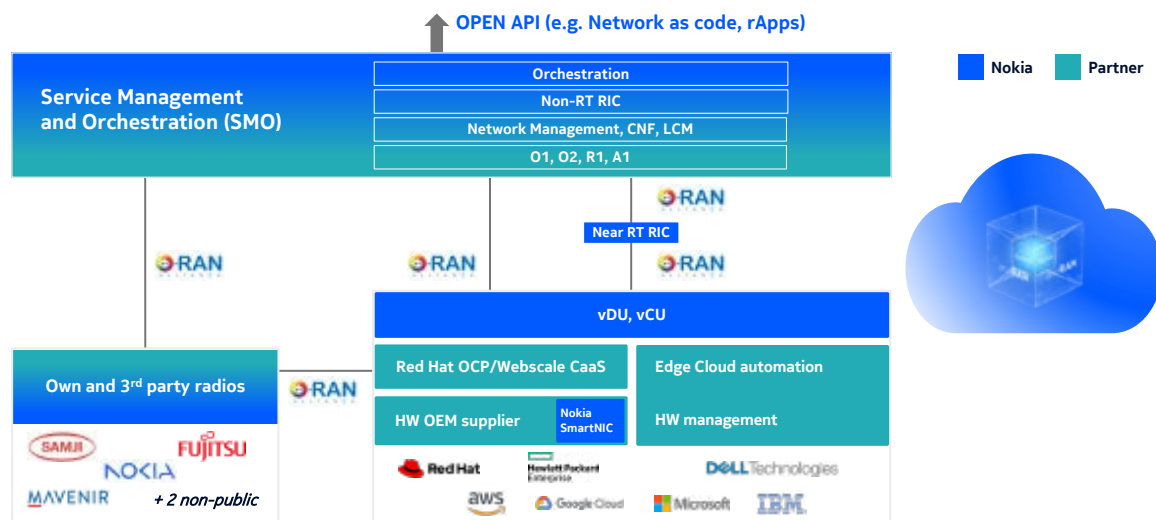Our customers benefit from the maximum flexibility and openness

Figure 1.

One of the key decisions operators face regarding network architecture is whether to implement a centralized RAN (CRAN), a distributed RAN (DRAN) or a combination of both. The chosen approach must support intended use cases, such as delivering high data rates in dense urban areas, serving dedicated enterprise users or supporting a public 5G network.

Flexible Options for Network deployments:

Nokia's Cloud RAN solutions are designed to accommodate various deployment options, supporting both centralized and distributed configurations. The options for deployment include:

- **Cloud Distributed RAN (DRAN):**
  - The virtualized distributed unit (vDU) is located at the cell site to meet stringent latency requirements.
  - The virtualized centralized unit (vCU) is positioned at the edge cloud to enhance hardware utilization efficiency.

- **Cloud Centralized RAN (CRAN) option 1:**

  - The vDU is situated at the far edge, while the virtualized centralized unit (vCU) is centralized at an edge or regional cloud.

  - Multiple Remote Units (RUs) are distributed across an area, each capable of meeting latency requirements for pooled vDUs, often referred to as the "Baseband Hotel." Additional efficiencies are achieved through centralized aggregation of vCU network functions.

- **Cloud Centralized RAN (CRAN) option 2:**

  - The vDU and vCU are collocated at the far edge.

  - This setup allows vDU and vCU to run on the same type of hardware within the same CaaS (Containers as a Service) cluster and data center, optimizing the hardware cost/performance ratio.
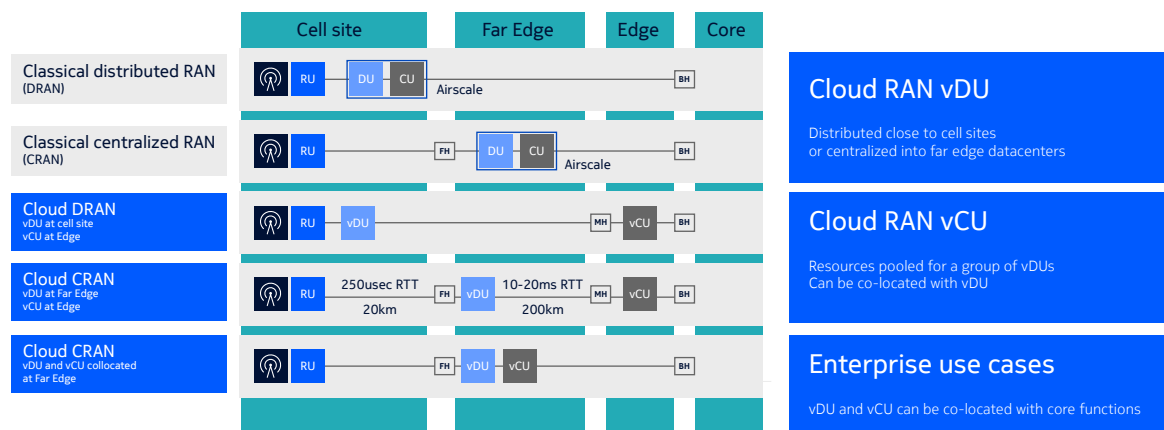

Figure 2. Centralized and distributed deployment options

e& UAE – AI-driven transformation:

In the digital era, e& UAE takes a proactive approach toward AI- and data-driven technologies, positioning itself as a leading service provider committed to embracing new technologies for long-term growth and success. The implementation of an end-to-end AI-driven autonomous network is a hallmark of e& UAE's telecom transformation. This innovation ensures optimal performance and efficiency throughout the network's lifecycle.

Elevating 5G Edge Slicing with Cloud RAN

5G edge is revolutionizing telecommunications by providing secure, high-performance, low-latency networks crucial for business-critical applications. As networks transition to cloud solutions, network slicing ensures efficient, end-to-end connectivity from devices to applications. Nokia's cutting-edge 5G edge slicing solution empowers CSPs to deliver customized Virtual Private Network services, enhance user experiences, and tap into new revenue streams.

Cloud RAN seamlessly integrates with edge computing infrastructure, enabling the deployment of edge computing capabilities at the network edge. This integration allows latency-sensitive applications and services to be processed closer to end-users, further enhancing the performance and efficiency of network slices.
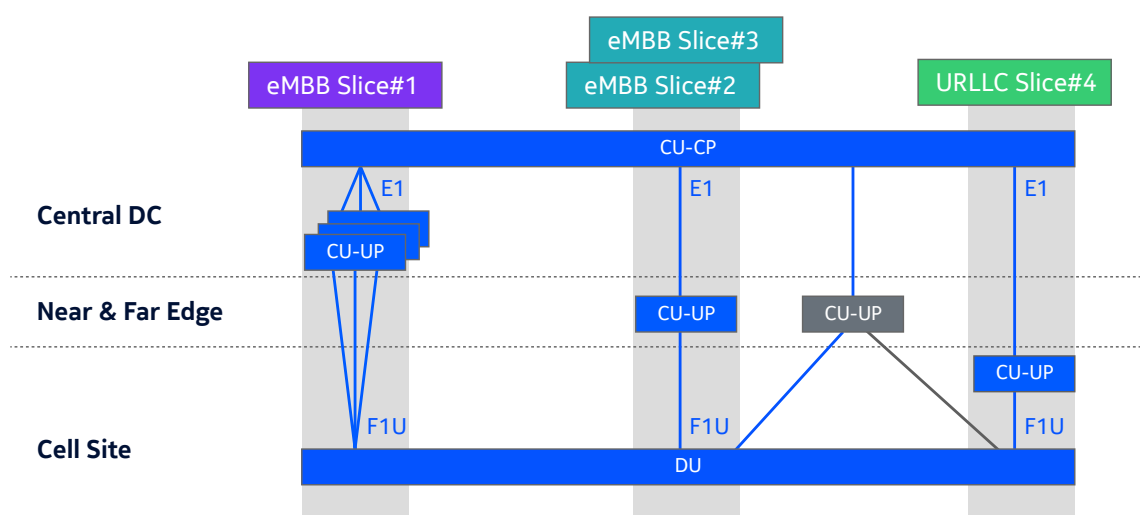

Figure 3

Cloud RAN supports multi-tenancy, allowing multiple network slices to coexist on the same physical infrastructure while maintaining isolation between slices. This enables efficient resource sharing and utilization, reducing operational costs and improving overall network efficiency.

Integrating network slicing at the edge with CloudRAN allows CSPs, such as e& UAE, to offer new scalable, secure and cost-efficient services to consumers, enterprise and industry customers, including:

- Sliced 5G VPN service in campus, metropolitan or wider areas with managed connectivity to enterprise data networks and applications

- Network Slicing-as-a-Service with E2E managed connectivity from various devices to enterprise private and public cloud applications.

- Premium 5G broadband services for smartphone business users with sliced connectivity to edge and central cloud applications.

- Premium Fixed Wireless Access services with slices for small and home offices, as well as remote work setups.

By combining network slicing at the edge with Cloud RAN , CSPs can deliver these innovative services, transforming networks into efficient monetization platforms. As a pioneer in network slicing, Nokia leads the way in enabling these advanced solutions, opening the door for further revenue and business opportunities across enterprises.

Use case 1: Augmented Reality (AR) in smart cities

Scenario: Imagine a bustling smart city where augmented reality (AR) applications are used for various purposes, such as navigation, tourism, and maintenance. These AR applications require low latency to provide real-time information and seamless user experiences.

Deployment of edge computing nodes: Cloud RAN integrates with edge computing infrastructure by deploying edge nodes at strategic locations within the city, such as near major tourist attractions, transportation hubs and business districts (enterprise campus locations).

Processing at the network edge: Latency-sensitive AR data processing tasks, such as image recognition, overlay rendering and contextual information delivery are offloaded to these edge nodes (CU-UP and UPF). This reduces the distance data needs to travel/break-out towards the end application (either deployed at the same edge data center or at short-distance), minimizing latency.

Table 1.

Use case 2: Intelligent traffic management in smart cities

Scenario: A smart city deploys an intelligent traffic management system that uses data from connected vehicles, traffic cameras and roadside sensors to optimize traffic flow, reduce congestion and enhance road safety.

Deployment of edge computing nodes: Cloud RAN integrates with edge computing infrastructure by deploying edge nodes at key traffic intersections and along major roadways. These nodes handle local data processing tasks, reducing latency, and ensuring real-time responsiveness.

Processing at the network edge: Real-time data from connected vehicles, traffic cameras and sensors are processed at the edge nodes. This local processing is made possible via dedicated user-plane slicing functions (CP-UP and UPF), enabling instant analysis of traffic conditions and immediate adjustments to traffic signals and routing recommendations.

Enhanced traffic flow optimization: Using RAN features such as precise vehicle location tracking, speed and direction data, the system can dynamically adjust traffic signals to optimize flow. For example, traffic signals can be synchronized to create "green waves" that reduce stops and starts, improving fuel efficiency and reducing emissions.

Table 2.

Mechanisms for Total Cost of Ownership reduction

Cloud RAN has the potential to trigger substantial operational cost reduction, justifying its initial investment.

It's crucial to recognize that Cloud RAN is set to significantly reduce operational costs, which will, in turn, justify the initial capital expenditure. This paves the way for a more efficient and cost-effective network infrastructure.

Cloud-based RAN offers several key levers that can drive down operational expenditures (OPEX) and enhance operational efficiency for e& UAE, helping it achieve its operational excellence goals.

These main levers include:

- **Centralized processing:** By centralizing RAN processing in data centers, CSPs can pool and dynamically allocate resources based on demand, leading to better utilization and reduced need for excess capacity.
- **Scalability:** Cloud RAN allows for scalable deployment, meaning CSPs can add capacity incrementally without large upfront investments.

Nokia is partnering with major private and public cloud providers (Amazon Web Services, Google, IBM, and Microsoft) by leveraging their cloud services and global cloud infrastructure at region, edge locations and on-premises to enable both private and hybrid Cloud RAN solutions and make centralized processing at scale a reality.

- **Centralized management:** Centralized infrastructure simplifies management and maintenance, reducing the need for onsite technical staff and visits. Even in a D-RAN deployment with a Cloud RAN hybrid implementation (on-premises and public cloud), Nokia, in partnership with hyperscale companies, delivers a solution with a fully managed cloud infrastructure. This ensures a single pane of glass for management, providing observability, AI/ML automation and support for highly distributed network architectures.

Enhanced Operational efficiency: Cloud RAN supports high levels of automation, which can reduce human error and the need for manual intervention. Advanced orchestration tools can streamline network operations and maintenance tasks, improving overall efficiency. Cloud RAN is designed to utilize common management and orchestration tools, which can help CSPs simplify and automate network operations, reduce complexity and costs, and enable faster deployments, maintenance, and network upgrades. Digitalization is key to achieving cost savings. Simplifying operations and implementing automation will optimize the cost position for CSPs. Holistic lifecycle management solutions allow for managing a diverse supplier base, ensuring optimal orchestration of resources, and achieving faster payback on investments. With Nokia's flexible and future-proof anyRAN solution, you can maintain an optimized cost base, protect your investment, and retain full control over future scenarios.

1) New business models and monetization opportunities

Cloud RAN offers a new paradigm in network architecture that can provide significant benefits to operators and businesses and has the potential to enable CSPs to explore new services, markets, and business models, particularly with enterprises. This includes offering network-as-a-service (NaaS), where operators provide a flexible consumption model that includes both infrastructure and services to support enterprise use cases on demand. It delivers the foundation capabilities to facilitate the introduction of use cases to capture new revenue opportunities, particularly in the enterprise segment, such as

- **Innovation and agility:** Cloud RAN enables faster deployment of new services and applications, especially when taking advantages of 5G Edge Slicing, which can help enterprises stay ahead in the digital transformation journey and enable CSPs to capture existing and emergency B2B markets.
- **Improved Performance:** With features like network slicing and edge computing, Cloud RAN can deliver high performance and low latency, with highlighted architectural choices such as the Centralized Unit (CU) split, which are critical for many enterprise applications.

Nokia anyRAN will support e& UAE with a hybrid RAN portfolio of purpose-build and cloud-based RAN solutions, helping the company achieve its key verticals and use case goals

Cloud RAN: Unlocking the power of 5G for a smarter, connected future

Conclusion

e& UAE has consistently demonstrated its dedication to excellence and innovation in the telecommunications sector, driving the evolution of Radio Access Networks (RAN) towards Cloud-based RAN.

Nokia's strategic partnership with e& UAE is a testament to our shared vision for the future of the industry. Our collaboration has been instrumental in advancing Cloud RAN solutions in the UAE, underscoring the transformative potential of this technology. Cloud RAN offers increased flexibility, scalability, and efficiency, paving the way for more robust and reliable networks.

Our goal is to ensure a seamless transition to Cloud RAN with minimal disruption to existing services. As purpose-built RAN and Cloud RAN are expected to coexist for extended periods, it is essential to enable this transition while maintaining the highest levels of performance and efficiency, in accordance with e& UAE's vision.Nokia is uniquely positioned to overcome this challenge with our extensive industry heavy-weight partner base.

According to Dell'Oro latest report, market for Cloud RAN/Open RAN is expected to steadily grow reaching 24% of the total RAN market by 2028. However, several challenges and barriers remain, such as integration efforts, transport readiness, performance consistency, and feature parity. Nokia is addressing these challenges proactively and transparently, ensuring that customer interests are prioritized and met.

With e& UAE's dedication to advancing telecommunications and its strategic partnership with Nokia, the potential of Cloud RAN, coupled with the need for a smooth transition, underlines the importance and inevitability of evolving towards Cloud-based RAN. This evolution will play a crucial role in shaping the future of telecommunications, enabling unprecedented levels of connectivity and opening new possibilities for digital transformation.

Abbreviations & Definition of terms

BBU Pooling Class 1	In telecommunications, BBU pooling allows multiple BBUs to be centralized and shared among several remote radio units (RRUs), optimizing resource usage, and improving network efficiency
Blue & Green deployment	A software deployment strategy that reduces downtime and risk by running two identical production environments, one (blue) running the current version and the other (green) running the new version. Traffic is gradually switched from blue to green.
CSMF	Communication Service Management Function
CU-CP	Central Unit Control Plane
CU-UP	Central Unit User Plane
NaaS	Network as a Service
NSMF	Network Slice Management Function
O-RAN	Open Radio Access Network, specified by O-RAN Alliance
PDCP	Packet Data Convergence Protocol. A protocol layer in the LTE and 5G radio stack responsible for header compression, encryption, integrity protection, and ensuring data is delivered in the correct sequence. PDCP protocol session is established between the UE and CU during 5G data connectivity
R-NSSMF	Radio Network Slice Sub-net Management Function
SDAP	Service Data Adaptation Protocol. A protocol in the 5G NR (New Radio) stack that maps between the Quality of Service (QoS) flows and data radio bearers, ensuring that the QoS requirements are met for different types of traffic
SMO	Service Management and Orchestration

References

- Nokia: Cloud RAN: A Guide to Acceleration Options
- Network slicing | Nokia
- 5G edge slicing | Nokia
- 5G-Advanced: The Future of Wireless Communications in the UAE | e& UAE
- Unleashing the Power of AI | e& UAE

About Nokia

At Nokia, we create technology that helps the world act together.

As a B2B technology innovation leader, we are pioneering networks that sense, think and act by leveraging our work across mobile, fixed and cloud networks. In addition, we create value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs.

Service providers, enterprises and partners worldwide trust Nokia to deliver secure, reliable and sustainable networks today – and work with us to create the digital services and applications of the future.