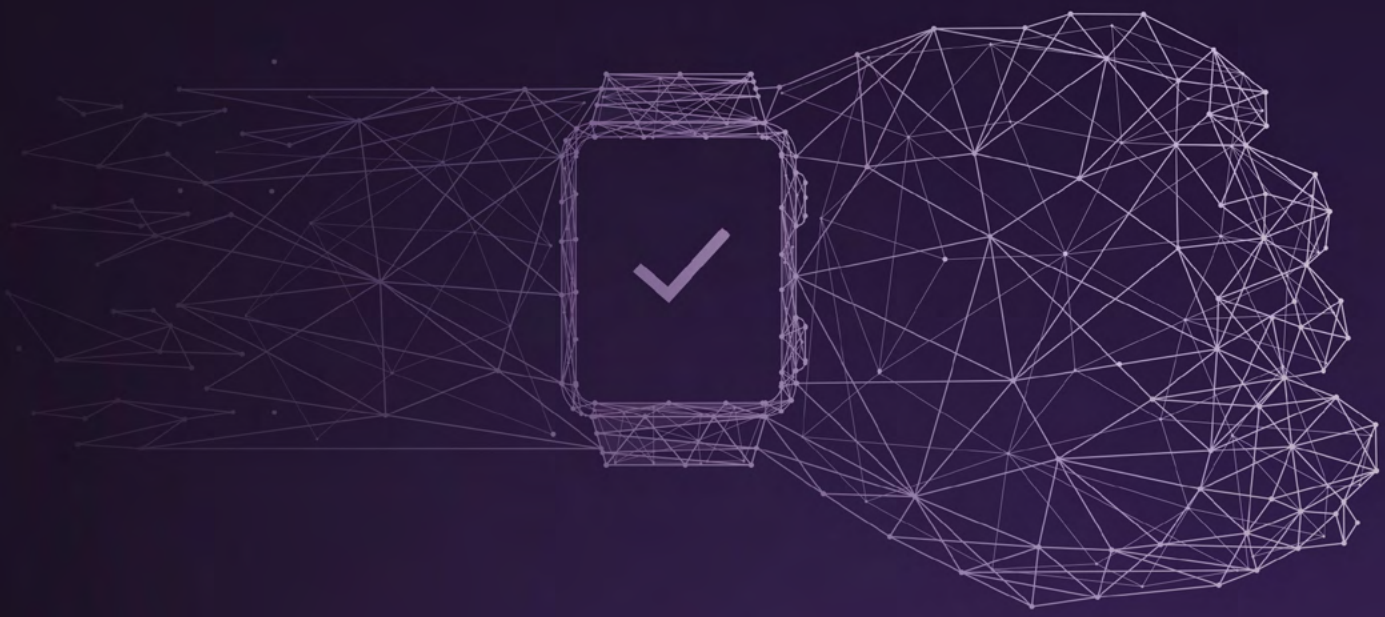
Design and Test Solutions for the Internet of Things

Develop mission-critical IoT devices to withstand the rigors of the real world—with flexible, high-performance design, test and security platforms



KEYSIGHT TECHNOLOGIES

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Keysight Technologies Solution Overview

The Internet of Things (IoT) has become increasingly prevalent, fundamentally changing the way we live, work and play. Billions of IoT devices already exist, with hundreds more coming online each second. Many of those devices are destined for the consumer market; however, an ever-growing portion are for mission-critical applications in the electrical power, industrial, and medical industries.

Mission-critical IoT devices have specialized requirements dictated by the market in which they operate. Wireless medical IoT devices must have unimpeded reliability and security. Industrial IoT devices for manufacturing, oil and gas, and utilities, must also be reliable, since they may have to operate 20-30 years before replacement, in harsh environments and remote locations. Moreover, they must be secure. An attack on the electrical grid not only inflicts a social and economic impact on millions of people, it jeopardizes national security. Many mission-critical IoT devices also require higher levels of precision and accuracy, resilience, low latency, scalability, interoperability with legacy technologies, and automation to ensure they work right, every time. Meeting these requirements demands a world-class approach to design and test of the entire mission critical IoT ecosystem, from edge devices to network performance and security.

Keysight Technologies is the world's leading electronic measurement company, transforming today's measurement experience through innovations in wireless, modular, and software solutions. Keysight provides complete end-to-end solutions for designing, testing, and securing IoT devices, wireless communications, networks, and infrastructure. Keysight's solutions span the entire stack (Layers 1-7), from edge devices to network performance and security, as well as the entire product lifecycle, from design creation to manufacturing and beyond.



Frost & Sullivan names Keysight Technologies 2016 Global Test & Measurement for IoT Company of the Year.

Keysight's customers benefit on many levels. Product and module makers develop products with optimized performance and functionality, faster, more thoroughly, and globally. Manufacturers realize products that are more robust, reliable, and safe, with a lower cost of test, and higher throughput and yield. Enterprises, mobile operators, service providers, and network equipment manufacturers (NEMs) gain faster time-to-market, optimized application performance, and higher-quality deployments, ensuring that their networks are resilient.



Keysight Technologies Solution Overview

With a 75-year legacy first created by Hewlett-Packard and Agilent, Keysight has maintained an unwavering focus on solving complex measurement challenges for customers around the world. Nearly 10,500 employees operate in more than 100 countries, using their expertise to help customers meet IoT design, test and security goals:

Keysight IoT device test solutions provide a comprehensive approach and methodology for creating designs that are fully optimized for battery life, tested for signal or power integrity issues, interoperable with other IoT devices, and can peacefully co-exist with an ever-growing array of wireless technologies. Keysight device test solutions help companies perform pre-conformance, design validation, pre-compliance and compliance testing to ensure their IoT devices pass wireless conformance and regulator testing to gain market entry. This testing must be accurate, thorough and fast to help get high-quality products to market ahead of the competition.

Keysight wireless communications test solutions are designed to ensure that IoT devices communicate efficiently, rather than buckle under the load of having to support multiple wireless technologies. Keysight solutions emulate complex real-world network traffic and interference conditions to speed performance verification and troubleshooting of multi-mode IoT devices and systems. Testing gives IoT product developers and manufacturers the confidence that their products will be able to withstand the rigors of the real world.

Keysight network and system test solutions address the complex challenges mobile operators face in rolling out high-quality, differentiated services. Mobile operators can use Keysight's Wi-Fi test systems and services to subject devices and configurations to high stress, high-scale conditions and a wide mix of voice, video, and data applications. Operators can evaluate the subscriber experience in the face of mobility, system overload, and even device failure on a large-city scale. And, with IoT test and security solutions, they can ensure that their Wi-Fi implementations are robust, cause no interference, operate as specified, and are secure.

Join our ever-growing customer base of successful design engineers, product/module makers, manufacturers, mobile operators, service providers, enterprises, NEMs, and more. When performance really matters, Keysight is here to serve, with the solutions you need to overcome your design and test challenges, accelerate your development, and bring your mission-critical IoT innovations to market faster.



Simulation and Design

Scenario: An IoT product is only as good as its initial design. Ensuring that a device is fully optimized for performance, functionality, and battery life, and free from any bugs requires a methodical and exacting approach to both design and validation. Unoptimized device performance often translates into missed business opportunities. Flaws missed early in the development process can lead to time-consuming troubleshooting efforts and expensive design iterations. The further along in the process the designer gets before those errors are found, the more expensive they are to fix and the more time-to-market schedules slip.

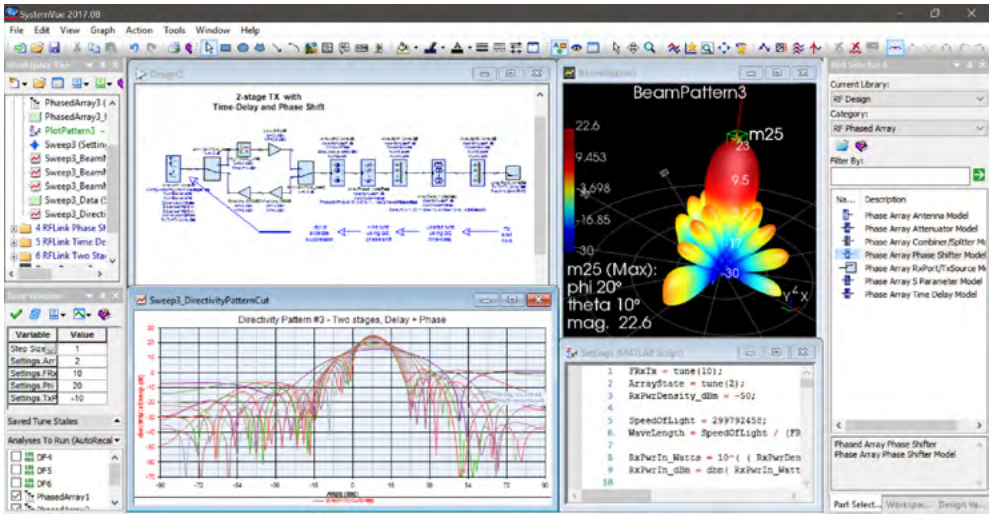
To create better IoT products faster and avoid costly delays, designers must use design and simulation software to gain a better understanding of their device operation and its underlying physics.

Benefits:

Innovate better products with greater insight into performance and speed time-to-market by cutting PHY development and verification in half.

- Best-in-class RF fidelity allows designers to virtualize RF subsystems and eliminate excess margin
- Accelerates real-world product maturity and streamlines design flow through tight integration with test
- Priced for networked workgroups to maximize design re-use and capitalize on baseband and RF synergies

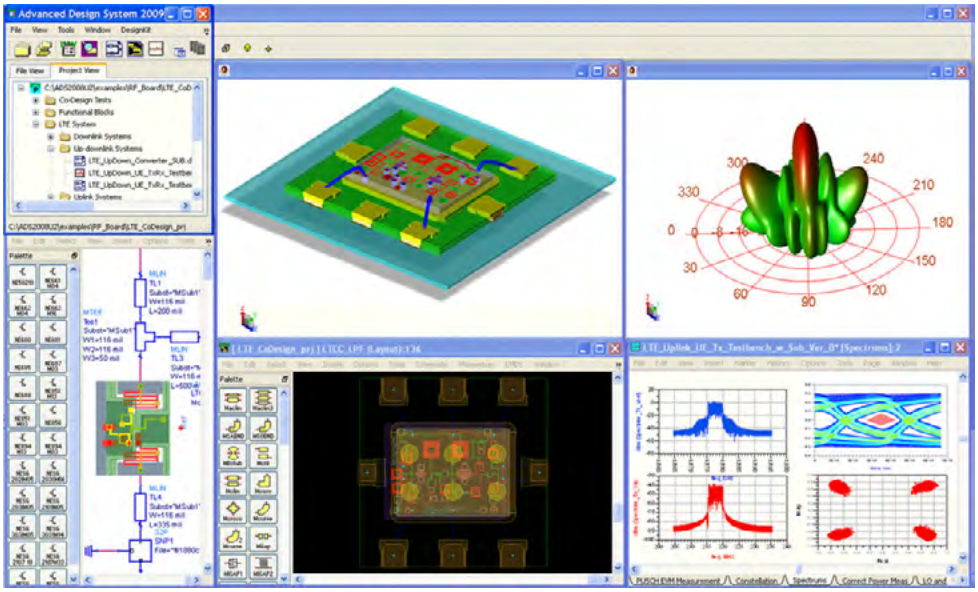
Solution 1: Keysight SystemVue



Keysight SystemVue is an electronic design automation software that is used to model and simulate system designs early in the development process. It enables system architects and algorithm developers to innovate the PHY layer of wireless communications systems, and provides unique value to RF, DSP and FPGA/ASIC implementers.

SystemVue helps designers create better designs by allowing them to make design changes and predict how those changes impact system performance using virtual measurement tools that can be attached to nodes in the simulation.

Solution 2: Keysight Advanced Design System



Keysight Advanced Design System (ADS) software provides fast and accurate system, circuit and electromagnetic (EM) simulation for RF, microwave, and high-speed digital applications. A design simulation environment for co-design of IC, package and board, enables designers to make tradeoffs interactively on the IC, package and board while they are being co-designed.

Keysight ADS software helps save time and reduces errors introduced when using multiple tools by allowing circuits designed in multiple technologies to be combined and simulated at both the circuit and full 3D EM level.

Benefits:

Develop better designs faster with accurate easy-to-use simulators and a streamlined flow.
Gain the confidence in first-pass design success that comes with measurement integrity.

- Application-specific DesignGuides encapsulate years of expertise in an easy-to-use interface
- Optimization cockpit enables real-time feedback and control
- Up-to-date wireless libraries allow designers to work with the latest emerging wireless standards
- Allows for easy design flow integration with Cadence, Mentor, and others

Battery Life Testing

Scenario: Finding the optimal balance between battery, protocol and software functionality to get good performance, and service life, requires an in-depth knowledge of battery life and current drain that traditional measurement techniques cannot provide. In mission-critical applications, failure of an IoT device battery is not an option. When IoT devices are deployed in a remote or inaccessible location, the maintenance and replacement costs—if even possible—can be detrimentally high.

Reducing project risk and support cost requires both battery life optimization and the confidence that the battery will perform as expected in the IoT device, regardless of the physical, radio or network environment in which it will be used.

Solution 1: Keysight CX3300 Series Device Current Waveform Analyzer



The Keysight CX3300 Current Waveform Analyzer captures waveforms from current or differential sensors with 14- and 16-bit resolution, and sampling rates of up to 1 GSa/s. Specifically built for low-power IoT device and chip characterization, it measures current down to 100 pA and up to 100 A—the industry's lowest current measurements—with a maximum of 200 MHz bandwidth. It is well suited for use during R&D or design verification.

The CX3300 makes achieving mission-critical power and current consumption reductions possible by precisely measuring previously unmeasurable wideband low-level current waveforms.

Benefits:

Optimize battery life and battery performance in the real-world while increasing revenue. Prevent premature battery failures and faulty operation with the ability to make low current and high bandwidth measurements with precision.

- Enables precise estimation of power consumption by capturing the voltage waveform
- Provides greater insight with built-in analysis tools designed to improve characterization and debug efficiency without requiring external analysis tools
- Identify and analyze intermittent anomalous signals and events with anomalous waveform analytics, a machine learning technology.

Solution 2: Keysight X8712A IoT Device Battery Life Optimization Solution



The Keysight X8712A IoT device battery life optimization solution combines the N6705C DC power analyzer, SMU modules, RF event detector, and dedicated software. This integrated solution enables IoT device developers to maximize battery life quickly and effortlessly.

The X8712A measures the total power consumption of an IoT device. It captures RF and DC events from the device and synchronously matches the events to the current consumption waveform. The powerful analytic software then automatically breaks down current consumption by key subsystem events and estimates battery life.

The N6705C and the N678x SMU modules are the key components of the X8712A. These components enable designers to capture dynamic currents of the device accurately through the use of patented, seamless current ranging technology.

Benefits:

The X8712A prevents unnecessary current drain, speeds time to market, and increases device performance to maximize the battery life of an IoT device.

- Measure a wide range of current, from nA to A, in one pass.
- Accurately capture fast-changing current waveforms, from low-sleep-mode to high-active-mode currents.
- Detect design weaknesses by quickly identifying events that consume the most current.
- Simplify battery life estimation with automated and powerful analytic software.

Solution 3: Keysight N6705C DC Power Analyzer + N6781A / N6785A Source Measure Unit (SMU)



The N6705C DC Power Analyzer and N6781A / N6785A SMUs enable fast and accurate power consumption analysis. The N6705C provides a platform for power, waveform capture, long-term current drain data-logging and display, as well as analysis of results. The N6781A / N6785A SMUs operate within the N6705C mainframe and are used for battery drain analysis during R&D or design verification.

The N6705C and N6781A / N6785A SMUs simplify characterization of IoT device current consumption through the use of patented, seamless current ranging technology to measure dynamic currents and by enabling designers to make measurements without writing a single line of code.

Benefits:

Maximize battery life by preventing unnecessary current drain, while speeding time-to-market and increasing revenue, with the confidence that comes from precision measurement integrity.

- Measures a wide range of current from nA to A in one pass
- Functions as both a current/voltage source and e-load
- Offers high accuracy for low current measurements; can also be used for high-power IoT devices
- Minimizes transient voltage drop for pulsed currents drawn by wireless devices with a fast-transient response
- Provides detailed measurement insight with a 200-kHz sampling rate



Solution 4: Keysight N2820A High-Sensitivity Current Probe



When used with a Keysight oscilloscope, the Keysight N2820A high-sensitivity current probe measures current at the circuit, subcircuit, or component level. The probe measures the voltage drop across a current sense resistor, making it easier to implement than a traditional clamp-on current probe. The N2820A is also more sensitive, accurate, and repeatable than a clamp-on current probe. Simply enter the value of the current sense resistor, and the oscilloscope scales the signal and displays it in the proper units.

Coupling the measurements of the N2820A current probe with the triggering, digital bus monitoring, and protocol decoding of the oscilloscope lets users measure energy consumption in context with other system activities, such as component current consumption and firmware functions.

Benefits:

Optimize energy efficiency while balancing performance and user experience to deliver a battery-friendly final product.

- Measure current as small as 100 nA or as large as hundreds of amps
- Measure sleep, active, and in-rush current simultaneously with 20,000-to-1 dynamic range
- Make measurements in extreme temperature environments (-55 to 150 °C)
- Use it with any Keysight oscilloscope with a 1 MΩ input
- Use it with any current sense resistor, from 1 mΩ to 1 MΩ

Signal and Power Integrity Testing

Scenario: Testing for signal and power integrity issues is essential to creating successful, reliable IoT designs. Unchecked or undiscovered issues can cause designs to fail or become unreliable in the field. An IoT design may work, but only at speeds slower than expected. During manufacturing, yield may be low, sometimes drastically.

To avoid costly failures and time-to-market delays, and enable designs to reach their full performance potential in the real world, development teams must accurately identify and troubleshoot signal and power integrity issues early in the design process.

Solution 1: Keysight E5080B ENA Vector Network Analyzer with S96011B Software



The Keysight E5080B ENA Vector Network Analyzer with S96011B Enhanced Time Domain Analysis with TDR software is a one-box solution for analyzing high-speed serial interconnects. It performs real time signal integrity m easurements simultaneously in the time domain (TDR/TDT) and frequency domain (S-parameters), as well as eye diagram tests without requiring an external bit pattern generator. The E5080B covers up to 53 GHz bandwidth.

The Keysight E5080B makes signal integrity design and verification easier, more impactful by delivering a solution with the look and feel of an oscilloscope, but with the accuracy and speed needed to automatically adjust skew and make measurements in just a few clicks.

Benefits:

Speed time-to-market and maximize real-world device performance while increasing revenue. Prevent device failures and low-yield manufacturing with the accuracy needed to find even the smallest discontinuity.

- Quickly validate and correlate signal integrity simulation with actual measurement
- Perform real-time measurements without the averaging traditionally needed with TDR oscilloscopes
- Reduce instrument repair fees and downtime with higher robustness against ESD.

Solution 2: Keysight Infiniium MXR-Series Oscilloscope + N7020A or N7024A Power Rail Probe



The Keysight low-noise Infiniium MXR-Series Oscilloscope is used with a specialized power rail probe, N7020A or N7024A, to perform highly accurate power integrity (PI) analysis. The solution measures periodic and random disturbances (PARD), static and dynamic load response, programmable power rail response, and similar power integrity (PI) measurements.

The Keysight Infiniium Oscilloscope and N7020A or N7024A probe probe speeds the design process by making it easier for designers to troubleshoot power integrity issues and ensure their IoT products meet tight DC power rail tolerances.

Benefits:

Speed time-to-market and time-to-profit while reducing project risk. Prevent degraded device performance or failures with the bandwidth and accuracy needed to find the high-speed transients that can have detrimental effects on clocks and digital data.

- Provides mV sensitivity for noise, ripple and transients on DC power rail measurements
- Accurately measures large power rail transitions
- Enables designers to set oscilloscope to maximum sensitivity and center their signal on the screen
- Delivers exceptional signal purity with support for compliance applications like DDR, eMMC, MIPI, USB, and more

Wireless Conformance Solution

Scenario: Conformance testing is carried out by specialized laboratories and is mandatory for all wireless products. Companies must confirm that their products comply with supported wireless standards and often do so in-house first, prior to sending the product to the lab. Failure to comply means the product cannot be advertised as having been certified by the organization that defined the standards and the lab that conducted the tests. It can also lead to lost revenue caused by a potentially costly redesign and delayed product launch.

Solution: Keysight T4010S Conformance Test System



The T4010S conformance test system covers conformance testing according to 3GPP TS 36.521-1 LTE, NB-IOT RF, CAT-M1 RF and 3GPP TS 36.521-3 LTE RRM for FDD and TDD, 1CC, 2CC, 3CC and 4CC, as well as LTE device acceptance test plans from major network operators. It allows designers to perform design verification during R&D using the same hardware utilized for conformance testing.

Benefits:

Perform full UE certification prior to conformance testing, with support of GCF/PTCRB validated test cases (TP 195). Speed time-to-market with the test case parameterization environment, test automation, and remote control you need for RF parametric testing, margin search, and complete system validation.

- Execute test cases with parameters other than those required by 3GPP
- Test all LTE, NB-IOT, FDD CAT-M1 frequency bands at no additional cost
- Easily and quickly analyze and report on test case results
- Remote test system operation

Compliance Testing

Scenario: Compliance is about making sure your IoT devices adhere to radio standards and global regulations before they gain market entry. There are two main categories of compliance tests. The first is radio standards conformance and carrier acceptance tests. The second is regulatory compliance tests such as RF, EMC, and SAR tests as required by the US Federal Communications Commission (FCC) or the European Telecommunications Standards Institute (ETSI).

Regulatory compliance tests ensure that a device can operate harmoniously in a busy wireless environment. Design engineers often scramble to meet tight product introduction timelines and ensure smooth global market penetration while complying with the latest regulations. Frequent regulatory updates add to the complexity.

Solution 1: Keysight ZA0047A Wireless IoT Device Regulatory Test Solution



Major regulatory bodies such as the FCC and ETSI impose stringent compliance test requirements for devices operating in the unlicensed 2.4 and 5 GHz bands. These requirements cover IoT devices supporting formats such as WLAN, *Bluetooth®*, and Zigbee and operation modes such as frequency hopping, adaptivity, and multiple-input / multiple-output up to eight channels.

The Keysight ZA0047A wireless IoT device regulatory test solution lets you quickly perform compliance or precompliance testing based on the latest test cases for ETSI EN 300-328 / 301-893, FCC Part 15.247 / 15.407, and dynamic frequency selection (DFS). Achieve up to 20x test time reduction with automation software suites. Simplify device-under-test (DUT) control with the Keysight X8711A / ZA0060A signaling tester. Quickly prove adherence to regulatory standards with the customizable report generation function.

Benefits:

The Keysight ZA0047A wireless IoT compliance test solution is a flexible and scalable automated test system that meets the latest regulatory requirements.

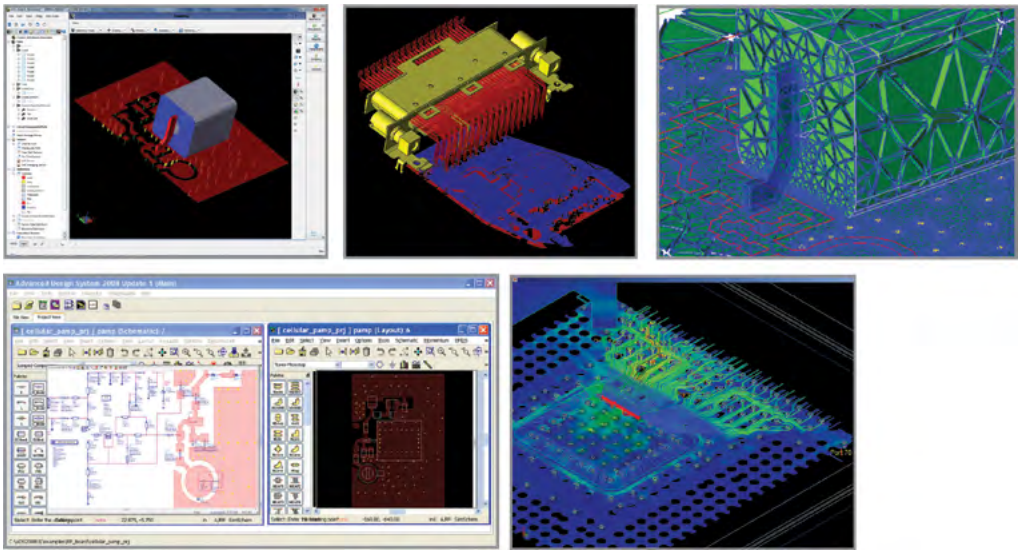
- Execute the latest test cases according to ETSI EN 300-328 / 301-893, FCC Part 15.247 / 15.407, and DFS.
- Reduce test time up to 20x by enabling DUT control and automating more than 200 test cases (DFS).

EMI/EMC Testing

Scenario: Electromagnetic interference (EMI) and electromagnetic compatibility (EMC) testing requires detailed and exacting methodologies to ensure all emissions are accurately measured. Meeting EMI/EMC compliance regulations is a critical step in bringing products to market quickly. Failure often results in expensive redesigns, delaying a product's introduction. The success of EMC compliance testing depends on moving products through the test queue quickly and efficiently.

To avoid costly project delays due to EMI/EMC compliance failures, development teams must perform early radiated emissions testing and pre-compliance testing on designs to identify EMI/EMC problems. EMC compliance testing can then be conducted to ensure designs comply with CISPR and MIL-STD standards.

Solution 1: Keysight EMPro 3D Electromagnetic (EM) Simulation Software



Keysight EMPro is a simulation software design platform for analyzing the 3D EM effects of components such as high-speed and RF IC packages, bondwires, antennas, on-chip and off-chip embedded passives, and PCB interconnects. Early in the development cycle, it can be used to simulate the radiated emissions of electronic circuits and components. Calculated results help designers determine if emissions are within levels specified by common EMC standards, such as CISPR, FCC Part 15 and MIL-STD-461G. Modeling helps designers estimate emission levels before hardware is developed.

Benefits:

Prevent costly failures in EMC compliance before hardware is developed. Keep your design on track and speed time-to-market with the accuracy and visibility you need to test with confidence.

- Enables 3D components to be simulated with 2D circuit layouts and schematics within Keysight Advanced Design System (ADS), using EM-circuit co-simulation
- Provides analyses using both frequency-domain and time-domain 3D EM simulation technologies
- Quick creation of arbitrary 3D structures; possible with a modern, simple GUI

Solution 2: Keysight N6141EM0E EMI Measurement Application + X-Series Signal Analyzers



The Keysight N6141EM0E EMI Measurement Application is an EMI-specific software that runs on an X-Series Signal Analyzer. It is used to perform pre-compliance radiated and conducted emission measurements to any international EMC standard and diagnostic evaluation of IoT designs early in the design cycle.

The Keysight N6141EM0E EMI Measurement Application saves time and money by allowing designers to find and fix problems before they enter the test chamber.

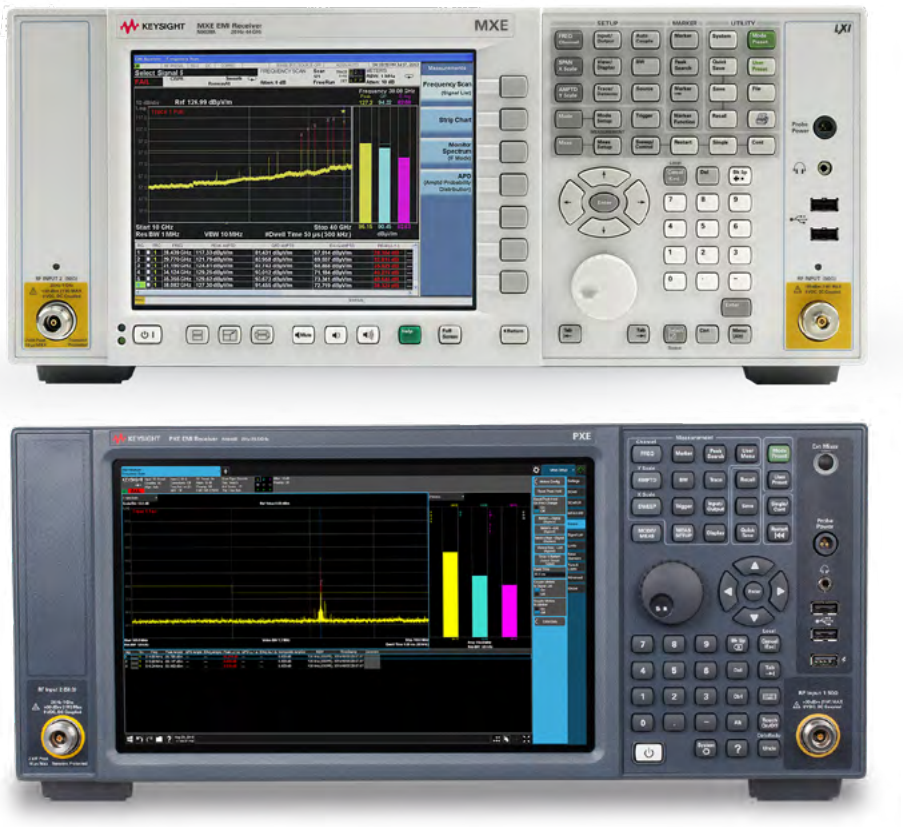
Benefits:

Reduce development expense and speed time-to-market by ensuring your IoT designs will pass final compliance testing at an accredited facility the first time around, without costly redesign and re-testing.

- Easily identify out-of-limit device emissions via signal list, frequency scan, and active detector meters that are all displayed on a single screen
- Collect emissions suspect lists rapidly using built-in testing to limit lines
- Simplify and automate data collection, analysis, and report generation for commonly tested emissions



Solution 3: Keysight N9038A MXE and N9048B PXE EMI Receivers



The Keysight N9038A and N9048B EMI Receivers are fully compliant with the latest CISPR 16-1-1 and MIL-STD 461 standards. They provide fast time-domain scanning, enhanced built-in EMC measurements, advanced diagnostic capability, and real-time scan for diagnosing high-speed transient signals.

The Keysight MXE/PXE EMI Receivers are more than a CISPR-compliant EMI receiver. They include X-Series signal analysis and graphical measurement tools that make it easy to examine signals in greater detail. With these diagnostic capabilities, it complements your knowledge and helps you advise designers if a component, device or subsystem fails compliance testing.

Benefits:

Maximize throughput in compliance testing and increase productivity while achieving measurement integrity. Keep your test queue flowing with the accuracy, repeatability and reliability you need to test with confidence

- Get greater confidence in test results with the industry-leading RF performance
- Boost test throughput with time-domain scan (TDS) and accelerated time-domain scan (Accelerated TDS)
- Enhance troubleshooting with gapless Real-Time Scan
- Automate testing supporting software from EMC industry leaders

Wireless Connectivity Testing

Scenario: Wireless testing of the IoT is a complex task, given the heterogeneous mix of wireless technologies and standards that have emerged to serve the diverse needs of IoT applications. Developers must verify that devices can interoperate and are able to handle multiple standards concurrently. Utilizing a separate expensive instrument for each individual standard can be a costly and time-consuming proposition, one that can reduce revenue and potentially delay time-to-market. Failure to adequately and accurately perform this testing may result in improper device operation in the real world.

To drive down the cost of test, speed development and deliver robust, reliable IoT devices, design engineers can replace their multiple wireless test instruments with a single instrument capable of testing all the necessary standards, and supporting the addition of new standards as they emerge.

Solution 1: Keysight X-Series Signal Analyzers + Signal Generators



The X-Series Signal Analyzers are high-performance benchtop solutions for comprehensive frequency domain, time domain, and modulation analysis during IoT design and prototype evaluation. The X-Series Signal Generators produce the signals needed—from simple to complex, from clean to impaired—to perform parametric testing of components during R&D and for functional verification of receivers with industry-leading ACPR, EVM, and output power. The X-Series Signal Analyzers simplify and speed analysis of signals during wireless test with front panel capabilities that enable fast one-button measurements, while the X-Series Signal Generators' fast and easy signal generation ensure faster test throughput and greater uptime.

Benefits:

Take IoT device performance to the limit with signal purity and precision fine-tuned for the highest performance. Keep your production line running efficiently and cost-effectively with the speed and reliability you need to accurately produce and analyze wireless signals every time.

- Accurately perform advanced receiver testing with the latest standards and everything from wide-open real-time analysis to low-cost essential measurements
- Realize greater performance to help mitigate interference, accelerate data throughput or enhance receiver sensitivity
- Realize deeper troubleshooting and insight with the broadest set of application-specific software
- Drive consistent measurements across your organization with 100% code-compatibility from R&D to manufacturing

Solution 2: Keysight M9410A and M9411A VXT PXIe Vector Transceivers



The M9410A and M9411A VXT PXIe Vector Transceivers are modular solutions for testing wireless components and IoT devices during manufacturing. The VXT drives rapid solution creation and faster throughput in manufacturing test with open-source test libraries and reference solutions.

Benefits:

Speed wireless test with faster test development and optimization time.

- Increase test density and reduce footprint with up to four VXT instruments in one 18-slot chassis
- Speed test with built-in real-time FPGA accelerated measurement
- Optimize test routines with proven software for standard-specific signal creation and analysis

Solution 3: Keysight E6640A EXM Wireless Test Set



The EXM Wireless Test Set is a one-box tester for use in wireless device manufacturing, when test speed, flexibility and footprint are critical. It provides the broadest multi-format coverage of any one-box tester in its class, with regular updates that add new formats. Current supporting formats include 2G/3G/4G/5G cellular formats, WLAN, ZigBee, Z-Wave, *Bluetooth®*, and Wi-SUN. The EXM simplifies and accelerates the wireless test process with its ability to quickly scale to meet production needs, while keeping in sync with the latest cellular and WLAN chipsets.

Benefits:

Maximize production throughput and yield with the speed, accuracy and port density you need to ramp up rapidly, accelerate test execution, and optimize full-volume manufacturing.

- Optimize multi-device testing with up to four TRX channels per EXM, with up to 6 GHz bandwidth on each TRX
- Test multi-format devices with the broadest range of multi-format coverage of any one-box tester in its class
- Get up and running in hours, not days, with validated turnkey chipset solutions

Solution 4: Keysight PathWave Signal Generation, PathWave X-Series Measurement Applications, and PathWave Vector Signal Analysis (89600 VSA)



To accelerate wireless design and test, Keysight offers three popular software applications to be used with the benchtop, modular and one-box tester platforms. PathWave Signal Generation software enables the creation of custom and standard-compliant waveforms, while the Pathwave X-Series Measurement Applications software enables one-button testing for the various IoT wireless formats. The PathWave Vector Signal Analysis software is the industry-leading tool for digital modulation analysis and is useful for deeper troubleshooting of wireless formats.

Benefits:

Keysight PathWave Vector Signal Generation: Speed testing of wireless signals with the confidence that generated signals are current with the latest emerging technologies.

- Create performance-optimized reference signals
- Validate component, transmitter and receiver testing
- Ensure designs meet the latest standards
- Speed signal creation and reduce simulation time

Keysight PathWave X-Series Measurement Applications: Accelerate from data to information to actionable insight with ready-to-use measurement software designed to simplify complex tasks and deliver repeatable results.

- Gain greater insight into signals and device performance with parametric and standard-compliant wireless measurements
- Speed time-to-insight with consistent measurements at your fingertips
- Speed time-to-market by leveraging the same measurements across design, verification and production

Keysight PathWave Vector Signal Analysis: Gain quick insight in the frequency, time and modulation domains, to optimize your IoT designs.

- Quickly pinpoint signal problems
- Measure proprietary signal, and more than 75 signal standards and modulation types
- Customize measurement displays to get greater information clarity
- Produce consistent, comparable results in simulation, prototyping and design validation

Solution 5: Keysight X8711A IoT Device Functional Test Solution



If you manufacture IoT devices for mission-critical applications, implementing the right RF tests is essential to avoid product failures or recalls that could damage your brand. Traditional test methods that use golden radio or companion device could be simple and cost-effective, but they limit test coverage. You may miss critical defects.

Catch manufacturing defects confidently and affordably. The Keysight X8711A IoT Device Functional Test Solution is a signaling test solution that enables over-the-air and conducted testing of IoT devices. It covers the most commonly used radio formats, such as *Bluetooth®* Low Energy, WLAN, and Zigbee. The solution comes with an automation software and a shield box that allows you to obtain accurate transmitter power and receiver packet-error-rate tests in seconds.

Benefits:

Keysight's X8711A helps you ensure device quality, reduce cost of test, and simplify test setup.

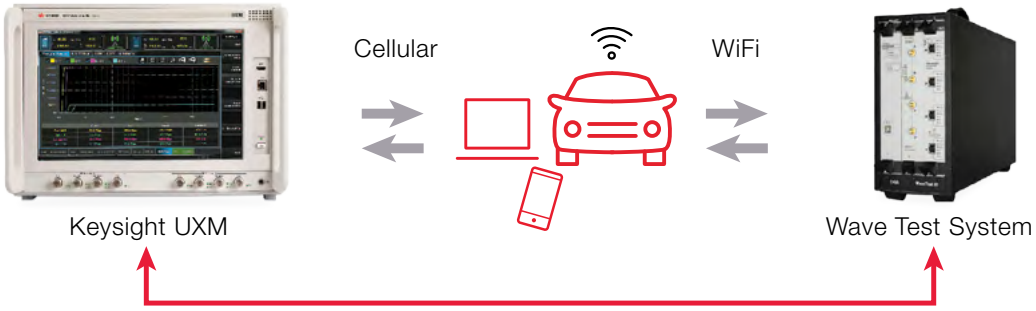
- Test IoT devices in actual operation modes and their final form.
- Simplify NPI test development with ready-to-use measurement suites.
- Maximize manufacturing throughput and accelerate time to market.

Co-Existence & Interference Testing

Scenario: Many mission-critical IoT devices and systems are today connected via a broad range of wireless technologies, many using unlicensed shared spectrums, and operating in complex deployment scenarios. In this environment, interference between the many IoT devices and systems can easily occur, compromising the co-existence of the different wireless technologies. Communication standards often fail to detail how to test for co-existence issues. Some of the currently used methods are costly, susceptible to ambient signals, and do not resemble the deployment environment.

To limit risk and increase revenue by ensuring mission-critical IoT devices and systems can perform their critical functions in the presence of multiple users—with different wireless technologies in the same spectrum—companies must use a robust testing protocol for co-existence.

Solution: Keysight T5510S Cellular + Wi-Fi Emulation System



The Keysight T5510S is a test system for validating and modeling multi-mode devices in a cellular and Wi-Fi ecosystem. It employs a comprehensive test automation platform (TAP) with emulation that can rapidly simulate, program, and monitor the unified ecosystem for rapid verification of new test scenarios. The solution comprises the Keysight UXM Wireless Test Set, Wave Test System Wi-Fi Emulation, Keysight Cellular and Wi-Fi Emulation Plugins, and Keysight Test Automation Platform. The UXM offers multi-format flexibility in support of 2G, 3G, 4G, Cat M1 and NB-IoT, as well as built-in fading and throughput testing.

The T5510S Cellular + Wi-Fi Emulation System helps find complex protocol implementation errors under repeatable real-world traffic and interference conditions for faster troubleshooting, benchmarking, and calibration of multi-mode devices to improve user experience.

Benefits:

Deliver a better user experience with the confidence that comes from comprehensive testing and measurement integrity.

- Measure user experience in realistic diverse interoperable test environments
- Improve productivity by finding issues rapidly before end-users find them
- Reduce costs by eliminating the need for a life-sized Wi-Fi and cellular testbed
- Accelerate time-to-market by testing multi-mode devices in a unified ecosystem

Network Simulation

Scenario: Understanding the real-world performance of a wireless IoT device is critical for its successful deployment and operation. The massive increase in the number and density of devices deployed for IoT applications and services, among other factors, conspire to degrade expected performance in the field, decreasing the quality of user experience (QoE) and impacting revenue.

To limit risk and increase revenue, IoT devices must be tested to ensure they can withstand the rigors of the real world.

Solution: Keysight Anite SAS Interoperability Test Solution

The SAS Interoperability test solution is a lab-based, easy-to-use network simulation solution that is currently used by major Tier 1 carriers in their device acceptance programs. It enables verification of Cat M1 capable products to ensure compliance with a North American carrier's Cat M1 focused Test Plan by quickly evaluating devices in the integration, interoperability, and carrier acceptance testing phases.

The Anite SAS Interoperability Test Solution accelerates the introduction of new mobile devices with cost-effective, controllable, repeatable and automated lab-based testing.

Benefits:

Achieve superior experience in terms of functionality and quality of voice and data transfer with the confidence that comes from rigorous testing in the lab.

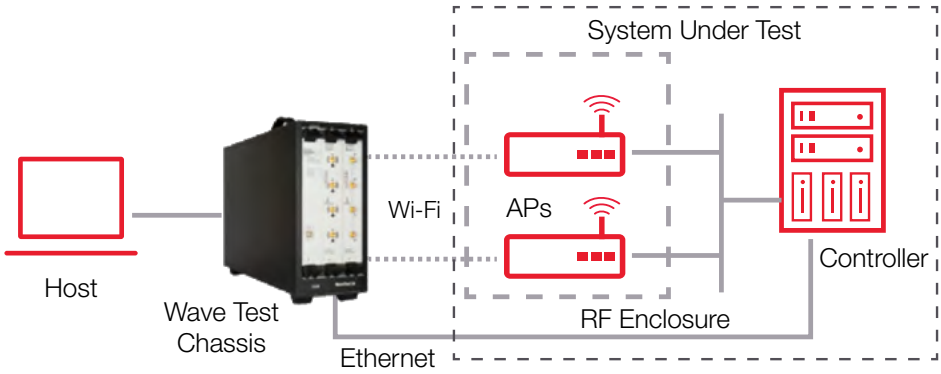
- Provides the broadest test coverage for device acceptance programs mandated by Tier-1 mobile operators including AT&T, Telefónica, T-Mobile (USA), Verizon and China Mobile
- Easy to use interface with cutting-edge functionalities and test cases
- Offers future-proof interoperability

Network Readiness Testing

Scenario: Wi-Fi connectivity is no longer a luxury; it is mission-critical. Great Wi-Fi networks are stable, with high capacity and performance, that exceed the quality of experience (QoE) needs of its users. For mission-critical IoT, networks have to support a broad range of IoT devices, often in dense deployments and cellular/non-cellular formats, while also providing coverage in a range of different environments and locations. However, most Wi-Fi networks today are only qualified for coverage, with basic element and interoperability testing. This woefully inadequate test strategy exposes companies to the risk of their business applications failing in the field. Testing after deployment is not sufficient due to high cost and negative feedback.

To ensure Wi-Fi networks achieve high quality and a high QoE, comprehensive Wi-Fi network testing is essential.

Solution 1: IxVeriWave



The IxVeriWave solution provides comprehensive testing to validate the entire Wi-Fi ecosystem. It delivers powerful independent Wi-Fi benchmarking and real-world ecosystems, as well as functional, soak, and stability testing for wireless local area networks (WLANs). Testing is done in a controlled, repeatable, automatable, and easily configured environment to provide extensive visibility and debugging of results.

The comprehensive test approach of IxVeriWave helps deliver great Wi-Fi networks and ensure their world-class delivery and operation.

Benefits:

Realize faster time to market for products, superior networks, and proactive problem resolution with the confidence that comes from comprehensive testing.

- Limits need and costs associated with real devices and their management using simplified test bed
- Easily scale; find maximum performance and capacity for improved marketing and deployment
- Reduce debugging cycles with extensive Layers 1-7 statistics and key performance indicators
- Improve release cycles with automatable, comprehensive test types and scenarios from functional to soak testing

Solution 2: Nemo Outdoor Drive Test



The Nemo Outdoor Drive Test solution is a laptop-based drive test tool for indoor and outdoor wireless network testing/mobile network testing, troubleshooting, and optimization. It supports over 300 terminals, IoT devices, and scanning receivers from various vendors, all the latest network technologies and the latest smartphones.

The powerful software platform helps deliver optimized wireless coverage and networks, while also ensuring wireless network quality for end users.

Benefits:

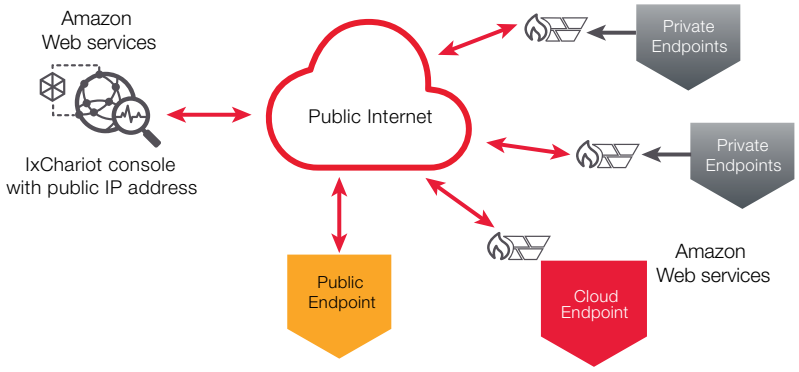
Realize faster time to market for superior networks, improved end-user satisfaction, and proactive problem identification and resolution with the confidence that comes from a full indoor/outdoor drive test solution.

- Provides quality-of-experience (QoE) metrics for the services and applications customers are using
- Supports all stages of the wireless network lifecycle, network rollout, optimization and network benchmarking, network monitoring and control, and network data post-processing and analytics
- Extremely easy to set up, configure and use
- Provides advanced analytics for easy comparison of terminals, IoT devices and networks
- Delivers automated measurements of wireless networks with extensive scripts and large-scale measurement

Network Performance Assessment & Monitoring

Scenario: Networks are in constant flux. Organizations frequently add new business services to their networks, and network equipment undergoes continual updates and upgrades. Whether existing network devices are capable of supporting a new service is a question often left to chance. To avoid blunders, organizations need to qualify the network, assess performance, and predict the quality of experience (QoE) of newly deployed services. For quality assurance engineers and IT teams, it is critical to have fast and efficient ways to verify and quantify performance before shipping products or rolling out services. Post deployment and while operating the network, monitoring network performance and providing capabilities to troubleshoot are key to successful day-to-day operations.

Solution: IxChariot and Hawkeye - Network Performance Monitoring



The IxChariot and Hawkeye - Network Performance Monitoring solution provides instant performance and reliability assessment and troubleshooting of complex networks from pre- to post-deployment using software agents to simulate application traffic and deliver key performance metrics to a central console for easy management. They can be used to provide efficient, software-based testing to check device and network readiness, then monitor the network services when they go live.

With IxChariot, "What-if" scenarios predict an application's impact on devices or the network pre-deployment with in-depth validation in QA cycles that will help ensure the best quality is delivered in day one. Hawkeye helps ensure networks are real-world ready and monitored 24/7 to check and improve quality of experience (QoE) of existing and newly deployed services by validating that any network changes do not disrupt the network's quality and performance. Hawkeye also provides visibility and diagnostics into cloud access performance that will be one of the main challenges of cloud-based IoT services.

Benefits:

Realize faster time to market for products, superior networks, and proactive problem detection and resolution in live deployments with the confidence that comes from extensive testing.

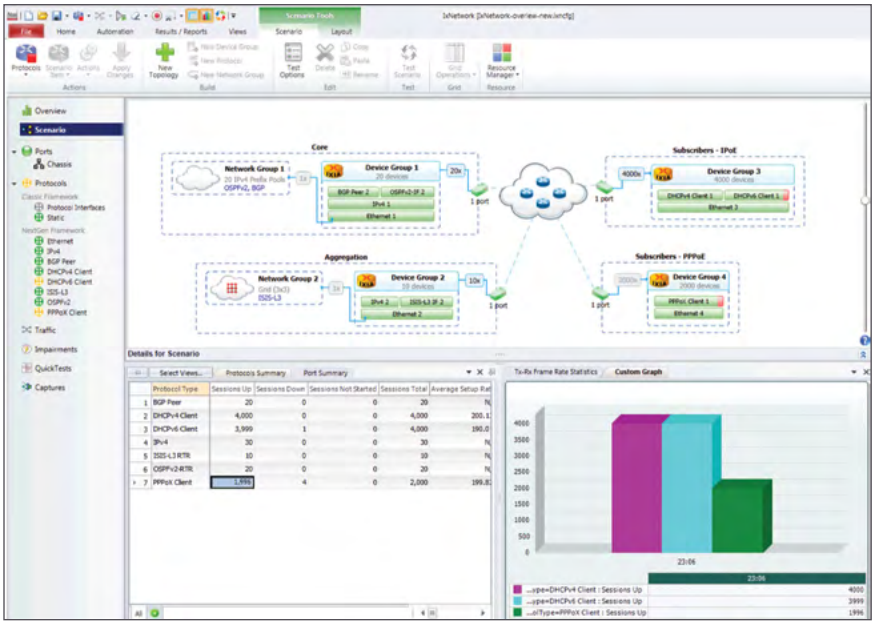
- Trusted solution for testing reliability of networks and applications running on a wide variety of transport interfaces, including wired, wireless, virtual data centers and cloud
- Fast assessment and monitoring of wireless performance and geo-location; access to and troubleshooting of cloud services
- Emulates a real-world application traffic used on today's networks in pre-deployment (IxChariot) and live networks (Hawkeye)

Network Infrastructure Performance Testing

Scenario: Organizations have long tested their networks for scale and performance. However, as networks become increasingly complex, so too do the challenges of ensuring peak network performance and resiliency. It's not about simply testing for sluggish response times—the right testing tool must now assess complex network topologies with thousands of network devices, emulate sophisticated traffic flows, and conduct stress tests under countless scenarios and network conditions.

To reduce test times and save capital expenditure in testing, companies must use a test solution that is able to handle complex and unpredictable networks, and can scale to handle the most powerful devices and the largest networks.

Solution: IxNetwork



The IxNetwork solution delivers performance testing under the most challenging conditions. Capable of generating multiple terabytes of data and analyzing up to 4 million traffic flows simultaneously, it scales to handle the most powerful devices and the largest networks. Enhanced real-time analysis and statistics enable IxNetwork to emulate everything from routing and switching, data center Ethernet and SDN to broadband access and industrial Ethernet.

The IxNetwork ensures the reliability of network infrastructure with comprehensive testing that scales to handle most powerful devices and largest networks.

Benefits:

Quickly identify problems in the lab before deployment in the field and increase revenue by emulating a very large number of routers/ switches without using real devices.

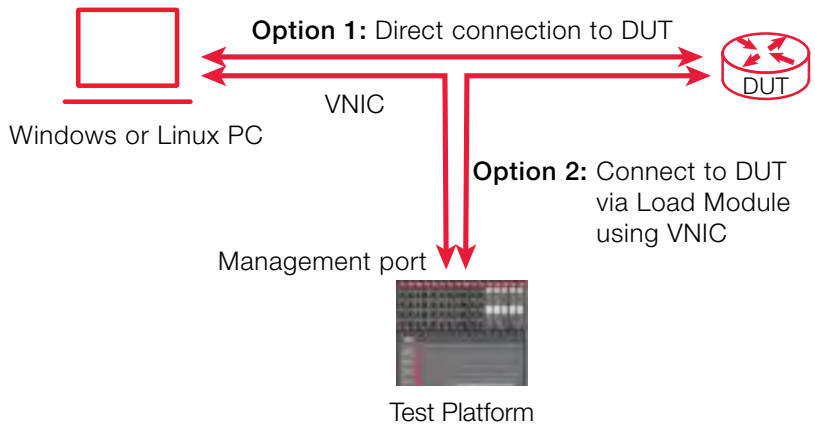
- Reduce test time using visual topology-based protocol configuration and comprehensive analytics with drill-down and learned information
- Realistically mimic real-world conditions with granular traffic generators and stateful AppLibrary
- Provides a deeper understanding of performance and scaling bottlenecks
- Easy to use GUI wizards enables users to meet a wide range of performance requirements with minimal resources

Network Validation

Scenario: Throughout a product's lifecycle, IoT device design needs to be validated. Does the device's protocol software meet specifications? How well does the device handle traffic from non-complying network components? How might new development impact existing code? Not only do these questions demand accurate responses, they also require a speedy resolution, since identifying and addressing last-minute product reworks can be considerably time-consuming and costly.

To maximize time and profit, companies need to validate protocol compliance and interoperability during a product's entire lifecycle.

Solution: IxANVL



The IxANVL (Automated Network Validation Library) solution quickly and effortlessly access a vast array of protocol libraries and utilities to validate protocol compliance and interoperability. It allows vendors to verify IoT device design during the product's entire lifecycle. Problems can be identified earlier to prevent costly last-minute reworks.

IxANVL emulates large, multi-node networks that previously were cost-prohibitive; resulting in more efficient tests and faster product release times, and reduced costs.

Benefits:

Realize increased confidence in product quality by enabling extensive and thorough testing, performed automatically and without supervision.

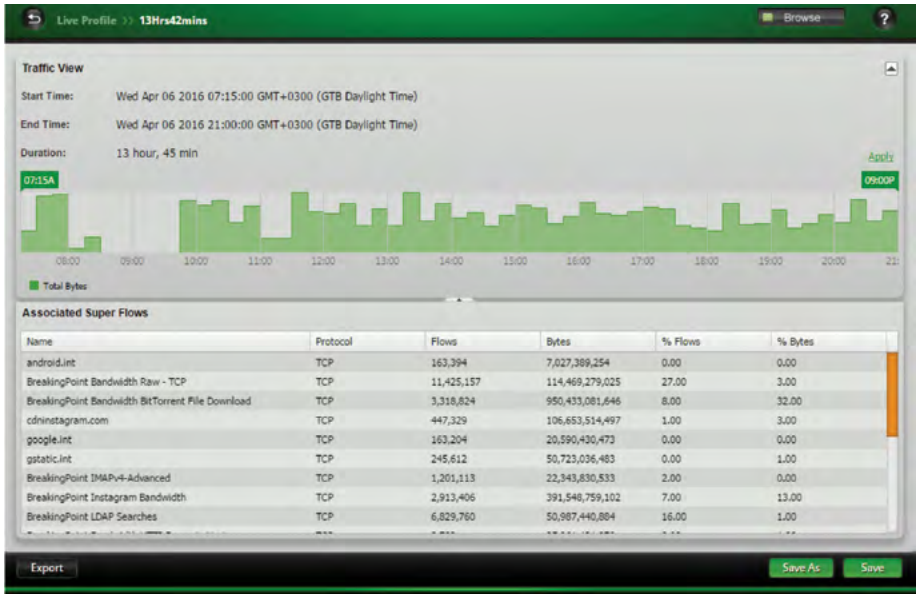
- Fast visibility into how well a device handles traffic from non-complying network components
- Easily expands to accommodate new interface types, protocols, and/or test cases
- Validates a broad set of protocols: including bridging, routing, PPP, TCP/IP, IPv6, IPsec, VPN, MPLS, Carrier Ethernet, Automotive Ethernet, and multicast

Applications and Security Testing

Scenario: Organizations rely on a wide variety of security solutions to protect their networks from cyberattacks and traffic anomalies. However, the more tools that are deployed, the more complex a security infrastructure becomes. What results is a mix of security solutions that are tough to verify and challenging to scale. Worse yet, these complex system interactions pose a serious risk to security performance and network resiliency. In the mission-critical IoT, such risks cannot be tolerated.

To ensure networks are robust and safe—and protect profits—companies must utilize a testing ecosystem that is powerful enough to measure and harden the performance of networks and security devices, while delivering an ease of use that breaks through the complexity.

Solution: BreakingPoint



The BreakingPoint solution validates an organization's security infrastructure by simulating real-world legitimate traffic, distributed denial of service (DDoS), exploits, malware, and fuzzing. It ensures network security by maximizing security investments—with onsite network-specific, proof-of-concept (PoC) validation and optimizing next-generation firewalls (NGFWs), intrusion prevention systems (IPS), and other security devices. It assures network performance by validating and optimizing 3G and 4G/LTE networks under the most realistic conditions, using real mobile applications over mobile tunneling and roaming, and by obtaining per-user equipment (UE) statistics.

Benefits:

Reduce the risk of network degradation and increase attack readiness with an easy-to-use testing ecosystem for modern networks.

- Stresses network infrastructures with 37,000+ security attacks, malware, botnets, and evasion techniques
- Finds network issues and prepares for the unexpected with the industry's fastest protocol fuzzing capabilities
- Emulates sophisticated, large-scale DDoS and botnet attacks to expose hidden weaknesses
- Ensures an always-on user experience in the midst of complexity and exploding traffic volume

Keysight Services Can Help in the Design and Manufacturing of IoT Devices

Keysight Services offers a broad portfolio of services and support targeted at assisting engineers working on the design and manufacturing of IoT devices. We understand design engineers count on repeatable measurements across work groups to avoid discrepancies that can impact development cycle time, time-to-market, and budgets. While manufacturing strives to meet production goals where inaccurate measurements and system uptime can affect yield and product quality.

For IoT manufacturing, where meeting time-to-volume and product quality goals are critical, you can:

- Achieve fast ramp times with test system installation
- Manage downtime with loaner services, onsite calibration, and onsite resident professionals
- Improve product quality by ensuring data correlation between NPI and manufacturing teams via Keysight's calibration services
- Have confidence your instruments are performing to warranted specs by utilizing Keysight's global network of 36 services centers in 19 countries

For design engineers, where measurement accuracy and repeatability is required, you can:

- Exchange older assets for newer, more reliable Keysight instruments with the Keysight Trade-in Program
- Keep your instruments operating to specification with repair and calibration agreements
- Let us help you solve your toughest problems by leveraging our consulting services

For lab or manufacturing managers looking to minimize capital and operating expenses, you can:

- Improve asset usage over time through instrument management solutions
- Use Keysight's Technology Refresh Services to extend, upgrade, or migrate existing test systems
- Lower your purchasing cost or use flexible financing with Keysight Premium Used, Instant Buy, or the Keysight Store on eBay
- Manage all of your instruments regardless of manufacturer with Infoline Instrument Management

To learn more about Keysight's complete service offerings, please visit our Services webpage at

www.keysight.com/us/en/products/services.html

EMI/EMC

The CISPR 16 standard specifies test equipment must be calibrated by labs accredited to ISO 17025. Keysight has a global network of service centers accredited to ISO 17025, spanning a wide range of electronic parameters and featuring industry-leading measurement uncertainties. Whether you are doing pre-qualification or qualification testing, you can trust your equipment will continue to meet its warranted specifications and comply with the CISPR standards.

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