Acceptance Testing Helps Mobile Network Operator Grab Early Leadership in 5G

KEYSIGHT

Organization

- a major mobile network operator

Challenges

- conformance test requirements not yet completed
- increase in test complexity
- limited window before rollout of commercial 5G network

Solutions

- S8701A Protocol R&D Toolset
- S8704A Protocol Conformance Toolset
- S8705A RF / RRM DVT and Conformance Toolset
- E7515B UXM 5G Wireless Test Platform
- E7770A Common Interface Unit
- M1740A mmWave Transceiver for 5G
- CATR OTA chamber

Results

- first mobile network operator to amass 1 million 5G subscribers

The promise of 5G extends far beyond faster speeds. It includes higher reliability for mission-critical communications, lower latencies for gaming and business applications, and massive Internet of Things (IoT) connectivity.

For mobile network operators (MNOs), 5G opens market opportunities and enables new business models. Those business models fall into three major categories: enhanced mobile broadband (eMBB), ultra-reliable and low-latency communications (URLLC), and massive machine-type communications (mMTC).

But delivering on this promise and capitalizing on these business opportunities requires MNOs to provide a quality of service that will enable subscribers to take advantage of all the benefits of 5G technology. With the stakes so high — and with standards still evolving — operators must adopt reliable test solutions that support the higher frequencies, wider bandwidths, and new physical layer features of 5G — not to mention conformance test capabilities compliant with the standards.

Challenges: Evolving Standards, Limited Time

In the summer of 2018, a major MNO began collaborating with Keysight on 5G network design, development, and testing. The primary goal of the collaboration was 5G device conformance testing. Conformance testing ensures that mobile devices adhere to industry standards and regulatory requirements. Those requirements include protocol and radio frequency (RF), with measurements such as occupied bandwidth, receiver performance, intermodulation distortion, and radio resource management (RRM).

Timing was critical. The MNO was preparing to roll out 5G services in early 2019. It needed to conduct testing on early 5G smartphones and other devices in the fall of 2018. At the time, the 3rd Generation Partnership Project (3GPP) conformance test requirements and test methods were less than 50 percent complete. Organizations such as the Global Certification Forum (GCF) and PTCRB, a group of leading US MNOs, were still preparing their device certification requirements. The MNO needed to develop test specifications and provide test case scripts for its device acceptance test plans to ensure the interoperability of the devices it was planning to launch with its 5G network. It needed a provider with experience in 5G device testing.

In addition to the evolving nature of 5G standards and test requirements, 5G conformance testing is complicated by a dramatic increase in complexity compared with 4G LTE. Issues include higher frequency ranges, wider channel bandwidth, and increasing coexistence scenarios. Test environments and test schemes are also different between Frequency Range 1 (FR1, 410 MHz to 7.125 GHz) and the millimeter-wave (mmWave) Frequency Range 2 (FR2, 24.25 to 52.6 GHz). Those differences significantly increase test complexity. The number of test cases for 5G represents an exponential increase compared with LTE.

Solutions: Keysight Network Emulation Solutions

Keysight has invested heavily in 5G. It partnered early with standards-setting industry leaders to understand the complexities of 5G and develop solutions that span the device development workflow. Keysight is also a contributor to the 3GPP, helping define 5G specifications and test cases. While mmWave is new to MNOs, Keysight has mmWave expertise from decades of experience in aerospace and defense. The MNO chose Keysight based on that expertise, coupled with Keysight's compelling 5G roadmap and commitment to collaboration.

Working with Keysight, the MNO realized the value of investing in a 5G test system that could handle protocol, RF, and RRM testing. The MNO ultimately chose to leverage Keysight's portfolio of Network Emulation Solutions (NES) built on the E7515B UXM 5G Wireless Test Platform, including Keysight's S8701A Protocol R&D Toolset, S8704A Protocol Conformance Toolset, and S8705A RF / RRM DVT & Conformance Toolset.

Figure 1. Keysight's E7515B UXM 5G wireless test platform

The E7515B UXM 5G is a highly integrated signaling test platform with multi-format stack support, ample processing power, and abundant RF resources. It enables users to test devices in different 5G NR deployment modes, including both standalone (SA) and non-standalone (NSA) modes across both FR1 and FR2. It supports Keysight's comprehensive NES portfolio, which spans the protocol, RF, functional, and performance test domains.

Keysight's S8701A Protocol R&D Toolset is a comprehensive suite of tools for prototyping advanced 5G protocol features, including beamforming at mmWave frequencies and SA and NSA use cases. It supports multiple phases of development — from early stack development through to modem bring-up and device integration — to ensure full utilization of 5G features such as beamforming, flexible numerologies, and subcarrier spacing for maximum performance and compliance. This solution was used by the MNO to develop a suite of test cases that enabled 5G devices to be tested against their network configuration and verify the interoperability and performance of those devices.

The MNO also used Keysight's S8704A Protocol Conformance Toolset to verify that the signaling behavior of the devices was compliant with the industry standards. This solution provides access to the latest 3GPP-defined 5G, LTE, and cellular vehicle-to-everything (C-V2X) protocol conformance test cases, which are validated by an independent test lab for use in GCF and PTCRB device certification testing.

To verify the RF performance of the 5G devices, the MNO used the Keysight S8705A RF/RRM DVT & Conformance Toolset solution. This solution provides GCF/PTCRB validated test cases to verify the RF/RRM performance of 5G devices against the 3GPP-defined test specifications. The solution is also used for design verification testing (DVT) to assess the performance of 5G devices above and beyond the 3GPP-defined limits, providing data about device performance that MNOs find useful when planning their 5G network deployments.

The MNO also included in its 5G device test system several other Keysight hardware components: a common interface unit (E7770A), a remote radio head (M1740A mmWave Transceiver for 5G), and a compact antenna test range (CATR) over-the-air (OTA) chamber. This comprehensive package provided an environment to execute tests that verify the 5G NR and LTE signaling protocols of 5G devices, addressing a range of test scenarios in FR1 and FR2.

Keysight engineers worked for months to develop test cases for a range of test scenarios, including user equipment (UE) data throughput, based on the MNO's 5G network configuration. These test cases were used to successfully test the first commercial 5G devices, such as Samsung's Galaxy S10 5G. The MNO has since successfully implemented the test cases Keysight developed to conduct its carrier acceptance testing. Keysight has continued to work with the MNO to further develop test cases even after commercial rollout of its 5G network.

The Result: First to Achieve 1 Million 5G Mobile Subscribers

Following the engagement with Keysight and the rollout of its 5G network, the MNO became an early leader in 5G. Thanks in part to its collaboration with Keysight on device acceptance testing, the MNO was able to launch 5G services commercially in the spring of 2019. Within five months, the MNO had amassed more than 1 million 5G mobile subscribers, becoming the first MNO in the world to achieve this milestone. In addition to mobile data subscriptions, the MNO has successfully launched focused 5G services in areas such as smart factories, smart media, virtual reality, and augmented reality.

Related Information

- **Brochure:** 5G Solutions for Mobile Network Operators

- **White paper:** Understanding and Testing the 5G Ecosystem

- **Web site:** S8701A Protocol R&D Toolset

- **Web site:** S8704A Protocol Conformance Toolset

- **Web site:** S8705A RF/RRM DVT & Conformance Toolset

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