



ENGINEER
NEXT
NIDays

The logo features the words "ENGINEER" and "NEXT" in a bold, white, sans-serif font, stacked vertically. A yellow graphic element, resembling a stylized 'X' or a folded ribbon, is positioned between the two words. Below this, the word "NIDays" is written in a smaller, white, sans-serif font, enclosed within a white rectangular border. The entire logo is set against a background of diagonal stripes in various shades of blue, green, and orange.



5G : de la théorie à la pratique

A Platform Approach for Design, Prototyping, and Test

The Race to 5G

verizon✓

Verizon to be first to field-test crazy-fast 5G Wireless

It expects "some level of commercial deployment" to begin by 2017 for next-generation wireless. That's much earlier than the common industry belief that 2020 will mark the start.

China to roll out 5G broadband mobile equipment trials across 100 cities

High-speed 5G networks can theoretically transmit data 20 times faster than current 4G speed, with less than one tenth of the latency.

South China Morning Post

NOKIA

Start building commercial 5G networks today

Nokia 5G FIRST allows operators to address the near-infinite capacity demands of new applications anywhere - seamlessly and securely. This industry-first 5G solution provides innovations that will power the global nervous system.

FCC Unanimously Opens Nearly 11GHz of Spectrum for 5G

Diana Goovaerts

“Ireland to be first country in Europe to roll out 5G geographically”

by John Kennedy



7,500+
EMPLOYEES
50+ COUNTRIES

\$1.23

BILLION
IN 2015

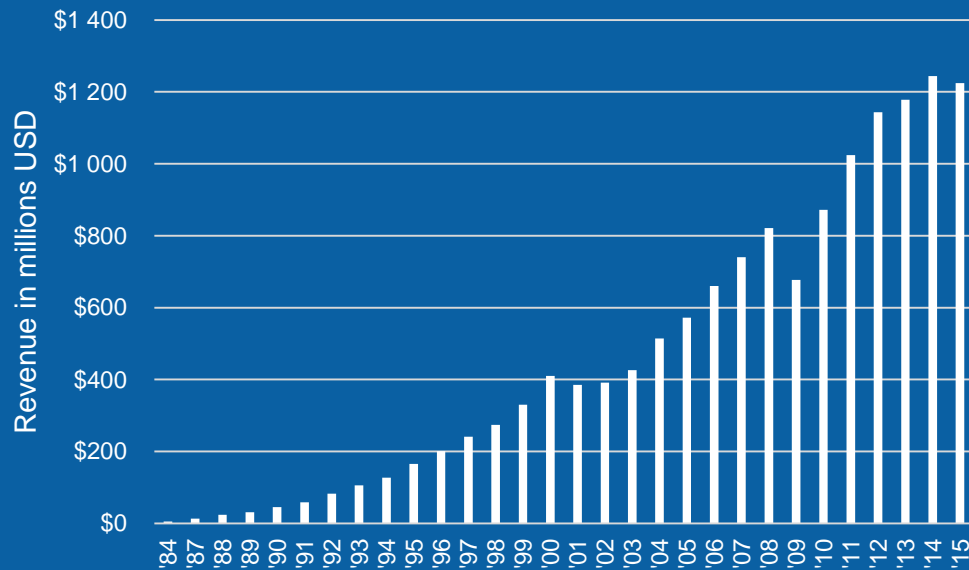


35,000+
CUSTOMERS WORLDWIDE



OVER 18%
INVESTMENT IN R&D

Long-Term Track Record of Growth

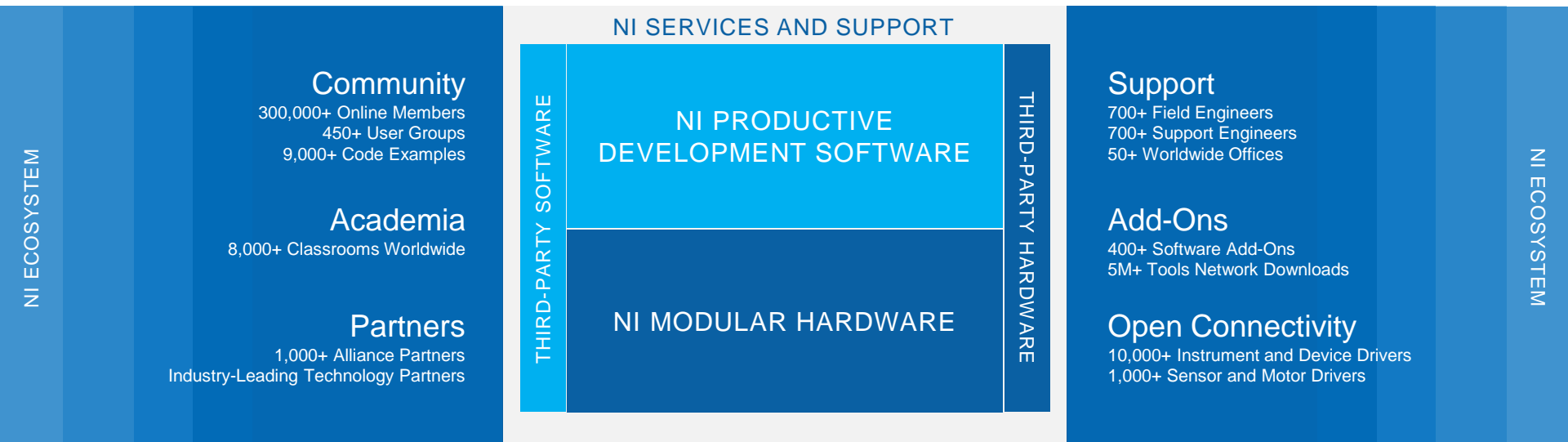


ONE-PLATFORM APPROACH

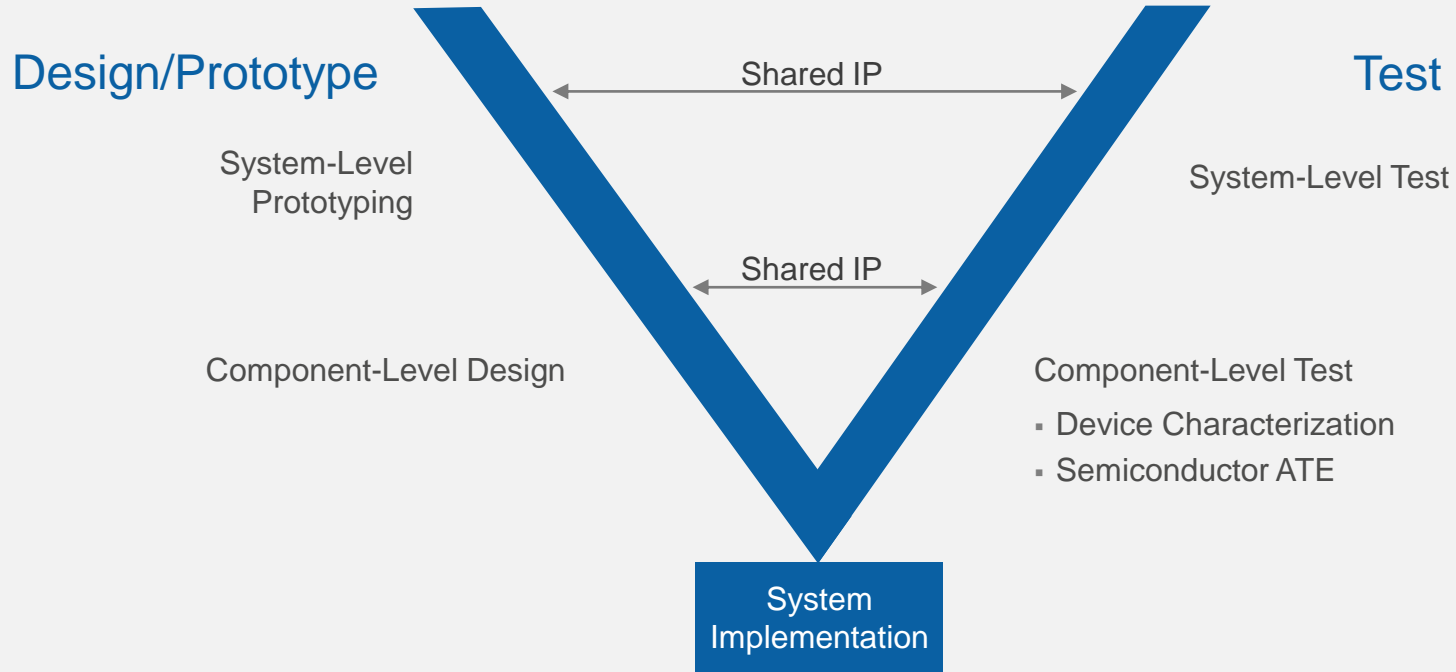


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ONE-PLATFORM APPROACH



A Unified Platform for Concurrent Design and Test



Requirements for 5G Prototype and Test

Design/Prototype

Real-time processing

Tightly integrated I/O

Synchronization

Agile RF front ends

Scalability

Test

Real-time processing

Tightly integrated I/O

Synchronization

Agile RF front ends

Scalability

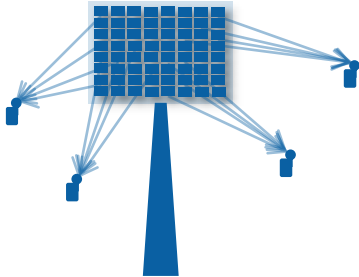


System
Implementation

Prototyping Key Technologies to Drive 5G Standards

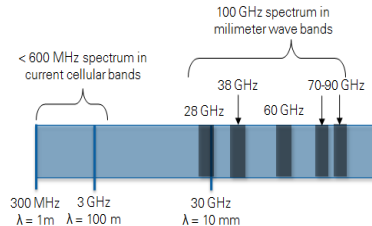
Massive MIMO

Dramatically increase number of antenna elements on base station to enable beamforming



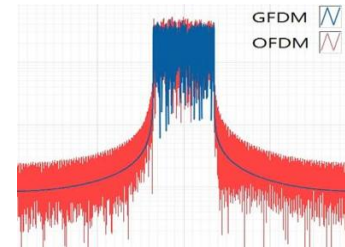
mmWave

Utilize potential of extremely wide bandwidths at frequency ranges once thought impractical for commercial wireless



Multi Radio Access Technologies (RAT)

Improve bandwidth utilization through evolving PHY Level and flexible numerology



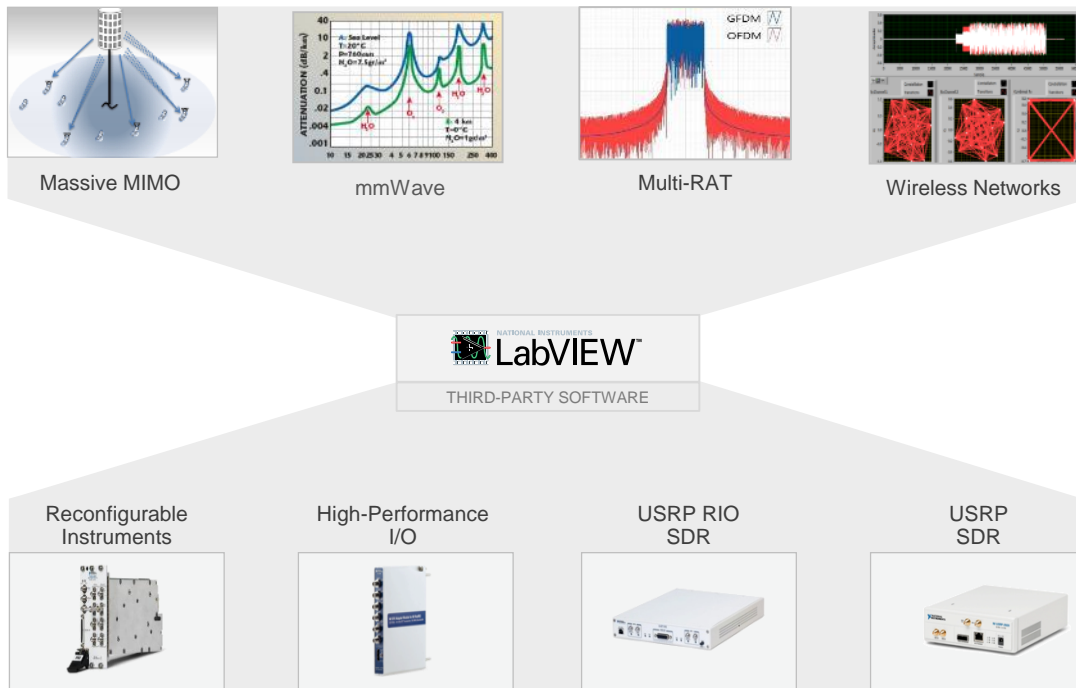
Wireless Networks

Ensure consistent connectivity to meet the 1000X traffic demand for 5G

- Densification
- SDN
- NFV
- CRAN



Prototyping Key Technologies to Drive 5G Standards





University of Bristol Sets New World Record for Spectrum Efficiency, May 2016

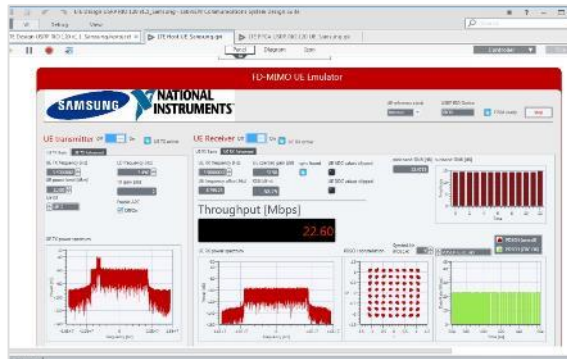
- 3.51 GHz
- 128 antennas
- 256 QAM
- 145.6 bits/s/Hz for 22 users



“In its demonstration, the team used a flexible prototyping platform from National Instruments built with LabVIEW system design software and PXI hardware.”



Other Massive MIMO examples



Samsung

Full Duplex
MIMO, LTE UE
Emulation

Intel

CRAN-Massive
MIMO

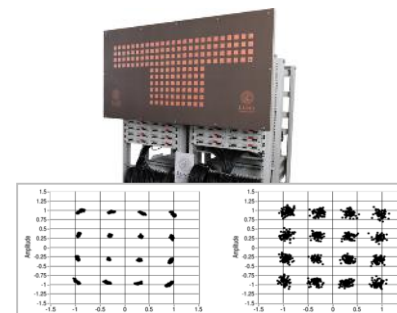


Facebook
ARIES Testbed

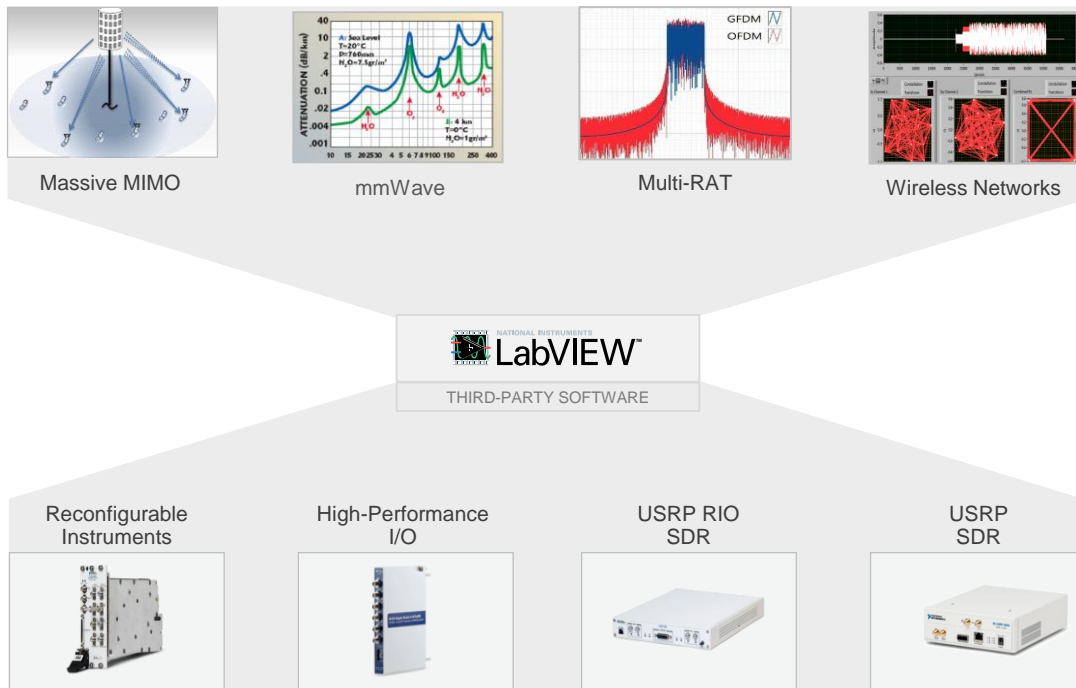
96-Antenna
Massive
MIMO System

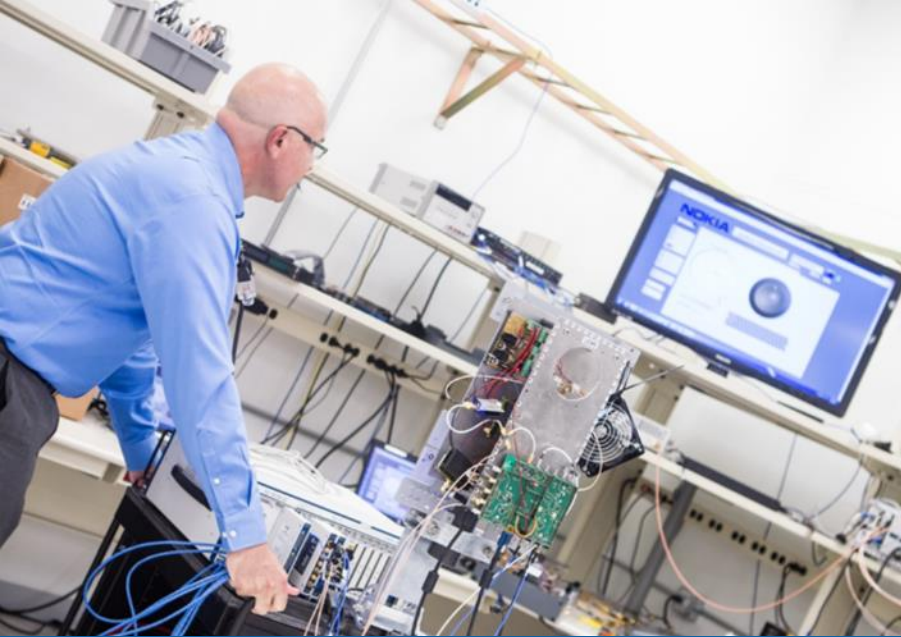
**Lund
University**

100-Antenna
Massive
MIMO System



Prototyping Key Technologies to Drive 5G Standards





NI and Nokia Demonstrate 14.5 Gbps

- 73 GHz
- 2 GHz bandwidth
- 2x2 MIMO
- 64 QAM

“It took about one calendar year, less than half the time it would have taken with other tools.”

—Dr. Amitava Ghosh, Head of Broadband Wireless Innovation

NOKIA

Nokia mmWave Prototype Timeline

Using NI's Platform



Brooklyn 5G Summit 2014



NIWeek 2015



MWC 2016

Frequency

73 GHz

Bandwidth

1 GHz

Streams

1x1

Modulation

16 QAM

Peak Rate

2.3 Gbps

73 GHz

2 GHz

2x2

16 QAM

>10 Gbps

73 GHz

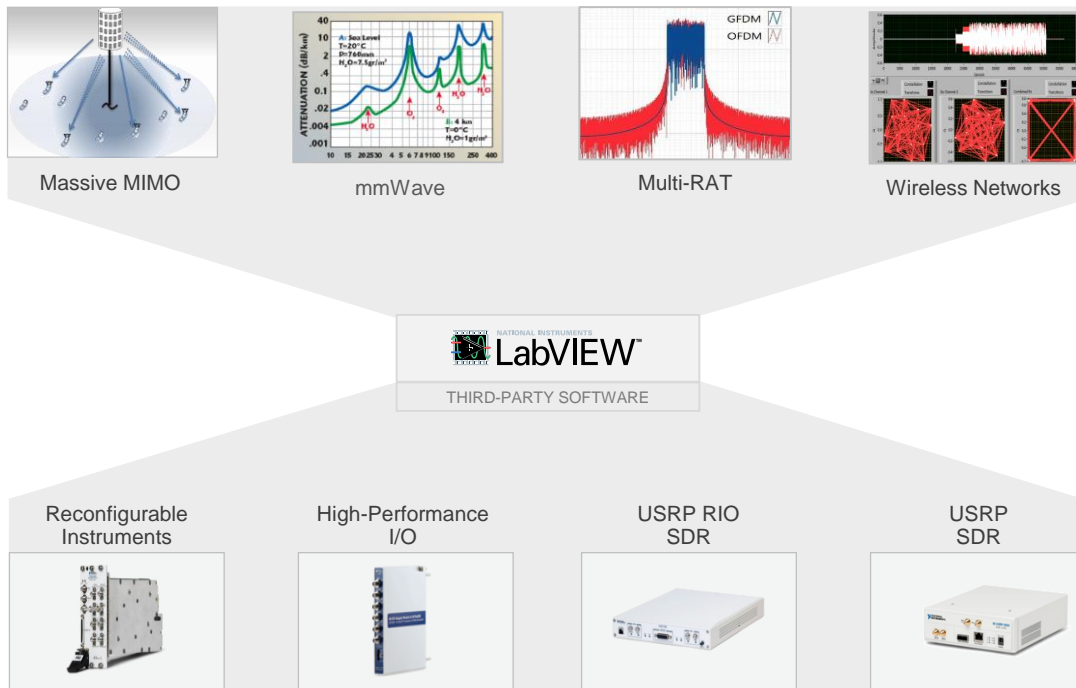
2 GHz

2x2

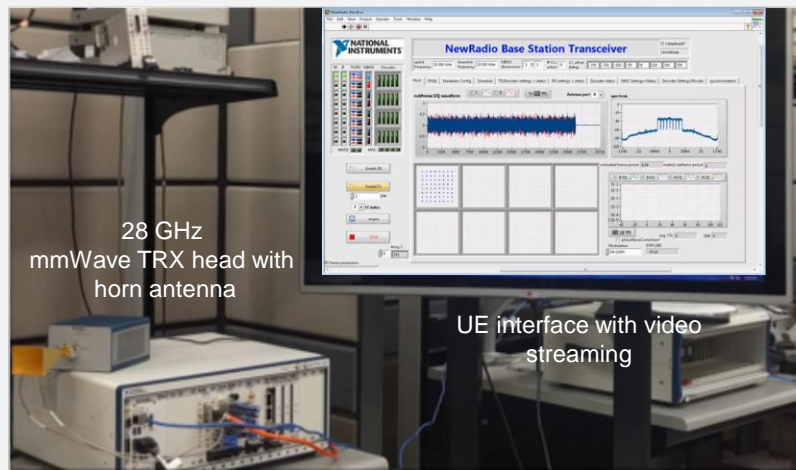
64 QAM

>14.5 Gbps

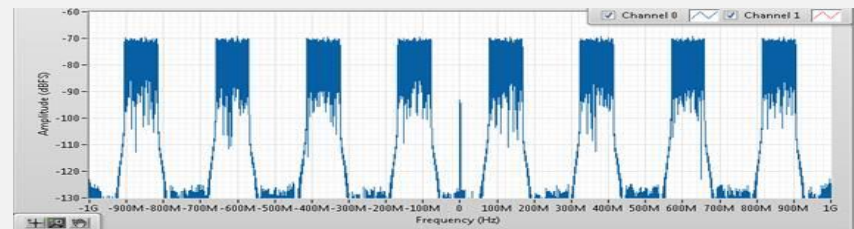
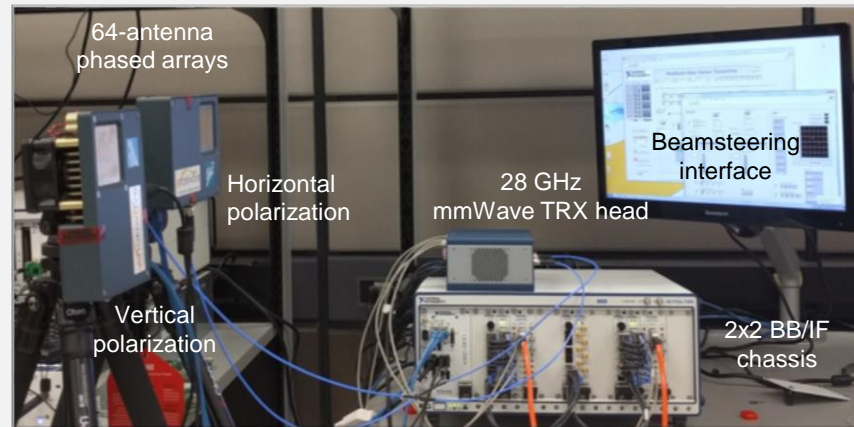
Prototyping Key Technologies to Drive 5G Standards



Verizon and 5G NR—New Generation of Standards



- 2x2 MIMO, 8 CC, 100 MHz per carrier
- 75 kHz subcarrier spacing, 64 QAM
- Hybrid beamforming
- >5 Gbps scalable to 20 Gbps



verizon

Requirements for 5G Prototype and Test

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Real-time processing

Tightly integrated I/O

Synchronization

Agile RF front ends

Scalability

Test

Real-time processing

Tightly integrated I/O

Synchronization

Agile RF front ends

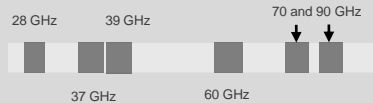
Scalability



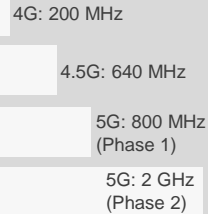
System
Implementation

Key Test Challenges for 5G

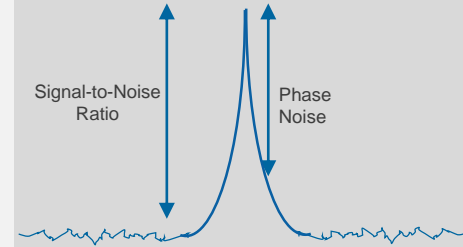
Multiple Antennas, Multistandard Coverage



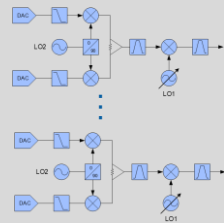
Ultrawide Bandwidths, Multiple Carriers/Beams



OTA Performance Calibration/Control

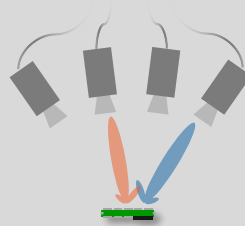


Channel Scaling for MIMO/CA



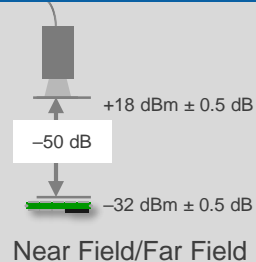
2-128 MIMO channels

Port Mobility



Don't forget cost!

Calibrated Air Interface



5G Test System Architectural Requirements

Modularity

- Add performance as future requirements emerge
- Integrate non-RF I/O into same system to maintain small footprint

Frequency and Channel Agility

- Flexible mmWave head configurations for multi-DUT, multifrequency, and beamforming test
- Tight timing and synchronization for MIMO configurations

Software-Defined Signal Processing

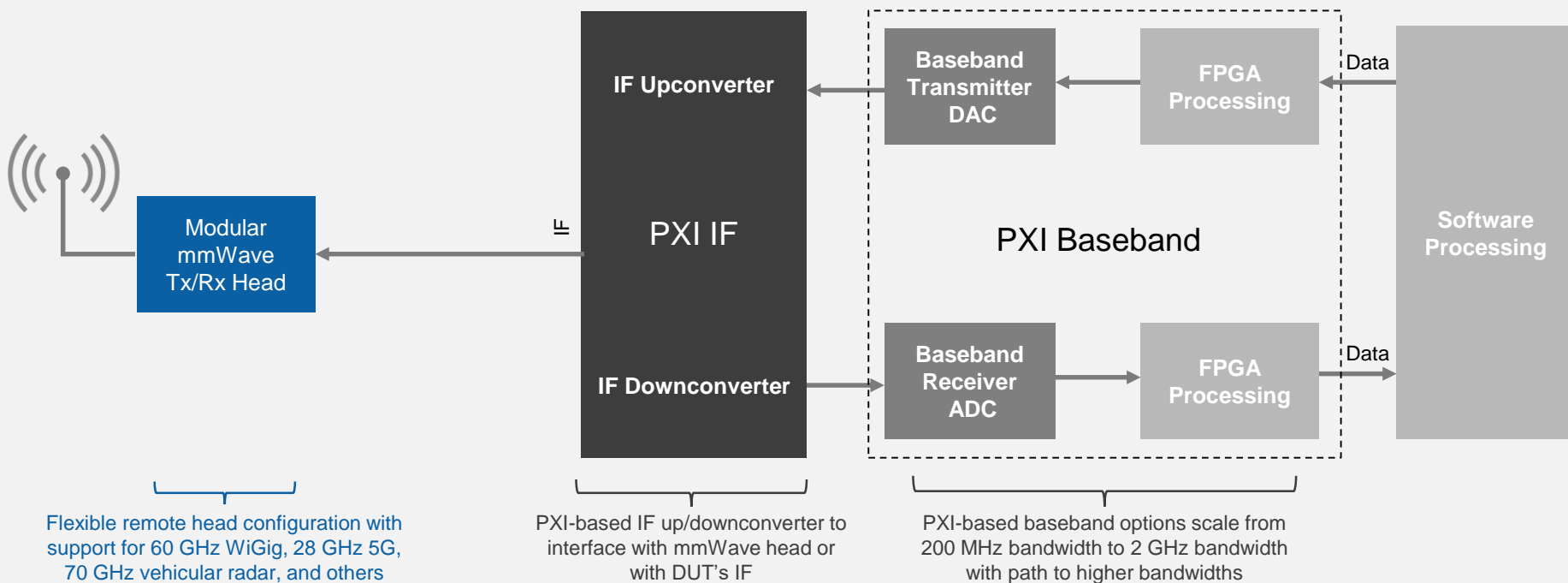
- Accelerated measurements using real-time FPGA processors programmed with LabVIEW FPGA
- Ability to meet demanding EVM requirements through more sophisticated calibration techniques

Key Open Issues for Test

- Test cost of millimeter wave and MIMO
- Over-the-air access/control

Example mmWave Test System Architecture

Modular approach allows designs to scale with new test configurations for 11ad, wider bandwidths for 11ay, and different frequencies for 5G and automotive radar.



World's Most Advanced Channel Sounder

1 x 4, MIMO configuration

7 x 64 permutations

Very fast measurement and switch time
within the coherence time of the channel

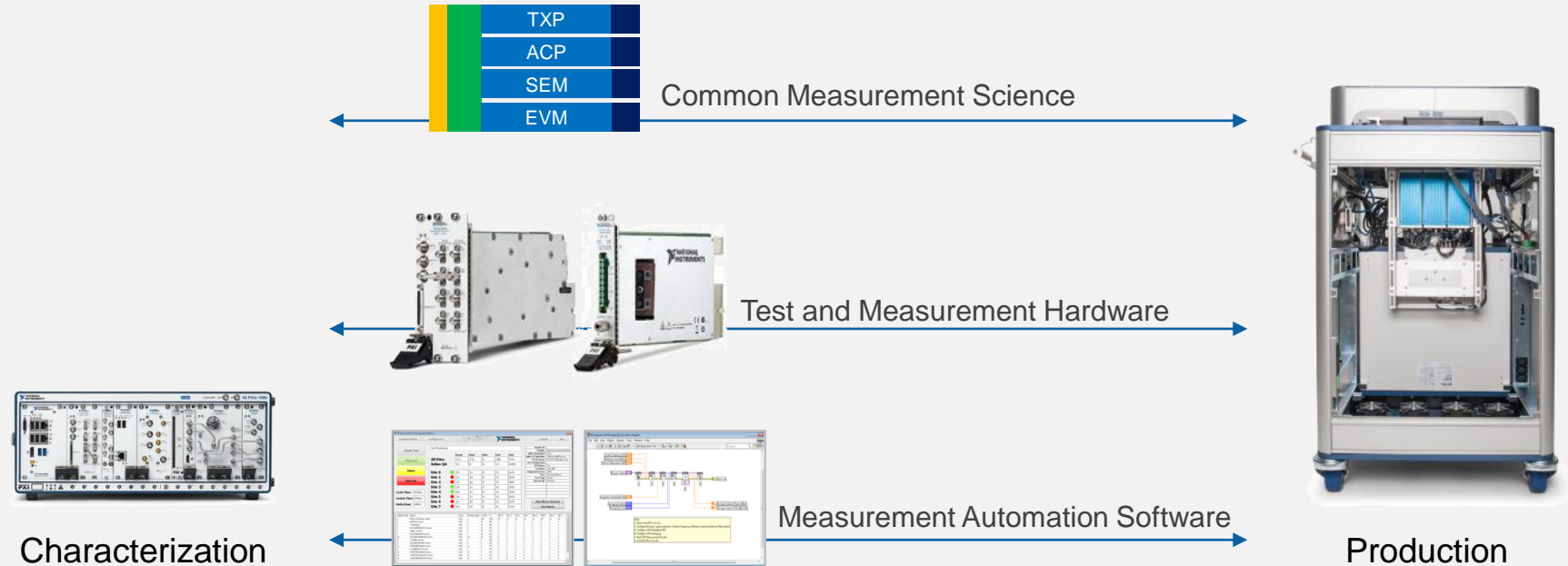
Joint work between NI and AT&T



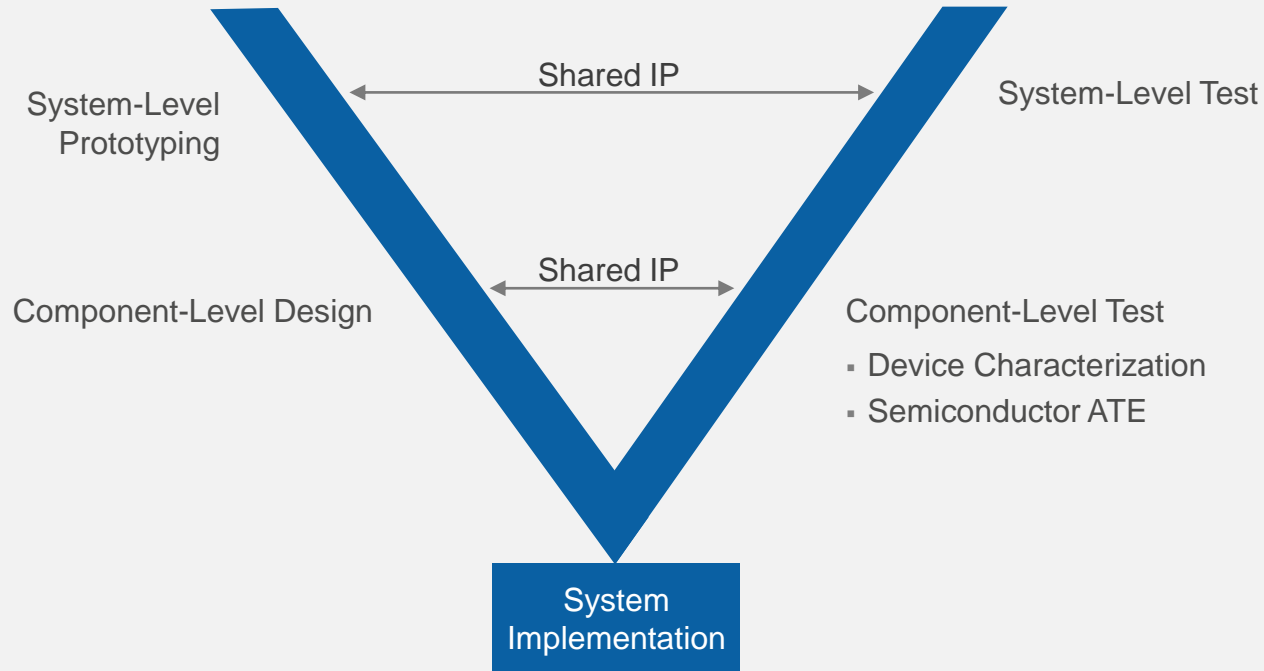
AT&T Video



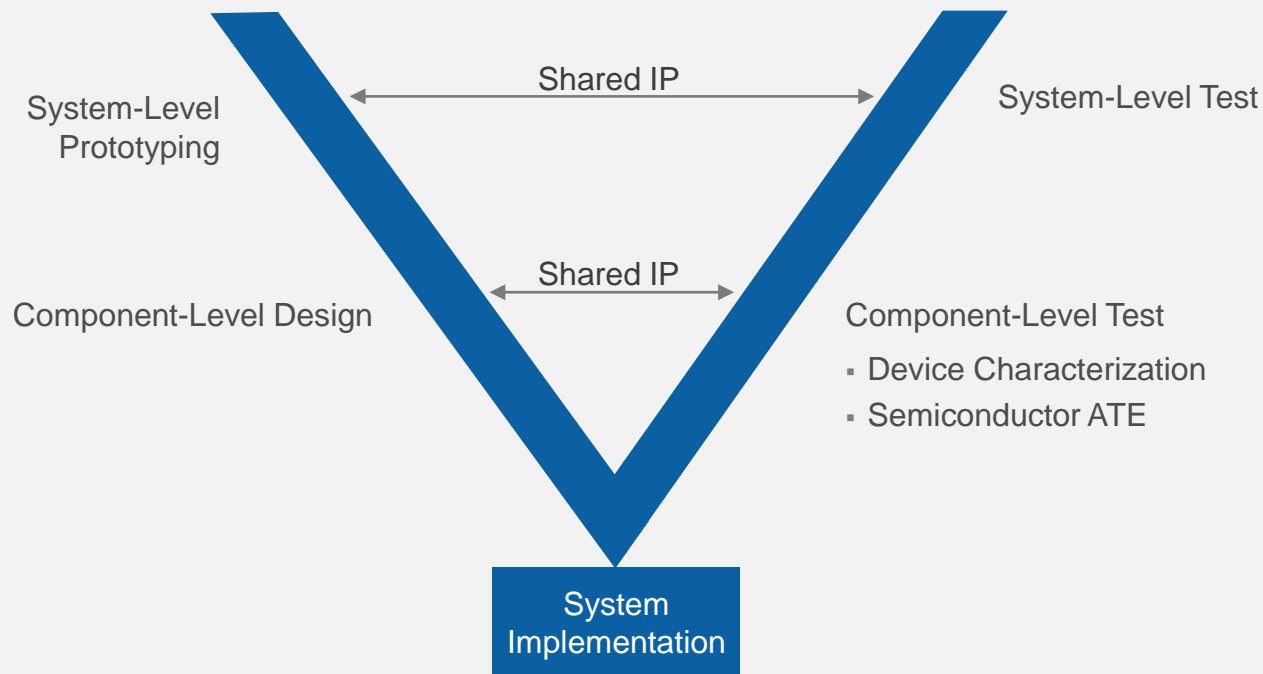
A Single Platform From Characterization to Production Enables Measurement Correlation



A Unified Platform for Concurrent Design and Test



A Unified Platform for Concurrent Design and Test



- Reduce time to market
- Lower design and test costs
- Iterate as technology evolves

