



The Essential Guide for Understanding O-RAN

eBook

 KEYSIGHT

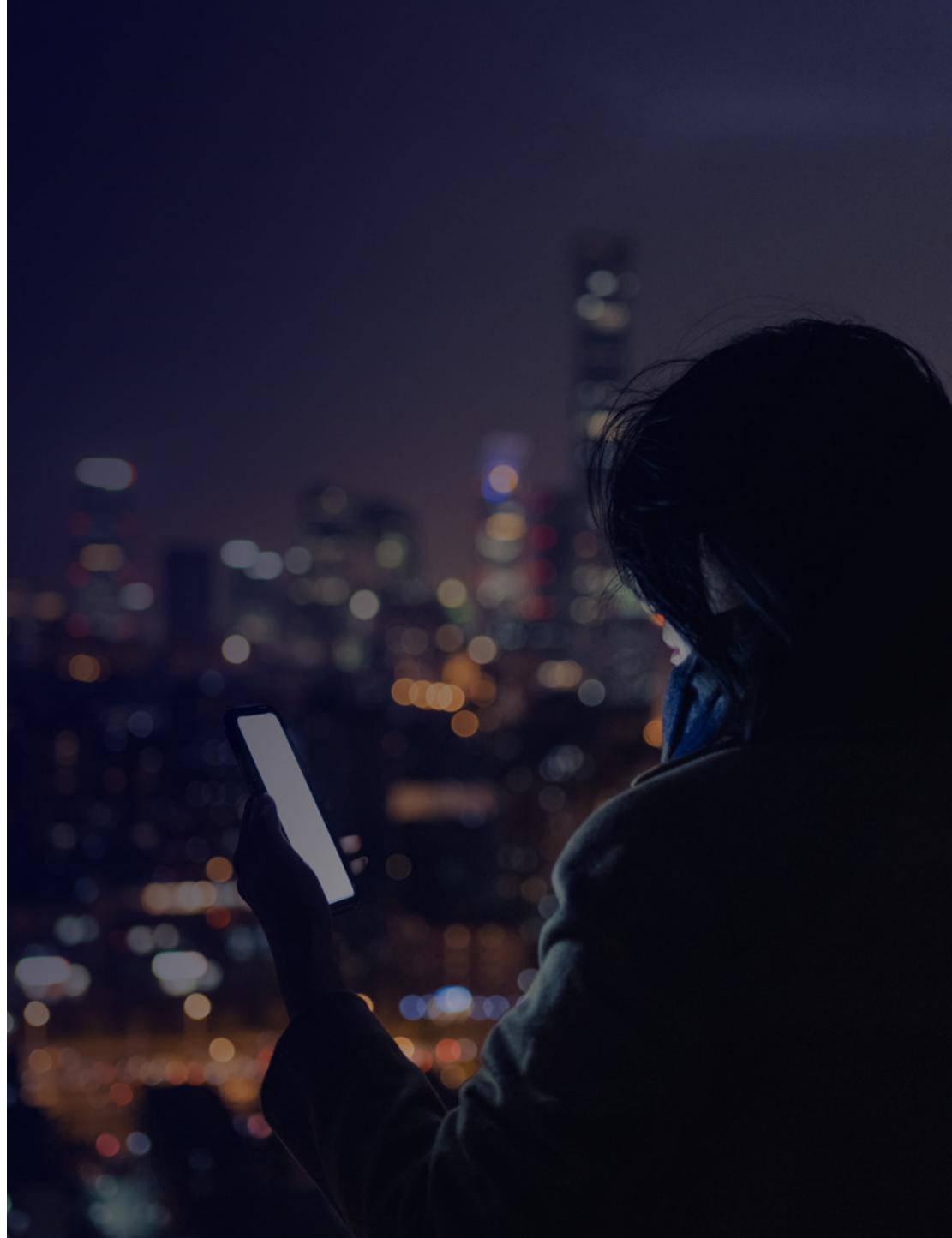
INTRODUCTION

O-RAN based radio access networks represent the mobile communication industry's move toward an open, virtualized, and disaggregated architecture. O-RAN revolutionizes how mobile network operators (MNOs) can build their radio access networks (RANs) using a multivendor, interoperable, and autonomous supply ecosystem.

RAN deployment for 4G and earlier generations of cellular technology relied on a single-vendor model. These networks used proprietary hardware and software systems, not compatible with other vendors' products, creating a closed and uncompetitive environment.

O-RAN breaks down the traditional hardware-centric RAN into building blocks (radios, hardware, and virtualized functions) using open and standardized interfaces. Network vendors can focus on specific building blocks rather than building an entire RAN. Operators gain the ability to mix and match components from multiple vendors.

In this new model, you must perform testing to ensure multivendor components work together seamlessly and without compromising performance. This eBook will bring you up to speed quickly on the following O-RAN topics: O-RAN architecture, conformance and interoperability testing, transport network requirements, and performance metrics.



Contents



CHAPTER 1

O-RAN Basics



O-RAN Basics

The mission of an open radio access network (O-RAN) is to create an open, virtualized, and intelligent radio access network (RAN) architecture to enable a multivendor, interoperable, and competitive ecosystem.

The O-RAN Alliance is a worldwide community with its members developing a unified roadmap for future O-RAN standards and specifications, a reference architecture, and the interfaces between the various components of the network.

Understanding the O-RAN architecture and the benefits it can deliver are key to helping you assess if this model is right for you.

O-RAN focus groups

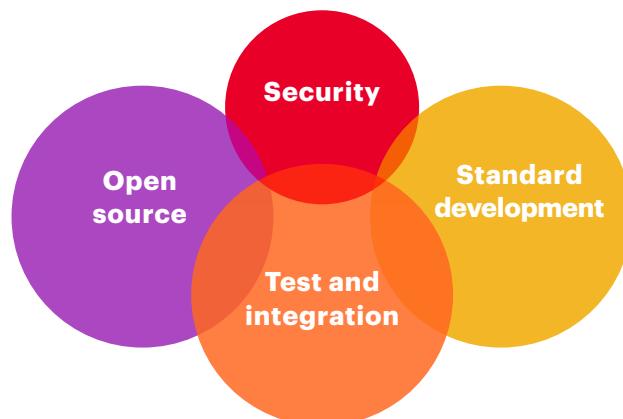


Figure 1. O-RAN Alliance working groups

O-RAN technical workgroups

Workgroup #1: use cases and overall architecture

Workgroup #2: non-real-time RIC and A1 interface

Workgroup #3: near-real-time RIC and E2 interface

Workgroup #4: open fronthaul interfaces

Workgroup #5: open F1/W1/E1/X2/Xn interface

Workgroup #6: cloudification and orchestration

Workgroup #7: white-box hardware

Workgroup #8: stack reference design

Workgroup #9: xHaul transport

Workgroup #10: OAM

Architecture

A 5G O-RAN architecture includes the following key components:

- O-RAN radio unit (O-RU) for processing the lower part of the physical layer
- O-RAN distributed unit (O-DU) for baseband processing, scheduling, radio link control, medium access control, and the upper part of the physical layer
- O-RAN central unit (O-CU) for the packet data convergence protocol layer
- O-RAN intelligent controller (O-RIC) to gather information from the network and perform the necessary optimization tasks

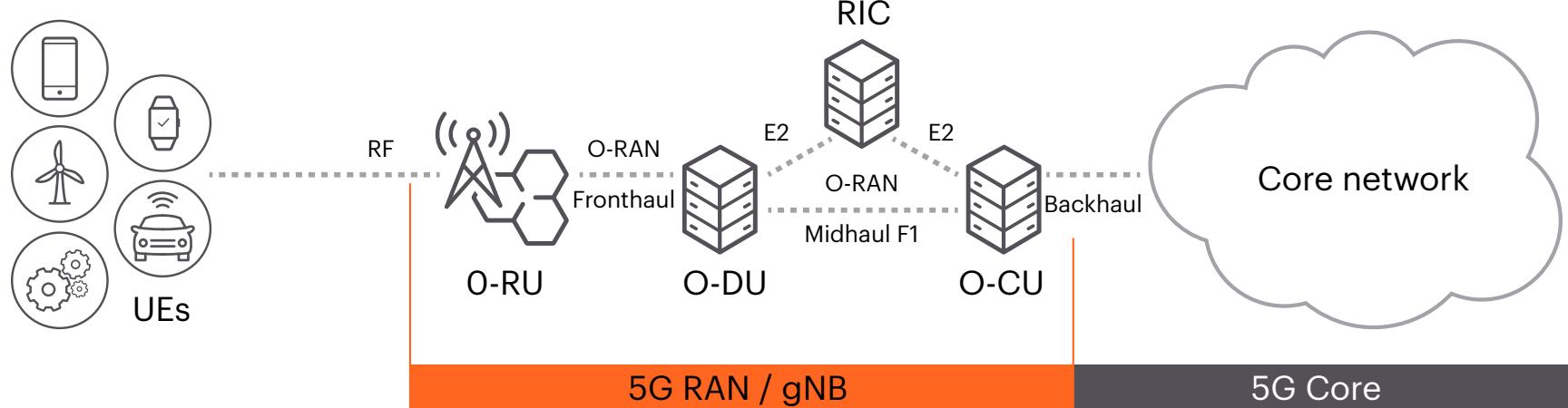


Figure 2. O-RAN architecture with UEs and core network

Benefits

The O-RAN architecture addresses traditional RAN challenges by creating a disaggregated and virtualized network with standard interfaces. In doing so, it delivers four key benefits:



Transformation

- Enabling more open, virtualized, and fully interoperable radio access networks.

Innovation

- Choose from the latest and best 5G RAN components with access to a wide variety of product, service, and feature options across vendors.
- Prepare for the future by adopting an architecture that supports 4G and 5G, and even 6G.

Agility

- Gain the flexibility to mix and match RAN components from more than one vendor to construct a 5G network that works best for you.
- Deploy and upgrade your 5G network at a faster pace with help from multiple specialized vendors.

Capital expenditure savings

- Reduce your 5G network deployment costs with a competitive supplier ecosystem.



CHAPTER 2

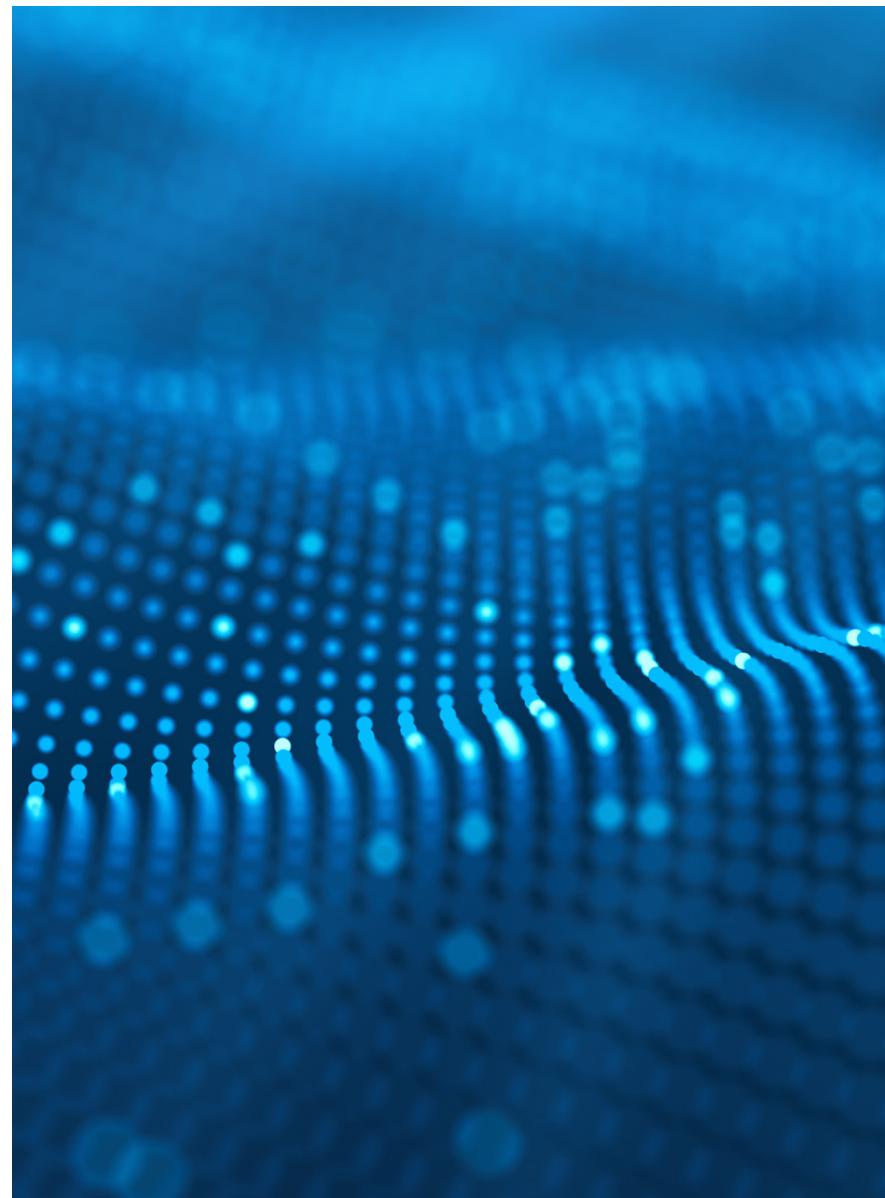
O-RAN Interface Conformance and Interoperability



O-RAN Interface Conformance and Interoperability

Next-generation 5G new radio (NR) RAN equipment design, validation, and production teams face new test challenges. O-RAN standardized fronthaul architectures and gNB disaggregation are driving the need for testing gNB components in isolation, flexible peer emulation, and conformance and interoperability testing of new O-RAN devices. These tasks require multi-domain test solutions with O-RAN protocol generation and measurement capabilities spanning all O-RAN interfaces.

Conformance testing ensures each component and its interfaces comply with industry standards. Interoperability testing ensures all elements work together. Both types of assessments are necessary to correct performance issues before network deployment.



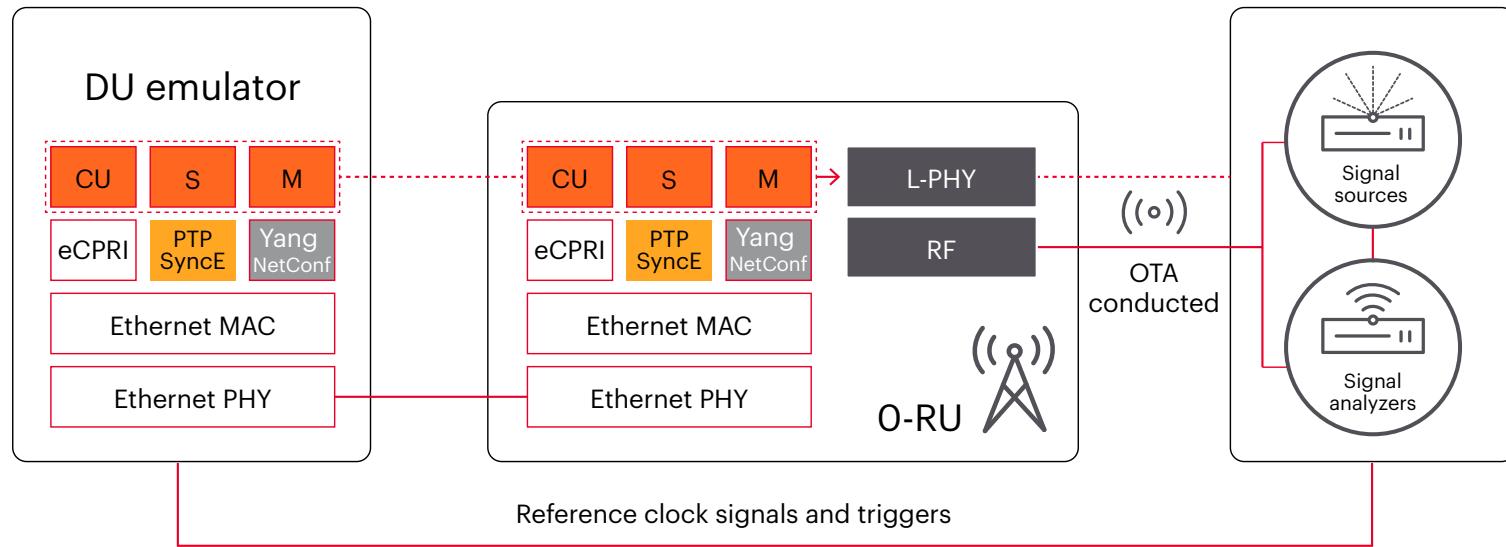


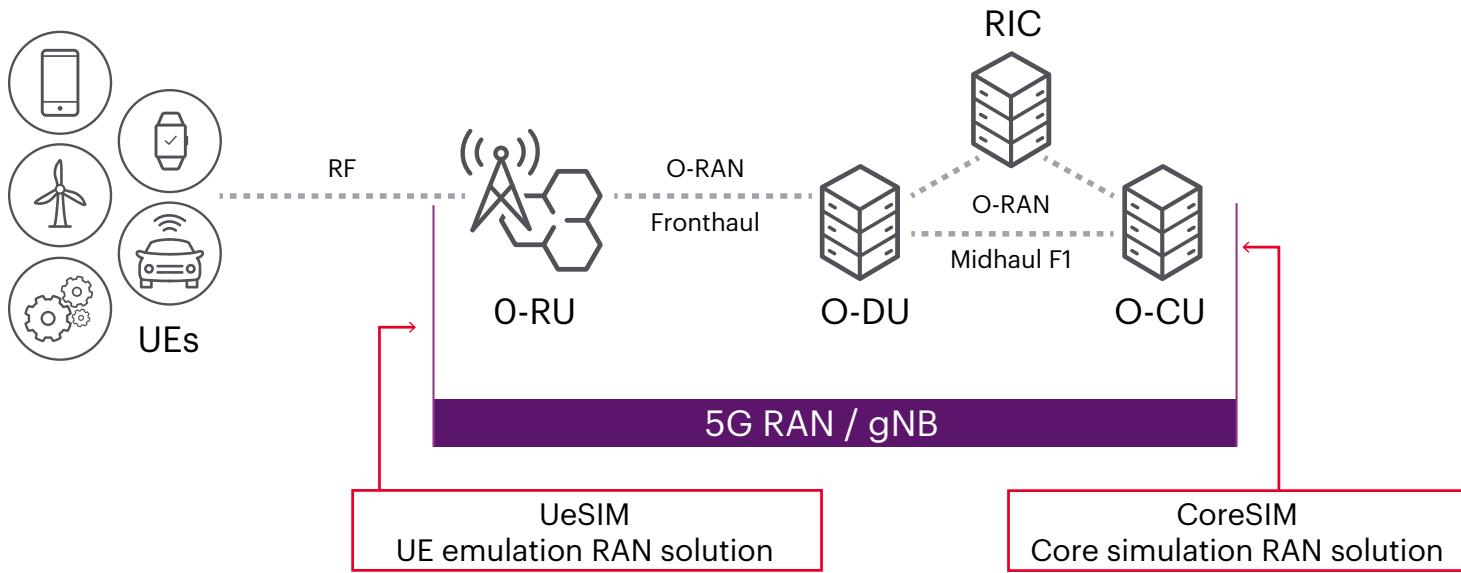
Figure 3. O-RU conformance test setup

Fronthaul conformance test

The fronthaul interface connects the O-RAN radio unit to the O-RAN distributed unit and transmits time-sensitive messages at extremely high data rates. The O-RU requires extensive testing to ensure compliance with [O-RAN specifications](#).

Test tips

- Use a test sequencer to automate the hundreds of tests needed for conformance test.
- Analyze the RF response of the O-RU to determine if it understands the distributed unit correctly.



Fronthaul interoperability testing

Fronthaul interoperability requires you to validate O-RAN units from different vendors. You need to overcome challenges such as the wide variety of O-RUs, the flexibility in the management plane (M-plane) implementation, and tight synchronization between the O-DU and O-RU.

Test tips

- Choose a test solution with broad capabilities to cover different radio units and simulate various behaviors.
- Use an actual distributed unit and radio unit combined with user equipment simulation to test the fronthaul interoperability of both units.
- Ensure your solution supports synchronization plane (S-plane) features.
- Use various setups to accommodate different network architectures, such as non-standalone (NSA) and standalone (SA).

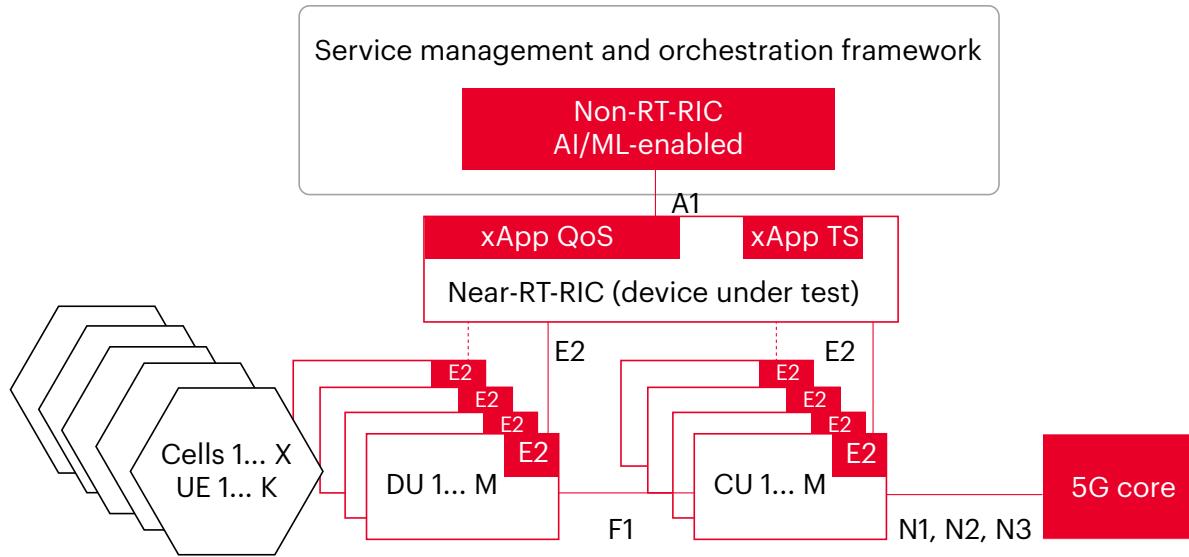


Figure 5. RIC test setup

Near Real-Time RAN Intelligent Controller Testing

The RAN intelligent controller (RIC) leverages artificial intelligence and machine learning to control and optimize radio access network elements and resources based on the applications running on the network. It connects to the O-DU and O-CU via an E2 interface.

Test tips

- Prepare to simulate thousands of distributed units, control units, and other applications to test the RIC E2 nodes.
- Use a cloud-based software solution to accelerate the process by automating the required tests.



CHAPTER 3

Transport Network Requirements



Transport Network Requirements

Testing the transport network is necessary to ensure optimal network performance since the O-RAN radio unit, O-RAN distributed unit, and O-RAN central unit can only communicate through the transport network.

The 5G radio access network adopts a functional split from the O-RAN Alliance and 3rd Generation Partnership Project (3GPP) because it requires different data rates and latency tolerance. Latency and speed tests are critical for fast and secure data processing.

The transport network also processes tasks such as time synchronization, deterministic delivery of critical data, segment routing, data encryption, and the virtualized deployment of the 5G-xHaul network. Tests like time-error budget, network slicing, and encryption are important for the transport network.



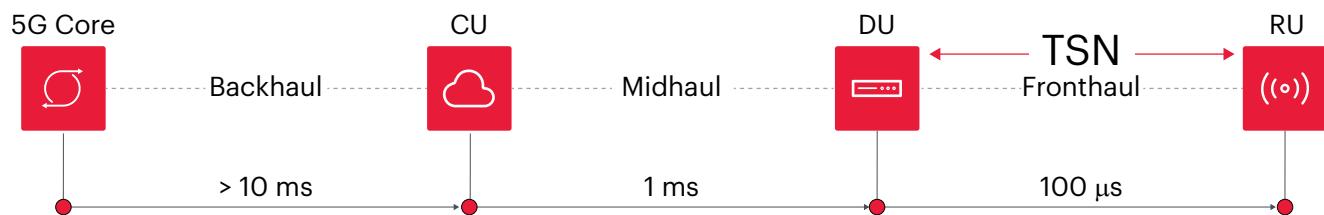
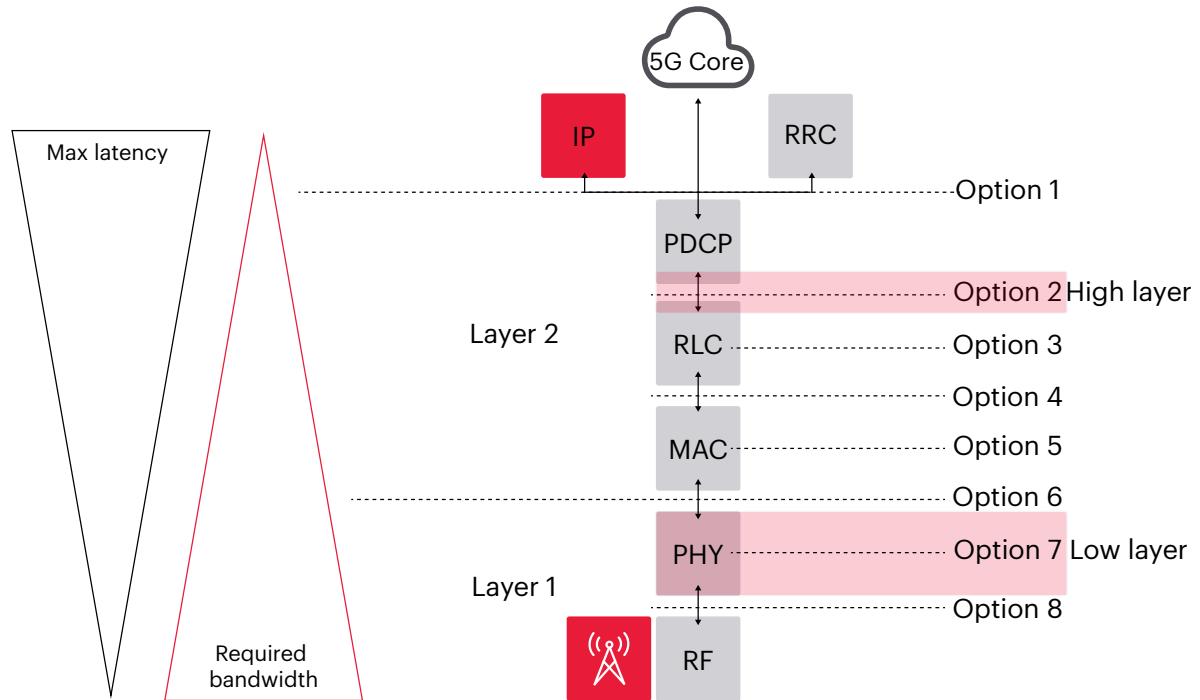


Figure 6. 5G split of the radio stack

Because of the O-RAN Alliance and 3GPP functional split, the fronthaul interface requires a data rate with low latency tolerance. Fronthaul testing requires a fast hardware connection, making such testing challenging.

Test tips

- Choose a test environment that can emulate low-priority traffic mixed with express traffic for latency testing.
- Select test equipment that supports wide bandwidths, fast connectors, and cables to simulate the fronthaul transport network.
- Use a wrap-around strategy to test both latency and speed — one simulator can emulate all O-RAN units.
- Leverage software and cloud-based solutions for protocol validation, network performance, resiliency testing, and hyperscale data center security analysis.

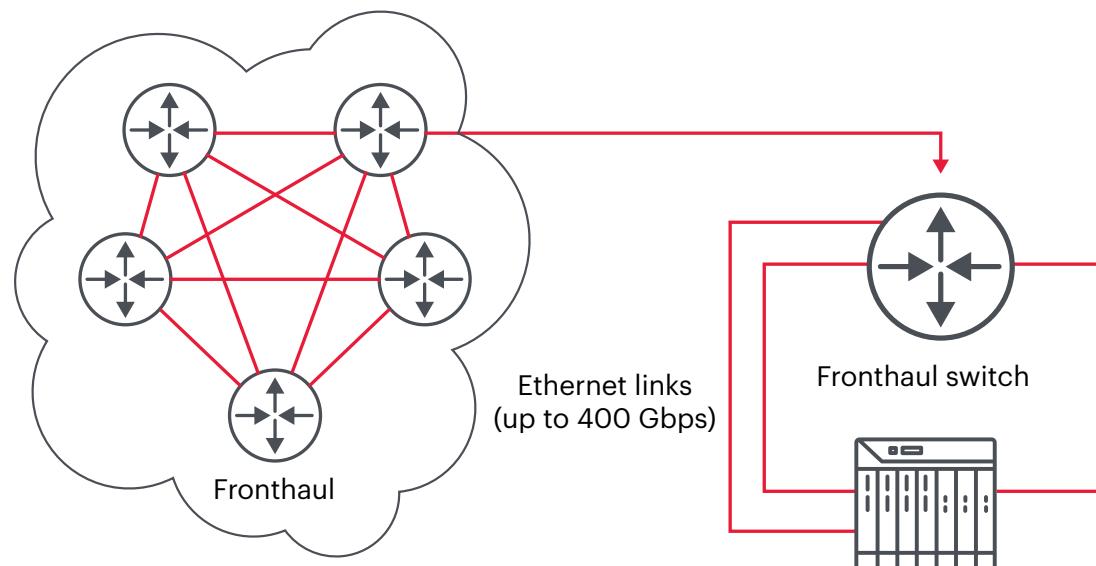
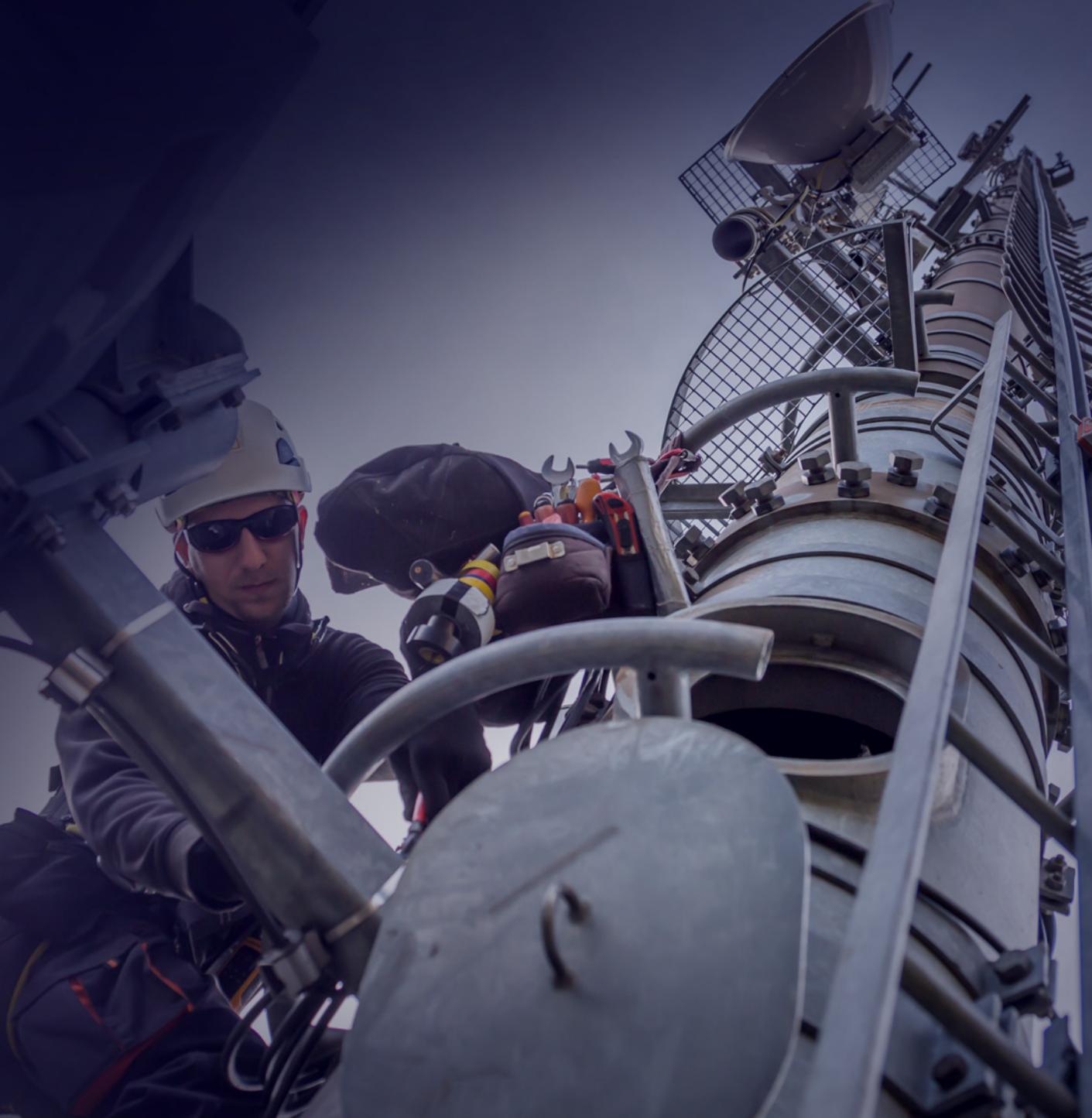


Figure 7. Wrap-around testing setup



CHAPTER 4

O-RAN Performance Metrics



O-RAN Performance Metrics

New services like remote surgery, autonomous driving, and smart cities have different data transmission requirements than smartphones. An O-RAN enabled network must handle the increasing amount of traffic and service types without sacrificing efficiency or reliability.

The International Mobile Telecommunications - 2020 (IMT-2020) standard identifies eight key characteristics for 5G network performance versus 4G. The O-RAN architecture must meet these 5G performance targets to compete against traditional radio access networks effectively.

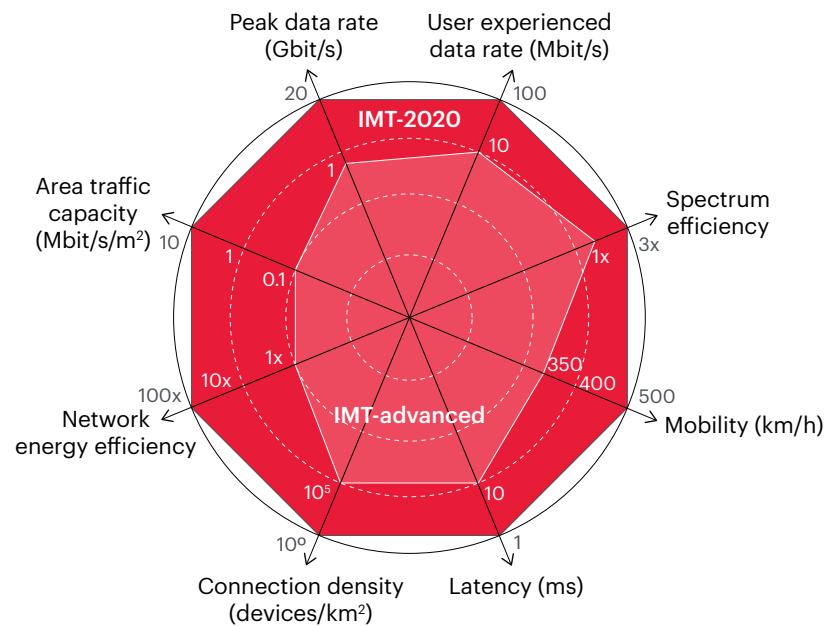


Figure 8. IMT-2020 performance metrics for 5G

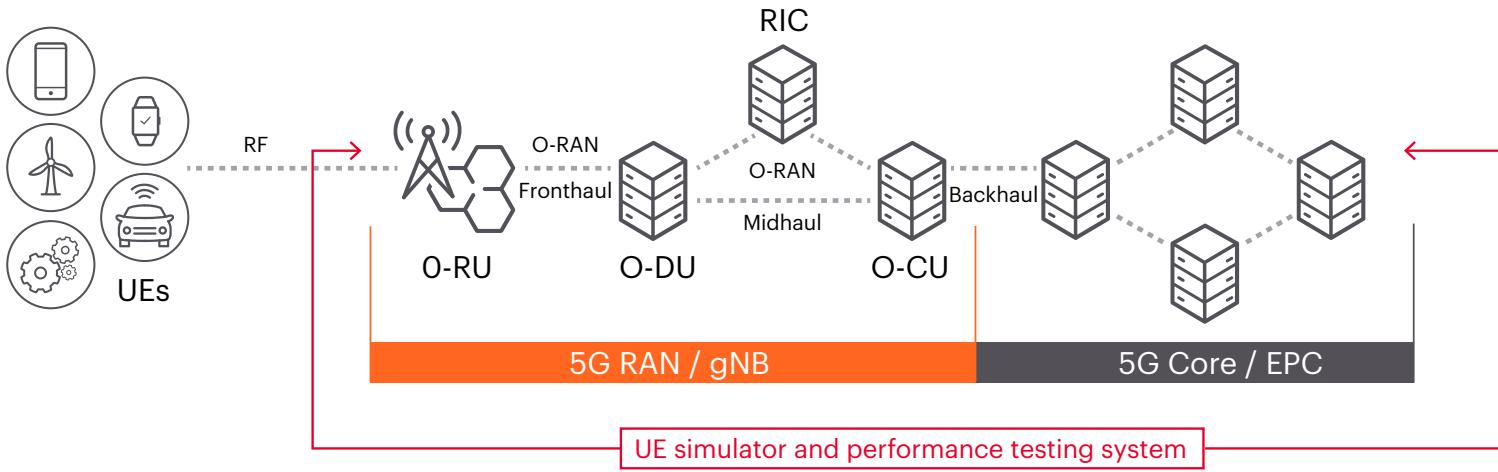


Figure 9. O-RAN end-to-end performance testing

UE emulation with wrap-around testing

Simulating large numbers of user equipment (UE) with different data types over radio is the ideal solution for ensuring network performance.

Test tips

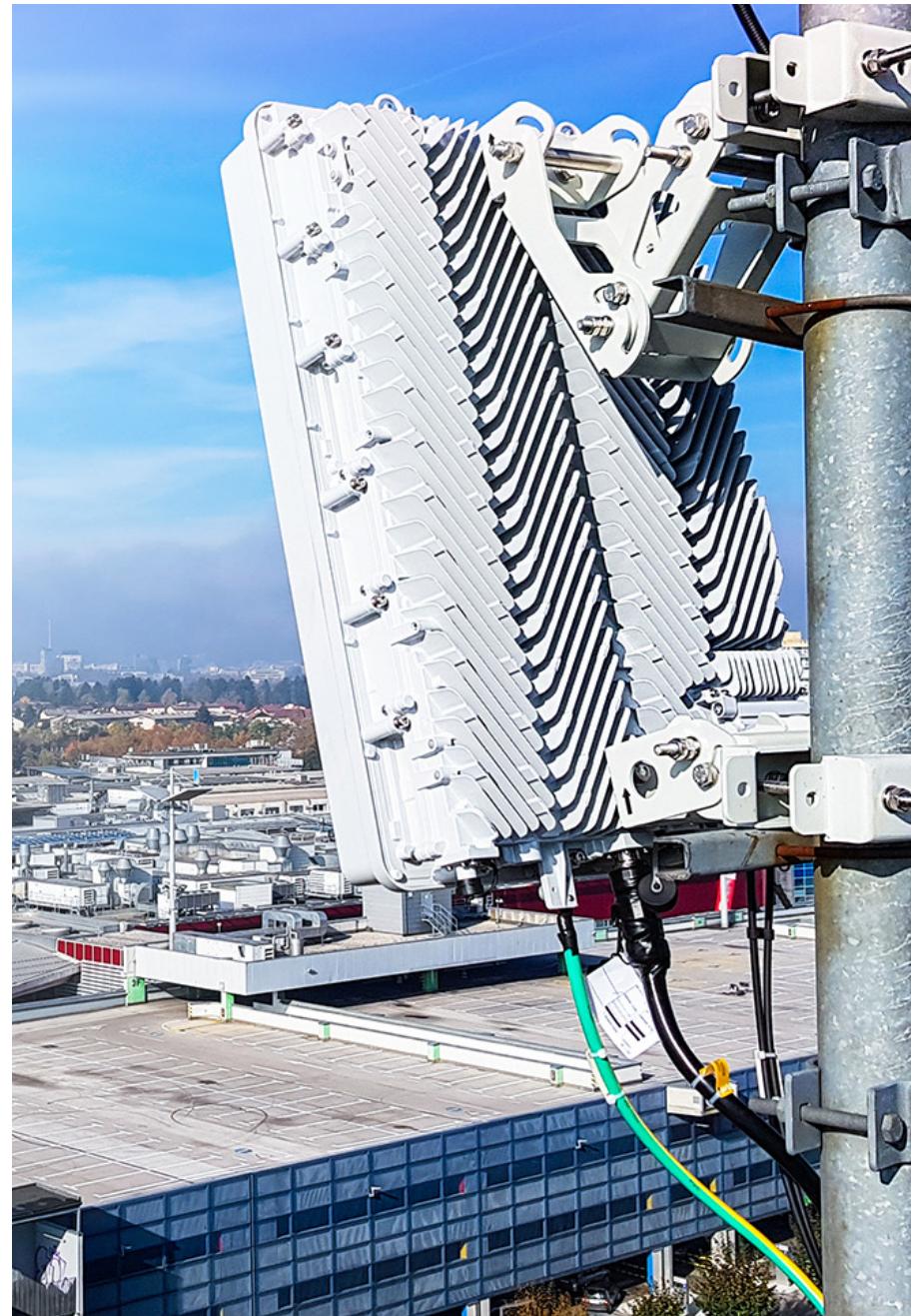
- Use wrap-around testing to check all eight key performance indicators for O-RAN.
- Simulate thousands of concurrent mobile devices with voice and application data to test end-to-end performance.
- Create a test strategy that considers multiple real-life scenarios, such as varying radio conditions, different priorities, and a mix of device types.
- Simulate key 5G features such as multiple-input and multiple-output (MIMO), beamforming, and ultra-low latency.

SUMMARY

O-RAN is a revolutionary technology set to transform the mobile communications industry. It will accelerate 5G deployment, reduce operational costs, lower maintenance complexity for operators, and foster innovation in the radio access network ecosystem.

A complex infrastructure requires thorough testing and validation. O-RAN conformance and interoperability testing ensure components from different vendors work together seamlessly and comply with industry standards. Transport network testing is crucial for maintaining optimal radio access network performance. Massive user equipment emulation ensures the O-RAN architecture meets all key performance metrics.

The 5G and O-RAN revolutions are unfolding simultaneously, unlocking a new world of possibilities. Mastering O-RAN's test requirements and using integrated solutions to perform the necessary testing are critical to your success.





Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.