



Accelerating 5G Innovation with Universities

Introduction

Universities around the globe are actively engaged in researching and developing technology and commercial applications for the new, emerging telecommunications standards and capabilities of 5G. Aside from the quest for knowledge itself, these institutions of higher learning have much to gain for themselves and their students and for businesses and consumers everywhere.

The transition to 5G, which is well under way, is enabling a new world of wider communications applications to rapidly unfold. Universities, with their access to emerging and top tier STEM (Science, Technology, Engineering and Math) talent, are exceedingly well-positioned to lead this innovation charge now and into the future.

Academic renown, riches, and prestigious partnerships await the research team or program that creates a world-advancing 5G solution. Substantial benefits, too, can be realized from employing 5G to improve on-campus communications and advance educational initiatives such as remote learning.

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At the heart of this opportunity is the use of advanced testing and service assurance technologies helping universities:

1. Establish leadership in 5G research and teaching through cutting edge 5G emulation, automation, test tools and methodologies.
2. Build financial sustainability by helping qualify and bid for public sector funding and investment.
3. Attract world-class partners from the private sector through joint innovation focused on future 5G-enabled industries.
4. Develop commercial opportunities through joint innovation and IPR development.

In addition, these real-world, advanced testing and assurance techniques can become important educational assets for integration into a university's teaching curriculum to further enhance student learning and career development.

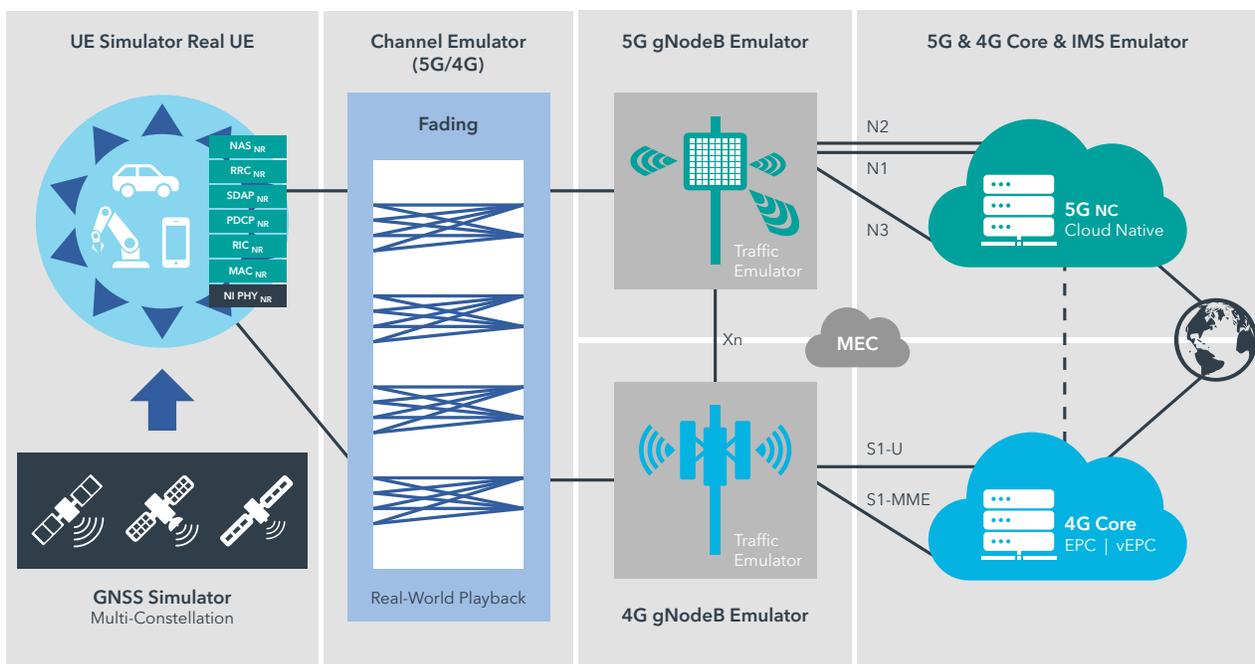
Innovation with the 5G Digital Twin

The 5G Digital Twin is an emulated software replica of the physical network allowing continuous prototyping, modeling and research.

Digital Twins are not a new concept and have been used in aeronautics, manufacturing, and building design to help simulate complex systems.

As 5G moves us from being a physical network to a living system the Digital Twin is an ideal solution.

The Digital Twin consists of multiple emulation, traffic and signal generation functions working in harmony to provide a virtual software version of the 5G Network.



The primary emulated components of the 5G Network Digital Twin include:

- **5G Radio Channel Emulation & Sounding**—Emulates new 5G RF channel ranges, densities and new RAN technologies. It also emulates the 4G RF for 5G Non-standalone scenarios.
- **5G gNodeB and 4G eNodeB Emulation**—Emulates 5G and 4G Base Stations with functionality that includes data transfers, mobility control, session management, radio access network sharing, positioning, and functional splits.
- **Fronthaul Emulation**—Emulates next-generation Ethernet fronthaul devices and traffic.
- **Core Network and Cloud Edge Emulation**—Emulates the evolving Core network with the functional disaggregation/separation and distribution to the Edge.
- **Network Slices**—Emulates network slices with different configurations, performance requirements and deployment topologies.
- **Device and Traffic Emulation**—Emulates millions of devices with various types of complex traffic mixes to continuously validate the performance of the network, interfaces and infrastructure.
- **GNSS Simulator**—Simulates satellite constellation signals with complete control over environmental conditions, location, motion, timing and errors.
- **Real-World Emulation**—Recording and playback of real-world captured signals and traffic that are then replicated in a test-bed through emulators for increased realism, repeatability, and predictability.
- **Impairment Emulation**—Emulates network impairments to validate how the network behaves and performs; the insights gained inform how best to compensate via network configuration and architectural adjustments.
- **Security Threat Emulation**—Emulates complex multi-vector attacks that test and audit the 5G environment to pre-emptively identify vulnerabilities and mitigate risks.

The Digital Twin delivers several significant advantages for university researchers. Because it is virtual, endless prototyping can be performed quickly, cost-effectively and simultaneously across research teams without impacting accessibility and performance. Additionally, researchers have the certainty that the data and results generated will correlate precisely with the real network's behavior under those same circumstances.

Building Financial Sustainability

Testing and assurance is just one part of a competitive 5G R&D program. To achieve overall success in terms of recognition, revenue, and sustainability, several key factors must come together. First and foremost is maintaining a mix of talented staff and students committed not only to research excellence, but also to society and the environment as they seek economically favorable government, industrial, and general public solutions.

A university should also conduct ongoing monitoring and reviews of its entire research program—just as developing applications are monitored—with a critical eye for improving quality, competitiveness, and other elements vital to attracting R&D talent, investors, and partners.

Diverse funding from a number of sources including private sector investors and philanthropy-minded donors should be thoroughly explored. Actions and attitudes often speak louder and more effectively than words. For instance, presenting an efficient and effective operation run by a talented, dedicated staff moving toward well-defined goals may be all that's needed to convince would-be investors to get involved.

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Establishing Leadership in 5G Research

The Digital Twin, innovative test methodologies, and learned knowledge that go with it play a critical role in streamlining research and clarifying the path to commercialization.

Such advanced technology capabilities additionally support and augment the effective teaching of 5G technology and related subjects within the university setting.

Maintaining testing and assurance that demonstrates quality and performance excellence also reflects positively on the program responsible for achieving such high levels of proficiency, thereby contributing to a university's efforts in building its reputation and fostering important relationships.

By integrating top tier testing and assurance with R&D, technologically advanced campus communications, and the overall education experience, a university powerfully conveys to key stakeholders—prospective students, faculty, potential partners, etc.—its leadership role in 5G research and teaching.

The benefits of such positioning can extend beyond the classroom to include gaining greater access to private/public funding and drawing the interest of world-class partners seeking joint innovation in developing 5G commercial opportunities and IPR (intellectual property rights).

The pursuit of intellectual property rights is at the core of university 5G R&D and a major consideration behind institutions accepting the inherent risks and costs. After all, achieving an IPR licensor or ownership stake in a valuable 5G product, service, or application could result in an enormous financial payout. Success on a commercial level also brings added peer and industry recognition that uplifts a university's reputation as a tech innovator and top educator. This, in turn, attracts highly desirable faculty and student candidates as well as investors, governments, communities, and others who are receptive to co-partnering.

Developing Commercial Opportunities and Attracting World-Class Partners

The potential of 5G lies in its ability to create interconnected, communications ecosystems that are defined and shaped through focused innovation.

Recognizing the vast enormity of this opportunity, it's no secret that universities around the world are moving fast to secure a pivotal and profitable role in developing and applying the new technology.

To realize this potential, focused innovation and technology leadership plays a pivotal role in universities working with governments, businesses, industries, and even other universities as a preferred partner. In this way, an institution can help ensure its involvement and influence regarding technological solutions, digital transformation, and policy innovation right from the start.

The commercial business avenues for reward are varied and inviting. They include:

- Licensing intellectual property rights
- Spinning out companies with university graduates
- Selling technology
- Providing pay-to-play test beds, lab facilities, and research fellows for the private sector

How Spirent Can Help

Spirent is an industry leader in test and service assurance, driving innovation and industry standards for the communications industry.

With customers and partners spanning the complete communications ecosystem, Spirent is well-positioned to help universities establish their leadership and reputation in research and innovation.

In addition, Spirent works in collaboration with NI (National Instruments)—a recognized international leader in the production of automated test equipment and virtual instrumentation software—to ensure outstanding network infrastructure performance through an array of highly effective tools.

The technology and solutions Spirent can support universities 5G ambitions include:

5G Digital Twin is an emulated software replica of the physical network allowing continuous prototyping, modeling and research.

Vertex® 5G Channel Emulator is a versatile platform that offers unprecedented scalability while supporting emulation of many channel models. The simple plug-and-play design is built to test a broad number of applications that require varying channel densities. Supported applications range from basic two-channel SISO to complex, high-density scenarios needed to prepare for 5G, such as 3- and 4-component carrier aggregation, higher order MIMO OTA, and 3D bidirectional beamforming

8100™ Mobile Device Test System and Base-station Emulator is the optimal solution for automated testing of today's mobile devices and chipsets. It supports a wide range of application and modem layer test areas as well as indoor and outdoor location testing scenarios that span conformance, certification, and operator acceptance. Its flexible option-based design allows you to add test capabilities as you need them, either in full rack-mount systems or more economical desktop platforms, for LTE, Wi-Fi, and upcoming 5G scenarios.

Landslide Core Network Emulator and Test System is an all-in-one solution for emulating and testing multiple Core Network technologies and functions such as 5G New Core, Network Slicing, 4G Core Evolution, LTE, 3G, WiMAX, Wi-Fi and IMS networks.

Spirent Test Center (STC) Signal Generator and Emulator provides a test and emulation solution for Cloud, Fronthaul and Virtual Network environments validating the critical multi-vendor and multi-distribution virtual infrastructure and interconnects for 5G Cloud RAN, Next-Generation Fronthaul and web-scale distributed Data Centers.

GNSS Global Navigation and Satellite Signal simulators simulate satellite constellation signals with complete control over environmental conditions, location, motion, timing and errors.

Spirent Network Emulator provides high-density point-to-point network emulation and real-world impairment conditions (latency, jitter, congestion, fragmentation, corruption, etc.).

CyberFlood Security and Application testing provides L4-7 traffic generation, high-performance security attack vectors and data-breach emulation.

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University Use Cases

Institution: The University of Surrey, UK

R&D PROGRAM:

5GIC (5G Innovation Center), now the largest capacity 5G test network for research, innovation and development in the world.

BACKGROUND:

5GIC operates a testbed covering 4 km² of indoor and outdoor environments on the University of Surrey campus.

CHALLENGE:

To study and provide context about users, services, networks, and devices for next-generation services such as broadband, mobile and IoT.

APPLICATION:

Deploying Spirent Landslide to emulate large numbers of customer users (now up to one million), test network traffic patterns and devise solutions that mitigate delays and impairments.

The University of Surrey 5G Innovation Center (5GIC) operates a testbed covering 4 km² of indoor and outdoor environments on the University of Surrey campus. This testbed is being used on a project that aims to study and provide context about users, services, networks, and devices for next-generation services such as broadband, mobile, and IoT (Internet of Things).

As a member of the 5G UK Digital Strategy, 5GIC is one of only three leading academic research centers selected by the UK government to advance the development of the next generation of mobile and wireless communications.

To facilitate their work in testing the performance of innovative 5G algorithms under realistic conditions, the 5GIC team and its industry partners chose to deploy Spirent Landslide. This all-in-one solution for testing multiple technologies such as LTE, 3G, WiMAX, and Wi-Fi mobile networks as well as 4G provides complete assurance across the evolutionary path to 5G.

The capability of Landslide to emulate large numbers of customer users (now up to one million) enables researchers and partners to test applications based on latency, bandwidth, quality of experience, signaling, and various traffic in sliceable and virtualized networks.

The Landslide-equipped testbed at the University of Surrey is now open for business to companies wanting to test their advanced applications and their readiness for 5G usage. The focus is on delivering real-world benefits from 5G technology that include improving connectivity for rural communities; increasing industrial productivity using robotics, big data analytics, and Augmented Reality; and the development of Connected and Autonomous Vehicles.

"Spirent Landslide supports our objective by validating new 5G algorithms before they are deployed in the live testbed. After the algorithms are validated, Spirent Landslide generates traffic consistent with typical large mobility networks, so we can understand the potential of these algorithms to impact user experience in the real world."

Professor Rahim Tafazolli
Founder and Director of the
University of Surrey 5GIC

"Spirent allows us to edge further ahead in the global 5G race, giving us the ability to stress test new 5G algorithms before they are used in live commercial networks and allowing us to pit them against usage traffic typical to many mobile networks."

Professor Rahim Tafazolli



University Use Cases

Institution: University of Warwick

R&D PROGRAM:

WMG (Warwick Manufacturing Group), an academic department providing research, education, and knowledge transfer in engineering, manufacturing, and technology.

BACKGROUND:

This project, led by Spirent Communications, aims to bring more accurate location awareness to intelligent vehicles and smart devices by 'fusing' Global Navigation Satellite Systems (GNSS) and Wi-Fi signals.

CHALLENGE:

Bringing location accuracy for autonomous vehicles down from five meters to 30 centimeters through sensor fusion.

APPLICATION:

Developing an RF (Radio Frequency) model that validates and verifies autonomous vehicle activities to assure levels of performance.

Spirent, in collaboration with WMG (Warwick Manufacturing Group) at the University of Warwick, UK is testing a concept that intelligent vehicles and smart devices can gain improved location awareness by "fusing" GNSS (Global Navigation Satellite Systems) and Wi-Fi signals.

Known as ELWAG or the 'Enhanced Assured Location Simulator Leveraging Wi-Fi and GNSS Sensor Fusion,' the project focuses on testing a hybrid Wi-Fi and GNSS location solution that is performed in a safe, repeatable, and cost-effective environment. The aim is to hone autonomous vehicle location accuracy, which is currently unsafe and can vary by up to five meters, to within an acceptable 30 centimeters that would have substantially positive implications for autonomous navigation.

Researchers, led by Dr. Matthew Higgins, are taking physical layer measurements of both Wi-Fi and GNSS signals in autonomous vehicle scenarios, in and around the University of Warwick campus and on the local urban road network. From these measurements, Spirent is developing an RF (Radio Frequency) propagation model that overlays RF effects on a Wi-Fi Access Point emulator. The final step is for WMG researchers to perform RF validation and verification activities around the developed model to assure the level of performance.

"The safety and functional assurance of future autonomous vehicles is one of the many critical paths to large consumer adoption. Through this project, we are making innovative contributions toward solving the challenges of using sensor fusion in this testing context."

Dr. Matthew Higgins

Associate Professor in the Intelligent Vehicles Group at WMG, University of Warwick

"Currently Wi-Fi access point plus GNSS simulation can only be achieved in an ad hoc manner and does not allow for the testing of moving vehicles, multipath effects, insertion of data errors, spoofing, and above all controlled, repeatable testing."

Mark Holbrow

Director of Engineering and Product Development at Spirent's Positioning Business Unit

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About Spirent Communications

Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks.

We help bring clarity to increasingly complex technological and business challenges.

Spirent's customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled.

For more information, visit:
www.spirent.com

The Best Never Stop Learning

That's true for researchers, engineers, professors, investors, students and even testing and assurance professionals. Love of the learning process is a great quality to have, especially considering how quickly technologies and technology solutions change.

Take the concept of the Digital Twin virtual network. It wasn't that long ago when we, at Spirent learned all about its potential advantages for testing 5G systems. Now, through this brief, we've been able to share our knowledge, giving you the opportunity to learn about it, too.

At Spirent Communications, we're always assessing, making adjustments and pushing the boundaries, not just of 5G, but of our own understanding regarding how to better assist customers and build solid business relationships.

Proven methodologies and an ongoing collaboration with National Instruments in attaining and developing best-in-class testing and assurance tools help set us apart. But our biggest differentiator, bar none, is expertise, which is constantly expanding, deepening, and improving due to our endless curiosity.

It's the quality that keeps us innovative and growing and is likely a large part of why universities and other clients want us to join their team.

As a world leader in 5G Test and Assurance, with end-to-end expertise and solutions to automate and harmonize test and validation across the lifecycle, we're ready to work with you every step of the way.

You promise your students, partners and commercial customers to make 5G a transformative reality. Spirent is here to accelerate and assure your success.

Spirent. Promise. Assured.



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