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How Diverse O-Cloud Environments Enhance RAN Resilience and Scalability

By: Rhonda Holloway

As mobile network evolution drives relentlessly toward next-generation technologies, network planning, operations and optimization continue to become more complex. This is particularly challenging given that legacy networks and new, more advanced architectures need to coexist and interact smoothly and efficiently.

At this point, it's virtually impossible for mobile network operators (MNOs) to manage end-to-end network parameter designs, tuning, operations, and optimization using manual processes and basic automation tools. Not only are manual processes time-consuming and susceptible to human error; this approach simply cannot accommodate all the moving parts of next-generation mobile networks in real-time.

Basic automated network operations have become a necessity for daily operations, troubleshooting, and performance optimization of 5G and LTE networks. Yet, the accelerating complexity of mobile network infrastructure demands even more sophisticated automation tools. With the growing adoption of Open RAN architectures, MNOs have at their disposal advanced network automation resources beyond the basics.

The O-RAN ALLIANCE standards include a number of capabilities to super-charge network automation, including guidance and specifications for standards-based infrastructure management and cross-organizational data collection. These functions not only facilitate multi-vendor integration in Open RAN networks, but also enable artificial intelligence (AI) techniques in automated network operations, helping optimize cloud-native 5G networks and significantly improving performance and efficiency.

Go Cloud-native

As the demands on today's networks escalate, a growing number of MNOs are turning their attention to cloud-native workloads to enable ever greater agility and automation. In fact, analyst firm IDC forecasts that cloud-native deployments will pick up the pace in 2024, with worldwide revenue for telecom cloud infrastructure software to grow at more than 16 percent per year through 2027.

A key aspect of successful migration to the cloud in an Open RAN architecture is a full understanding of the Open Cloud (O-Cloud), as well as management and orchestration of O-Cloud environments leveraging the O-RAN Service Management and Orchestration (SMO) framework. Because the O-RAN SMO allows managed functions to interoperate and communicate within an O-RAN-compliant network, this architecture provides a sophisticated system for programming, operating, and managing billions of network components in a multi-vendor environment, and helping accelerate and automate 5G deployments.

The O-RAN SMO includes integration and data services allowing it to connect to and manage RAN Intelligent Controllers (RICs), O-RAN CU/DU network elements, virtual network functions (VNFs), and the O-Cloud compute platform. This framework is vital to managing and orchestrating the O-Cloud platform, and is a key enabler of more programmable, flexible, and interoperable RANs.

Orchestrating Clouds

Multi-cloud orchestration and management distributes cloud-native applications and software across O-Cloud environments, ideally ensuring efficient use of compute, storage, and network capabilities and optimizing resource utilization. This can streamline network operations by managing infrastructure and life cycles across diverse O-RAN environments for greater resilience, scalability, and flexibility in the virtualized RAN.

Proper O-Cloud infrastructure management leverages distributed control and management of automation and other policies and functions, dynamically adjusting configurations based on network requirements. This allows O-Clouds to be rapidly deployed and scaled to meet changing network demands in real-time, enabling faster service rollout and better responsiveness to traffic fluctuations.

O-Cloud orchestration enables MNOs to easily coordinate and manage deployment, operation, and interaction across multiple cloud providers, including AWS, Microsoft Azure, Google Cloud, and Wind River. And in a disaggregated, open environment, operators are free to choose providers based on services, pricing, or regions, relying on effective interoperability to ensure seamless integration between applications and services throughout the network lifecycle, from deployment to decommissioning.

Embrace O-Cloud Diversity

In the Open RAN ecosystem, the O2 interface connects the SMO function to the O-Cloud, enabling efficient communication and data exchange for comprehensive infrastructure management. This functionality allows the SMO to remotely monitor, control, and optimize distributed RAN elements, leading to more agile, efficient, and cost-effective network operations.

To allow efficient and automated Open RAN deployment and configuration, an important first step is O-Cloud registration and initialization. This process ensures that the SMO has accurate and up-to-date information about available O-Cloud resources and configurations. The SMO framework needs this to enable intelligent decisions about resource allocation and associated orchestration to improve efficiency and First, register each O-Cloud environment to identify the O-Cloud capabilities, resources, and location. Second, initialize the O-Cloud's services, allowing the O-Cloud to prepare itself for serving RAN functions and applications, such as loading software, configuring hardware, and starting specific services. Finally, use the O-RAN O2 interface to initiate communication between the RAN and the SMO.

As resources, capabilities, and operational states change, the O-RAN O-Cloud inventory update function communicates changes in its inventory to make sure that the SMO always has the latest information. By understanding the real-time state and configuration of the O-Cloud resources, the SMO can intelligently manage and optimize network performance, as well as identify potential problems such as resource failures, configuration errors, or performance bottlenecks.

The O-Cloud registration and initialization function and the O-Cloud inventory update play a crucial role in unlocking the full potential of Open RAN. By enabling multi-cloud application orchestration across diverse O-Cloud environments, MNOs can empower seamless onboarding, efficient resource management, increased flexibility, and a more open and innovative RAN ecosystem. Together, these benefits translate to improved fault management, network performance, cost optimization, and ultimately a better user experience for mobile network subscribers.

Home in on QoE

As 5G adoption continues to grow rapidly, the stakes could not be higher for service providers worldwide, driving the need for innovative new ways to improve service quality. With the combination of the O-Cloud registration and initialization function and inventory updates, operators can ensure that up-to-date O-Cloud information is available to the orchestrator prior to resource allocation. This accuracy helps MNOs perform a type of mobile network orchestration called application homing.

This capability allows the SMO to select the O-Cloud with the most appropriate latency, throughput, and cost performance for a specific application. Application homing can automatically improve quality of experience (QoE) for subscribers and deliver improved application performance. That improvement may even contribute to reducing the battery consumption of end-user devices. MNOs also can use application homing to increase network efficiency, enhance service differentiation, and reduce network congestion.

For example, during the 2023 global O-RAN Plugfest organized by the O-RAN ALLIANCE, application homing was demonstrated across interoperable, Open RAN solutions using the defined O-RAN O2 interface specification. This O-Cloud orchestration test used two Wind River O-Cloud platforms — one supporting a low-latency operating system (OS) and the other supporting a standard OS.

During the test, the SMO successfully deployed an application requiring a low-latency OS on the O-Cloud meeting the latency requirements, while an application with no specific OS requirements was automatically deployed on the O-Cloud with a standard OS.

Both tests successfully demonstrated resource orchestration between clouds, proving the potential for SMO and standards-based infrastructure management and inventory retrieval and updates. In addition, the tests demonstrated multi-vendor RAN interoperability using the defined O-RAN O2 specifications.

As a result of this demonstration, the O-RAN Plugfest team made several observations about best practices for enhanced RAN interoperability and standardization in the O-RAN ecosystem. The team suggested that developers expose standard capabilities to the Open RAN SMO and assign separate attributes to certificates and tokens in REST messages. These recommendations help advance standardized capabilities, allowing for easier integration and understanding of security measures across different systems.

Tame Network Complexity

Advanced network automation is no longer a ”nice-to-have” feature. Rather, it’s imperative for today’s mobile networks to keep pace with evolving infrastructure, escalating service demands and fierce competition. As the RAN becomes increasingly cloudified, the network is infused with ever greater agility, intelligence, and performance. The O-RAN O-Cloud is a key component in this evolution toward more flexible, programmable, and interoperable radio access networks.

With an accurate understanding of managed O-Cloud instances and their infrastructure inventory and associated capabilities, MNOs can leverage intelligent multi-cloud application orchestration across diverse O-Cloud environments to ensure the most appropriate use of compute, storage, and networking capabilities in each environment. This not only optimizes application resource allocation and orchestration across O-Clouds, but also enables advanced automated network operations and optimization in cloud-native 5G networks, reducing complexity, enhancing RAN resilience and scalability, and significantly improving performance and efficiency.