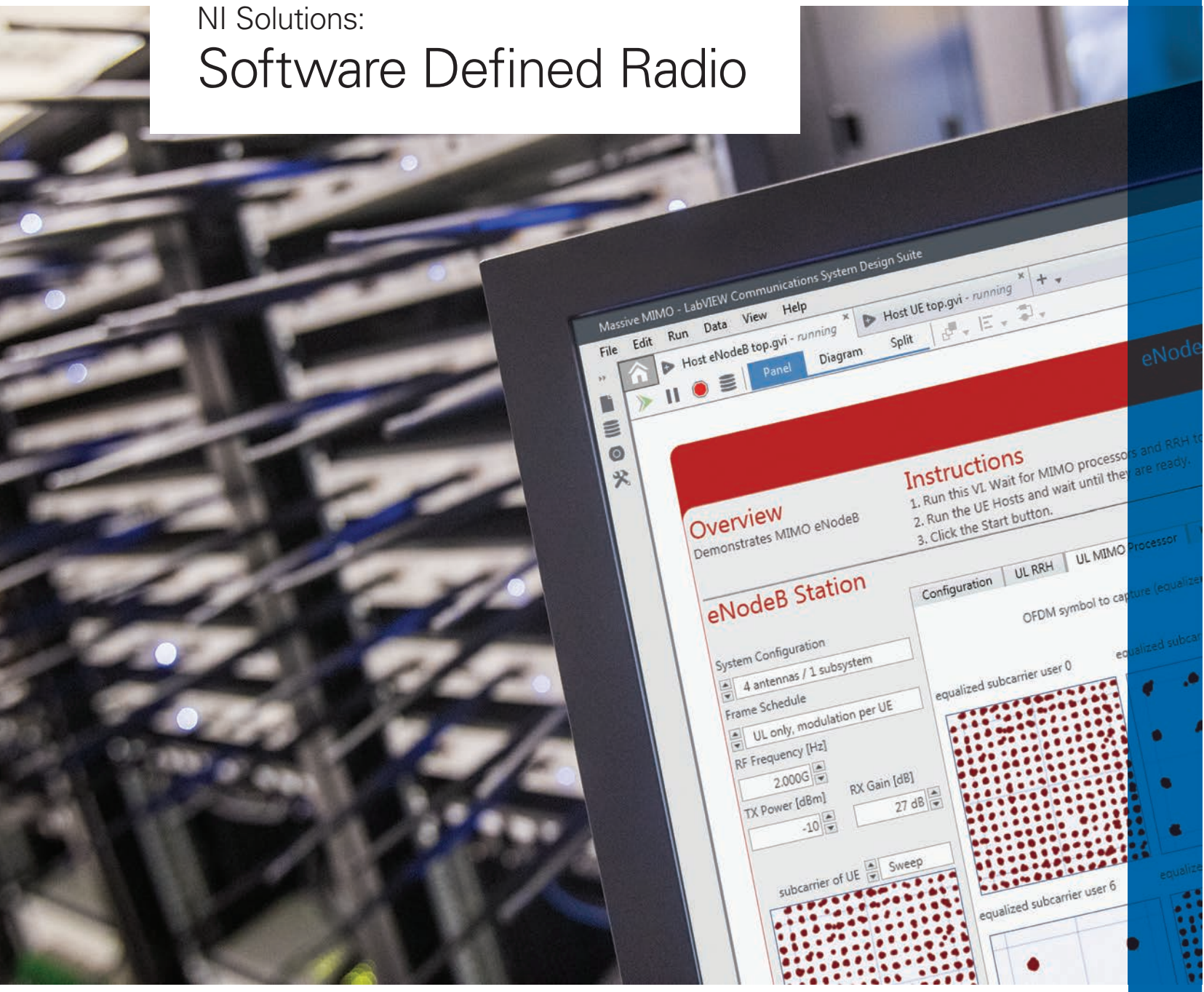
NI Solutions:

Software Defined Radio



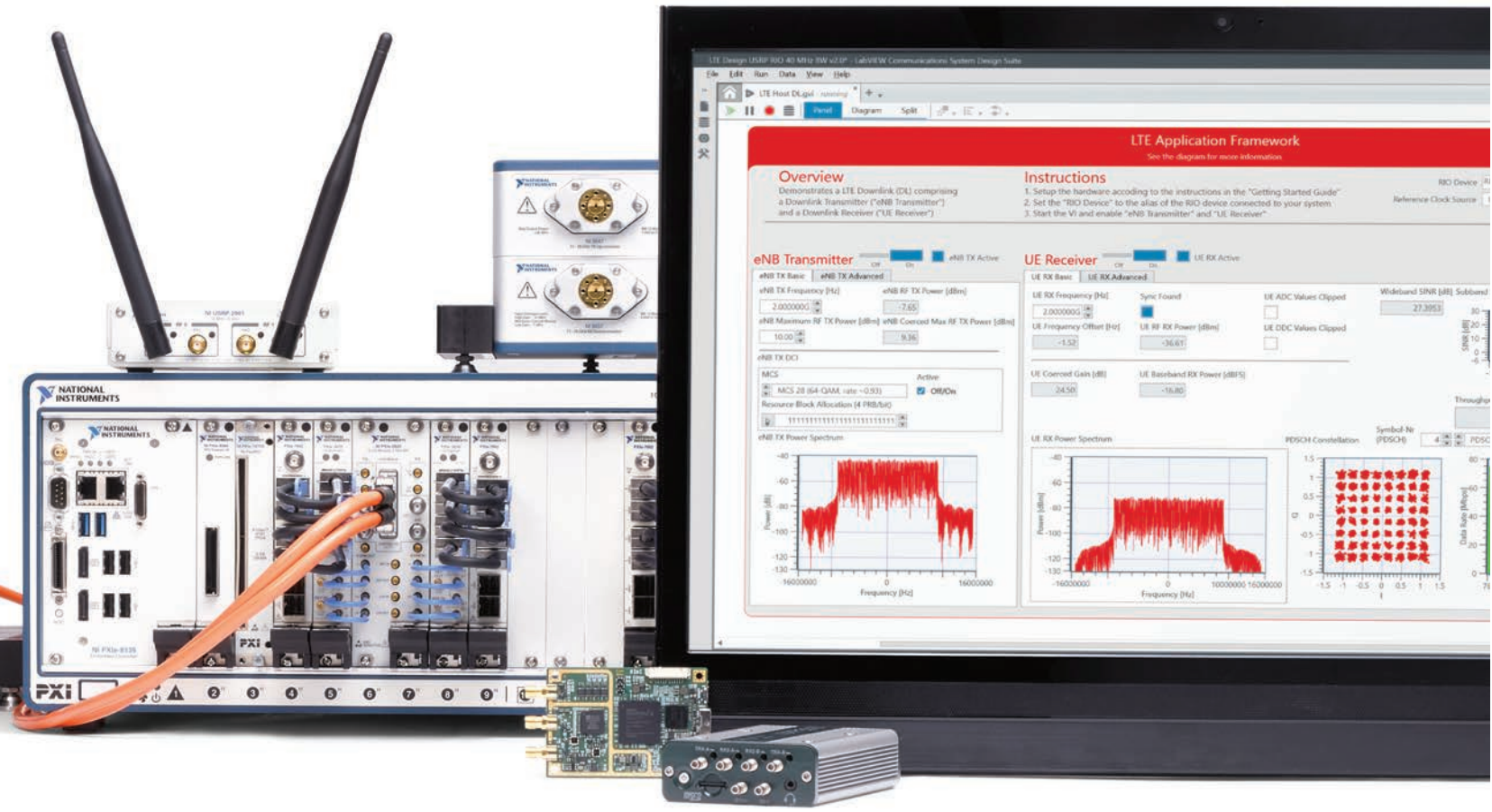
Unparalleled Solutions for Software Defined Radio

The most complete software defined radio offering from design to deployment

NI software defined radio (SDR) hardware and software solutions drive productivity, shorten time to results, and empower engineers, scientists, and researchers to design next-generation wireless technologies.

The breadth and depth of NI's SDR offering are unrivaled. Scaling from small to massive, NI SDR tools, including those from Ettus Research, an NI company, can be used for a wide variety of applications including signals intelligence, military communications, radar, and communications research.

Across applications and industries like these, wireless researchers can leverage NI tools that scale from cost-effective single-user experimentation systems to densely packed Massive MIMO systems capable of accommodating hundreds of radios and antennas. And when it comes to software, NI provides unmatched flexibility and choice from the simplified FPGA programming of the LabVIEW Communications System Design Suite to a wide, vibrant community of open-source software contributors through GNU Radio.



SDR Applications

- Next-generation wireless technologies
- Military communications
- Signals intelligence
- Radar
- Communications research
- Massive MIMO systems
- Spectrum monitoring
- Direction finding

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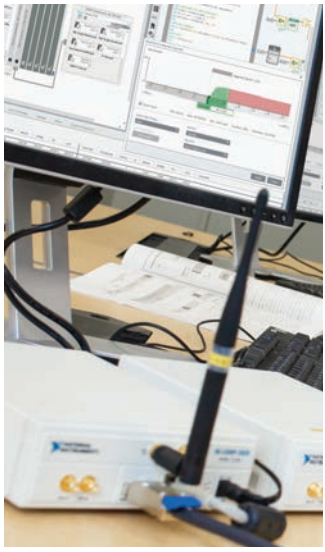

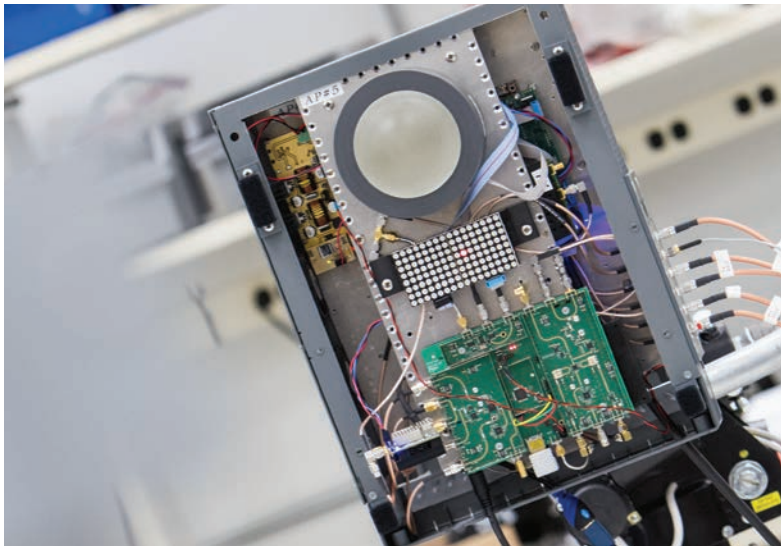

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Real-World SDR Applications and Success Stories

1 Bristol and Lund Universities Set World Records in 5G Research

Bristol and Lund universities used LabVIEW and the NI MIMO Prototyping System to rapidly innovate 5G cellular networks through Massive MIMO techniques, successfully demonstrating greater than 20X increases in bandwidth efficiency and setting new world records in the process.

2 Rutgers Prepares Students for Success in Wireless Communications Careers

Rutgers University used LabVIEW and USRP transceivers for open-ended, project-based courses that provide students with a truly hands-on experience relevant to working in the wireless communications industry.

3 The University of Texas Demonstrates a Vehicular Radar System

The UT Wireless Networking and Communications Group used LabVIEW and USRP RIO hardware to explore new low-bandwidth radar prototypes for government mandates requiring frontal collision detection and avoidance on all new vehicles.

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4 Averna Creates a Flexible RF Record & Playback Solution

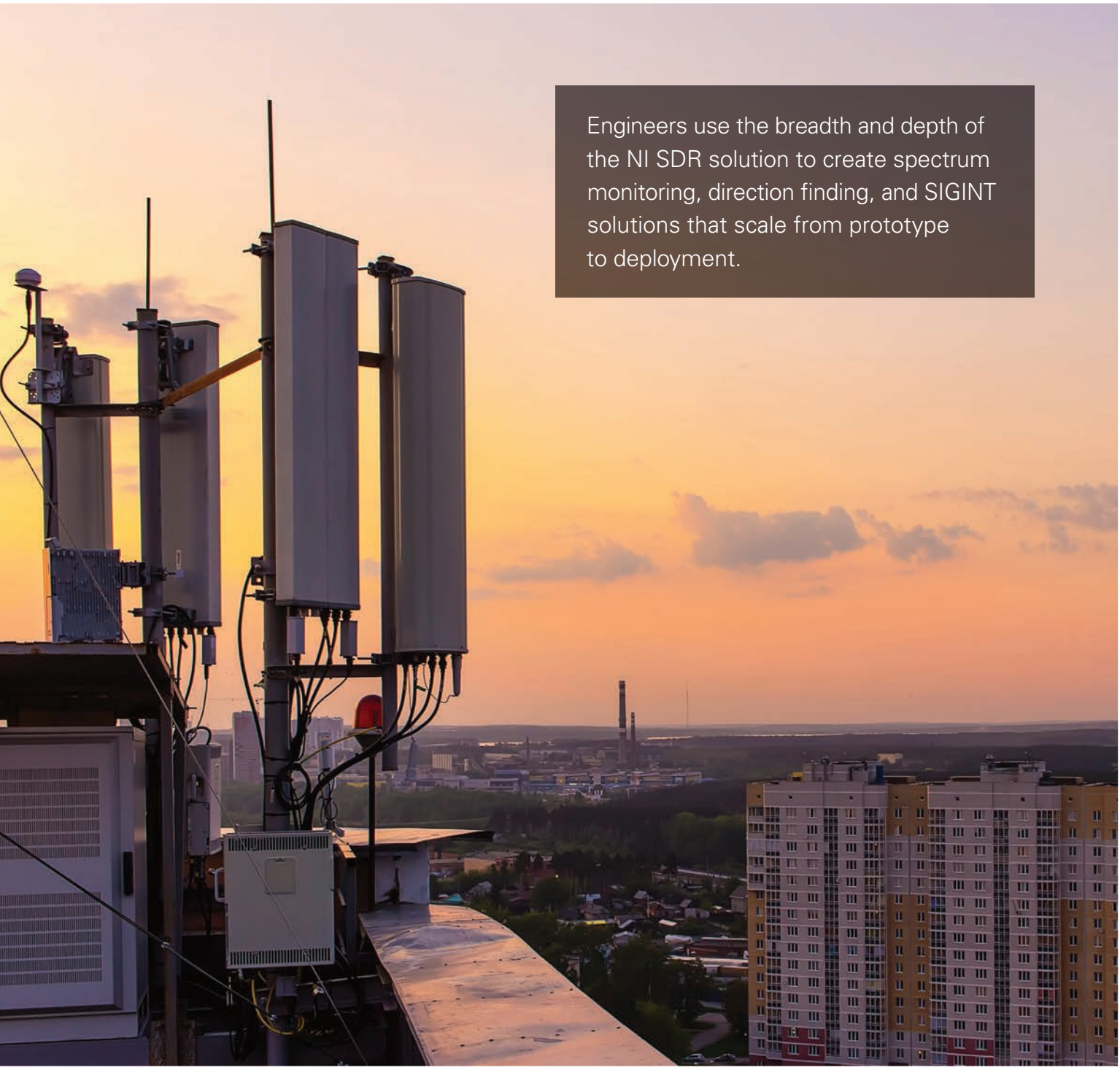
Averna integrated Ettus X300 SDRs with Averna RF Studio workflow software to create the RP-6100, a powerful and cost-effective multichannel RF record and playback system capable of capturing up to 160 MHz simultaneous bandwidth for wide-ranging RF test and analysis needs.

5 Nokia Rapidly Prototypes a 5G Proof of Concept

Nokia Networks used LabVIEW and NI PXI hardware to facilitate a unified design flow through its development process, which resulted in the company being able to quickly prototype its ideas for mmWave mobile access in a fraction of the time of conventional design approaches.

6 M3 Systems Develops a Fully Configurable Multiconstellation GNSS Receiver

M3 Systems used LabVIEW and USRP hardware to develop a fully configurable multiconstellation global navigation satellite system (GNSS) receiver so that users could access the core of signal processing algorithms.



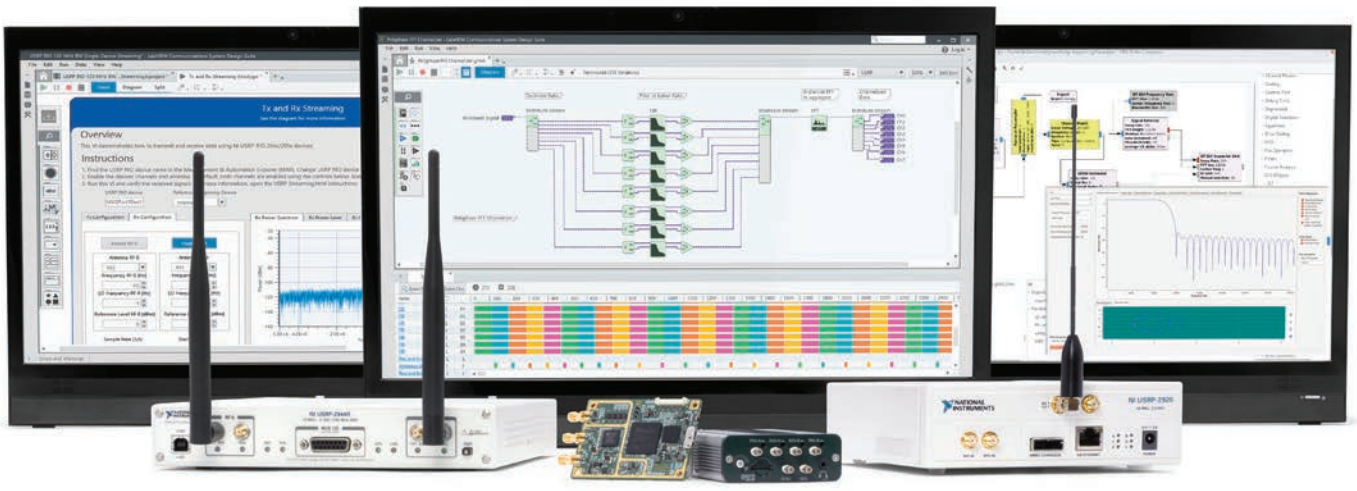
Engineers use the breadth and depth of the NI SDR solution to create spectrum monitoring, direction finding, and SIGINT solutions that scale from prototype to deployment.

"LabVIEW and NI USRP are an ideal choice for rapidly prototyping wireless signal transmission, reception, and processing."

Bo Tan, University College London

Wireless Prototyping and Deployment

Use NI SDR solutions to evolve beyond software simulation and validate algorithms in the real world with real-time communication. By providing the ability to use either a seamless host and FPGA-based workflow in the LabVIEW Communications System Design Suite or an open-source workflow with UHD, RFNoC, and GNU Radio, NI SDR solutions give you choice and flexibility to help you get the job done using the tools you need faster.



SDR Applications

NI SDR solutions scale from small to massive so you can use NI's complete platform for a wide variety of applications including classroom teaching, portable handheld deployments, and advanced multiantenna research testbeds. Across each, NI SDR solutions provide unrivaled scale and flexibility, with proven success.

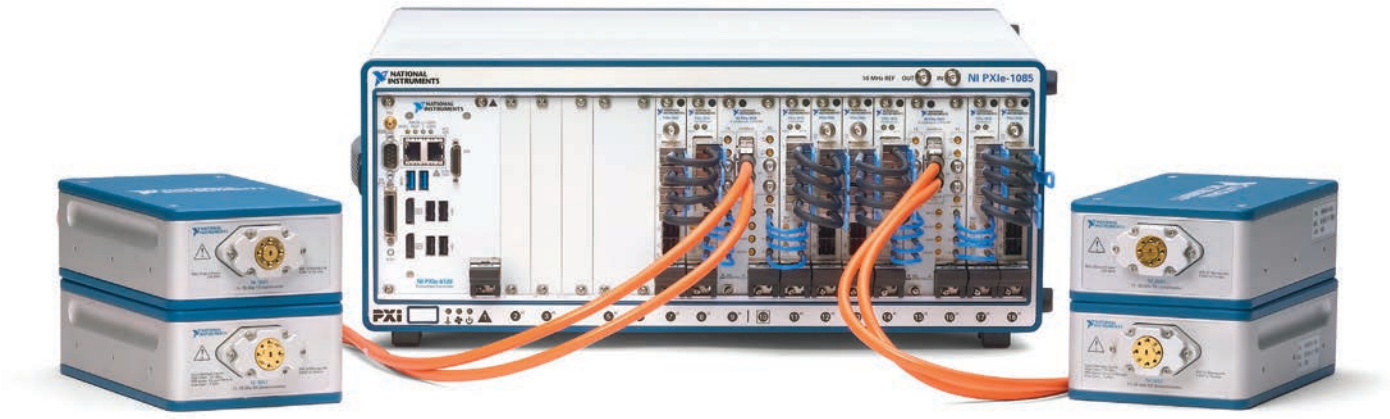
Military Defense
Take advantage of the small size, weight, and power (SWAP) of NI SDRs to create customer solutions for SIGINT, radar, electronic warfare, military communications, and more.

Spectrum Monitoring and Analysis
Capture vast sections of spectrum with SDRs featuring up to 160 MHz of instantaneous bandwidth and analyze the data in real time using FPGAs programmed in LabVIEW or UHD/RFNoC.

Communications Research, Development, and Deployment
Rapidly prototype new algorithms and devices for applications including 5G, GNSS, IoT, and SATCOM. Move from merely simulating to seeing results in real time with real-world signals.

Proven 5G Leadership

The technologies that will make up the next-generation 5G wireless systems are being defined today. Though simulations are important, prototyping new ideas is the vital step in proving the viability of new technology. By pairing flexible NI SDR solutions with the computing power of FPGAs and IP developed in LabVIEW, NI provides an out-of-the-box starting point for real-time 5G prototyping.



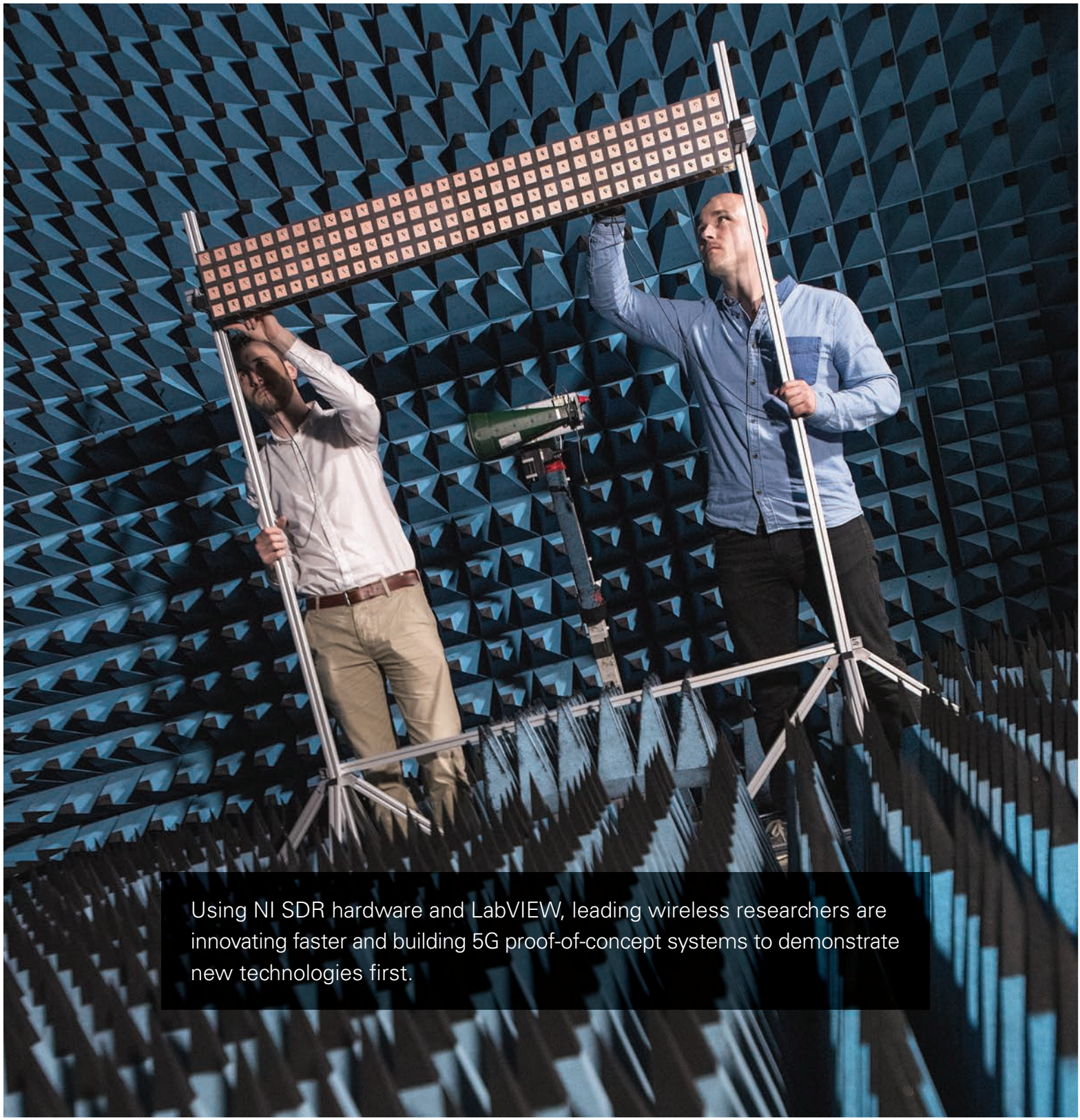
mmWave Transceiver System
Prototype real-time communications systems for mmWave frequencies with the mmWave Transceiver System, a modular hardware solution with 2 GHz of bandwidth and a multi-FPGA architecture for computationally intensive digital signal processing.

Massive MIMO
Use the MIMO Prototyping System, based on USRP RIO and PXI hardware, to build Massive MIMO systems scaling from four to 128 antennas. The powerful multi-FPGA architecture meets the demands of real-time applications.

Open LTE and 802.11 Physical Layer IP
Use NI application frameworks for real-time signal processing IP that is optimized for LTE and 802.11 prototyping with real-time MAC layer functionality. Built in LabVIEW Communications, these application frameworks are completely open and modifiable.

"Using National Instruments' software defined radio platform, I think we were able to save a year's time instead of building the baseband components from scratch."

Mark Cudak, Nokia



Using NI SDR hardware and LabVIEW, leading wireless researchers are innovating faster and building 5G proof-of-concept systems to demonstrate new technologies first.

NI SDR Hardware

NI offers the most comprehensive range of SDR hardware in the world. With banded frequency options from DC to 71 GHz, up to 2 GHz of real-time bandwidth, powerful DSP-focused FPGAs, and form factors ranging from handheld devices to high-channel-count systems, NI SDRs can meet your needs from design to deployment.

B Series/USRP-290x
Cost-effective USB SDR with a wide frequency range, a compact form factor, and up to 15 MHz of streaming bandwidth

N Series/USRP-292x
High-value Ethernet-connected USRP featuring superior RF performance, MIMO capability, and 20 MHz of bandwidth

E Series
Portable and stand-alone wideband SDR containing a Zynq SoC, a 2x2 MIMO transceiver, and 56 MHz of bandwidth

X Series/USRP RIO
High-performance PCI Express/10 Gigabit Ethernet, including a powerful Kintex-7 FPGA, a 2x2 MIMO transceiver, and up to 160 MHz of bandwidth

ATCA-3671
Four Virtex-7 690T FPGAs in an ATCA form factor, dedicated internal serial links between each FPGA, and up to 160 GB/s of external digital connectivity

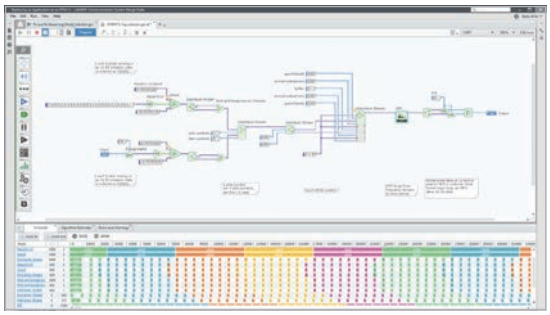
mmWave Transceiver System
Advanced multi-FPGA solution for real-time 5G prototyping that features 2 GHz of bandwidth at the 28 and 71 GHz bands

Ettus Research, an NI company, hosts detailed product information for B Series, N Series, E Series, and X Series products online at **ettus.com**.

NI SDR Software

NI SDR software solutions provide unmatched flexibility and choice, from the LabVIEW Communications System Design Suite that simplifies FPGA programming and makes it easy to visualize, create, and test with real-world over-the-air signals, to a wide, vibrant community of open-source software contributors that help you program NI SDRs, including those from Ettus Research.

LabVIEW
LabVIEW Communications enhances your ability to program wireless prototyping systems, so you can streamline development and shorten time to results. You can easily import and edit third-party languages such as C, The MathWorks, Inc. MATLAB®, and VHDL within the software, while interactive learning contents and hardware examples help you get started quickly.



LabVIEW FPGA
LabVIEW Communications provides one seamless programming environment, from processors to FPGAs, on a variety of NI SDR hardware. Using LabVIEW FPGA, you can develop and deploy powerful FPGA code without needing an HDL expert. Automatic hardware discovery and graphical hardware representation help you visually navigate the hardware mapping, and advanced FPGA-based software reference designs are available for Massive MIMO, LTE, and 802.11 applications.

Open-source Software
Use a variety of open-source software tools to program NI SDRs from Ettus Research. With the flexibility of the USRP Hardware Driver (UHD), you can choose between tools and languages such as GNU Radio, Python, and C to program your SDRs and access existing IP, examples, and support through NI's extensive online communities. Additionally, RFNetwork on Chip (RFNoC) software simplifies FPGA IP integration on NI SDRs from Ettus Research. Visit **ettus.com** for more info.

"By using a high level of abstraction offered by LabVIEW to handle FPGA programming, we completed all the development stages in six months, saving more than four months on the initial schedule."

Alessandro Bizzarri, TEA SISTEMI

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NI Services and Support

Hardware Services

Fix maintenance costs, improve uptime, and maintain traceability starting at only a fraction of the hardware price with NI service programs.

Training and Certification

Develop 50 percent faster and spend 43 percent less time on code maintenance with NI training courses. Also validate your expertise with NI certifications.

Technical Support

Get started with NI products faster or troubleshoot tough issues by contacting NI applications engineers who are ready to help via phone and email.

Consultation and Integration

Leverage our extensive network of Alliance Partners and NI systems engineers for assistance with prototyping, feasibility analysis, consulting, and systems integration.

Software License Programs

Streamline NI software management by accessing multiple levels of training, technical support, and tools through your software license.

Technical Resources

Access volumes of self-help information at **ni.com** including application tips, example programs, and developer communities.

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