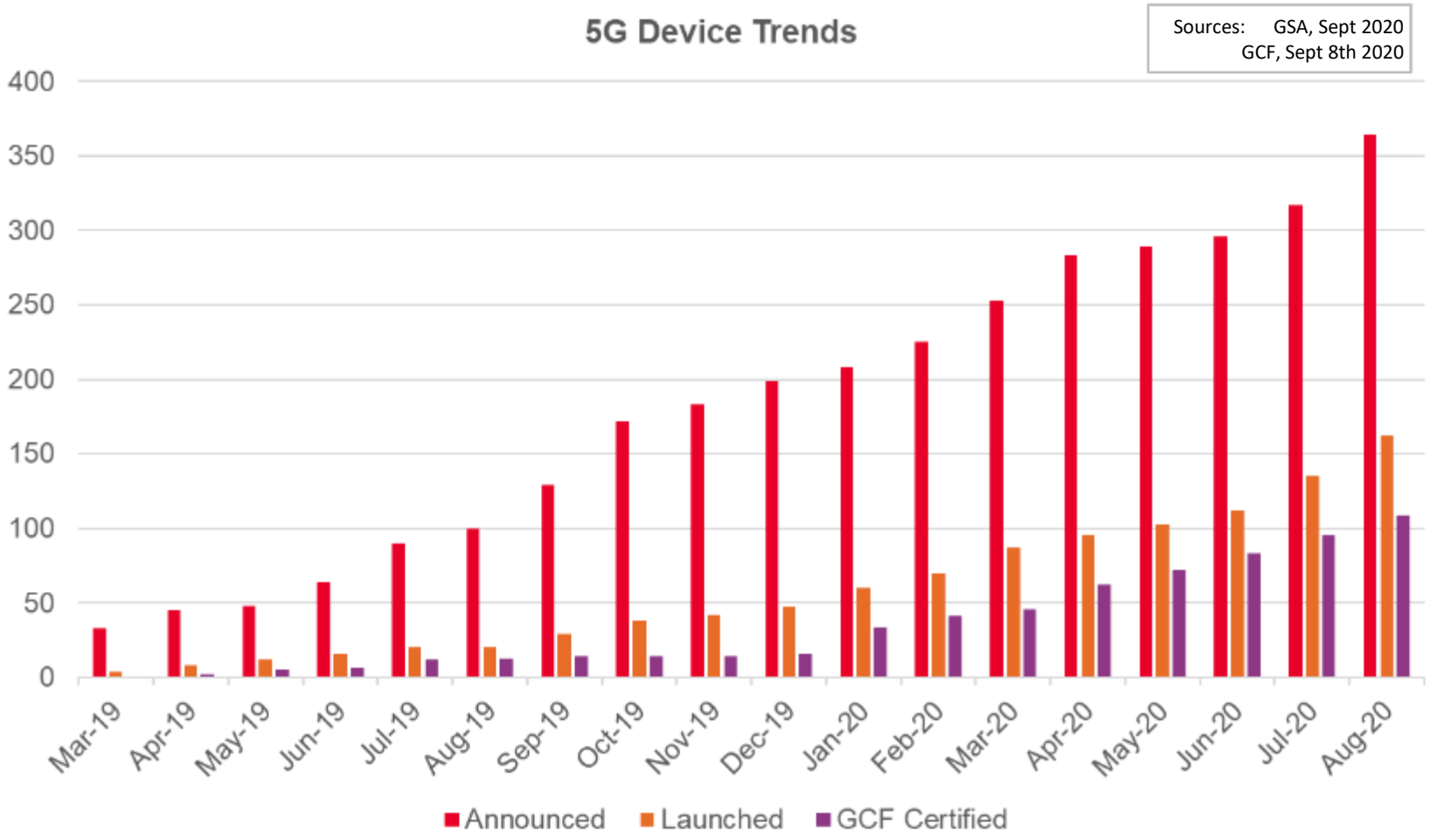
Optimize 5G Device MFG

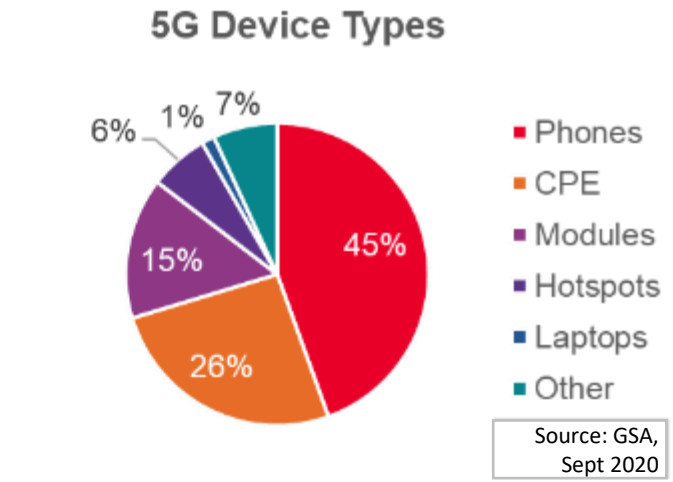
Keysight Technologies	2020.12.22
Dannis Yu	

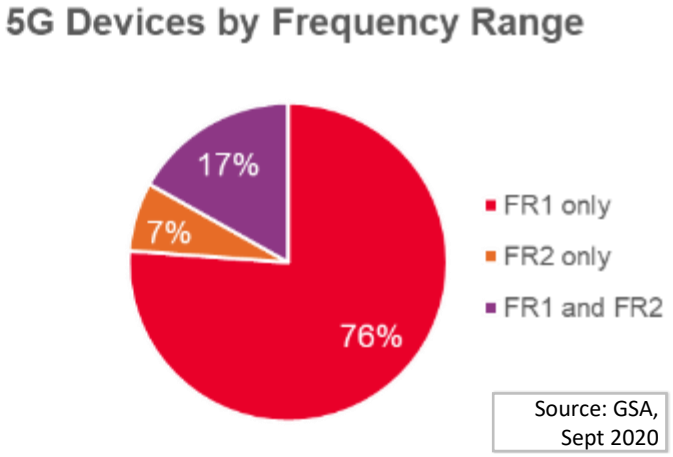
KEYSIGHT TECHNOLOGIES

5G Devices Trend

SOURCES: GSA & GCF BY SEPTEMBER 2020







Optimize 5G Device MFG

KEY CHALLENGES

- **Quickly deploy new 5G production lines**
  - Leverage work across workflow stages
  - Utilize industry proven solutions

Leverage work across workflow stages

STAGES MAY BE MERGED OR FURTHER SPLIT

Challenge
- OTA

Start → Download Stage → 2G/3G/4G/FR1 UE Cal + Verify → Assembly → 2G/3G/4G/FR1 Verification → FR2 Verification

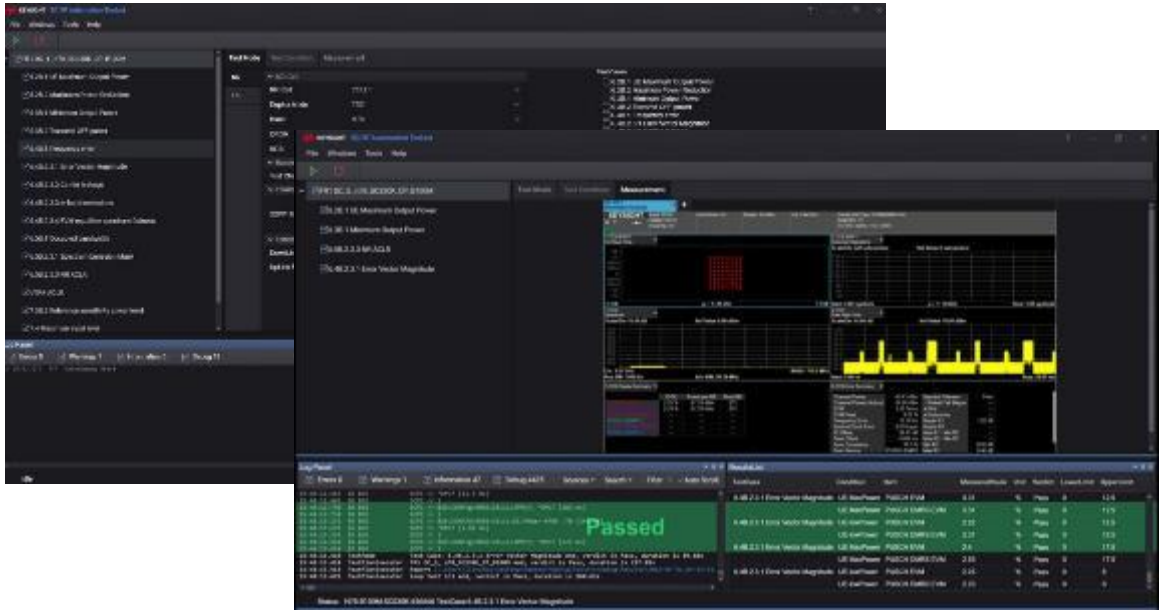
Rework Repair | Rework Repair | Rework Repair | Rework Repair

5G Signaling Verification → WLAN Verification → Bluetooth Verification → Other Test → Address Download → Packing

Challenge
- Signaling

Leverage work across workflow stages

SIGNALING TEST FOR DEVICE MANUFACTURING TEST



S8702A RF Automation Toolset extends the capabilities with **UXM 5G** from R&D to Manufacturing by providing:

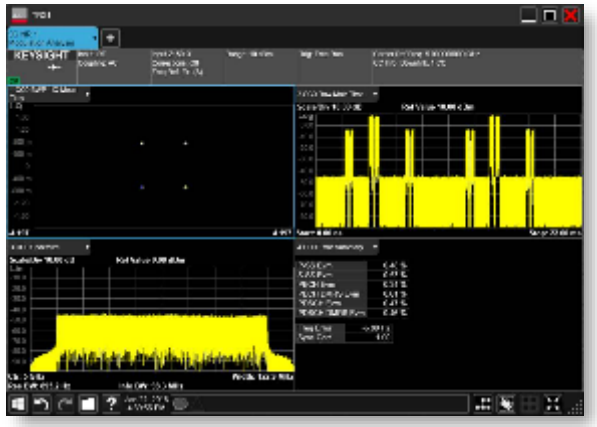
- An intuitive and easy-to-use graphical user interface for creating, configuring and running test campaigns
- A suite of fully-automated signaling RF Transmitter and Receiver tests
- Optimized test execution times, enabling rapid inspection of the RF performance of 5G NR devices
- A report generator to summarize the results of test campaigns
- Support for LTE, NSA and SA modes in the same network emulator, providing a small footprint benchtop solution for production

Utilize industry proven solutions

ALIGNMENT WITH R&D & CHIPSET

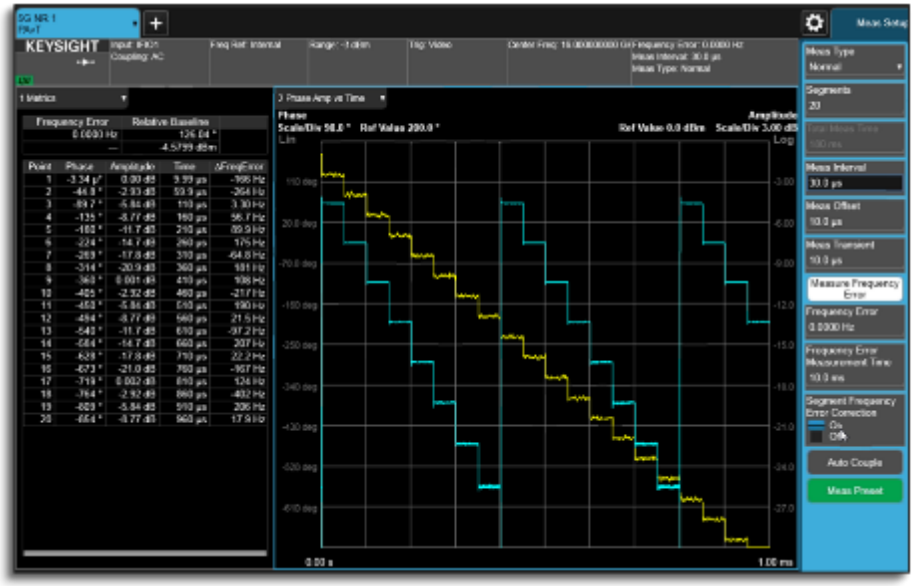
Common measurement science required

- **Same 5G NR Measurement Application for Keysight HW platforms**
  - N/V9085EM0E X-Series 5G NR Measurement Application on various HW platforms
  - Shared Demodulation Algorithm Library
- **Same 5G NR Signal Generation for Keysight HW platforms**
  - N7631C Signal Studio waveform license available on various platforms
  - Shared Signal Generation IP



Integrated into Chipset Vendor's Tool Required

- **Qualified by Chipset Specific Tool**
- **Support Chipset Specific Testing**
  - Sequence Analyzer Mode support Fast-Cal and Verification test
    - Single capture, multiple measurement (List Mode)
    - In-parallel capturing & measurement with multithreads support



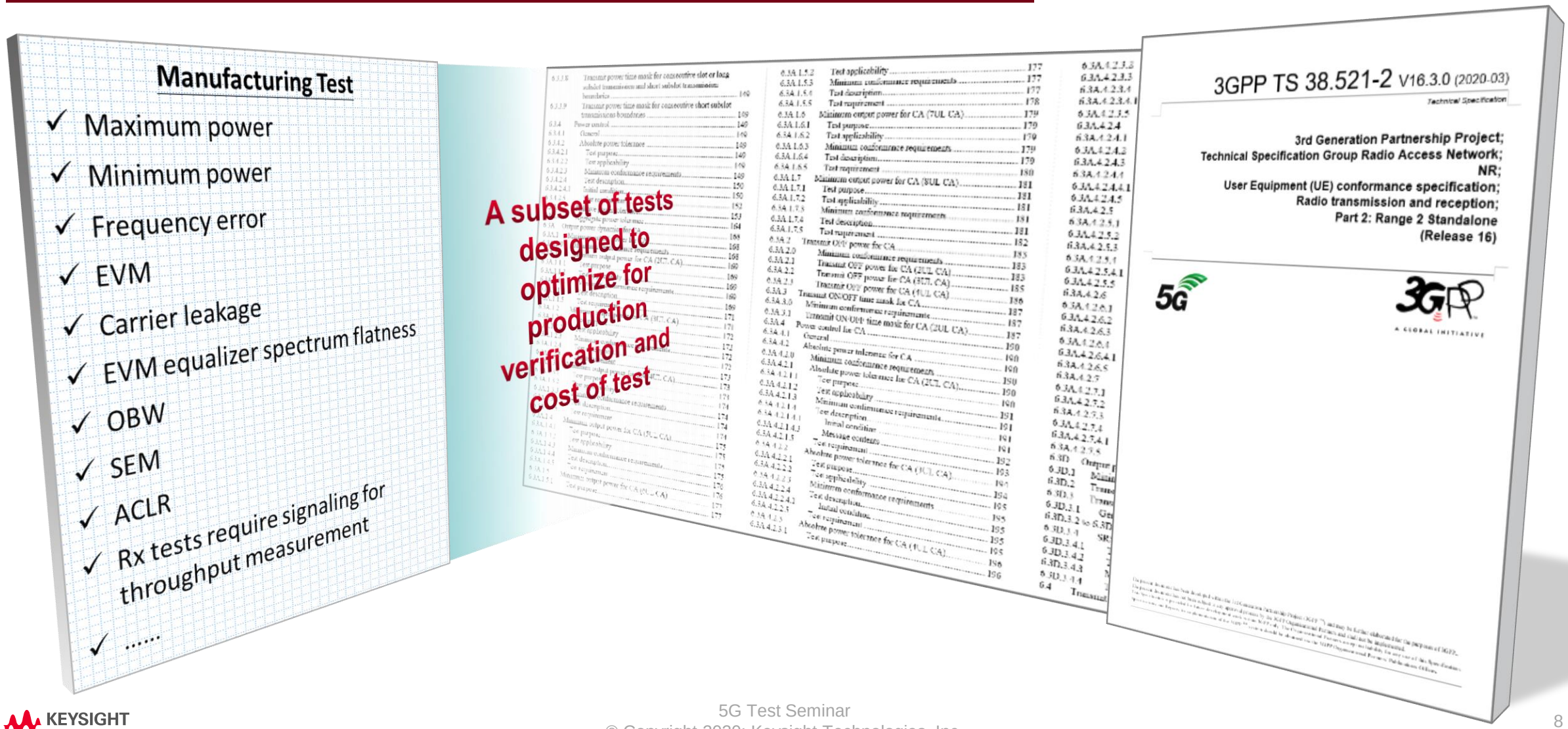
Optimize 5G Device M

KEY CHALLENGES

- Quickly deploy new 5G production lines
  - Leverage work across workflow stages
  - Utilize industry proven solutions
- **Efficiently ramp to high volume**
  - Optimize test plans for speed
  - Customize scripts, automate efficiently and debug

Optimize test plans for speed

FROM 3GPP TS 38.521 TEST SPECIFICATION



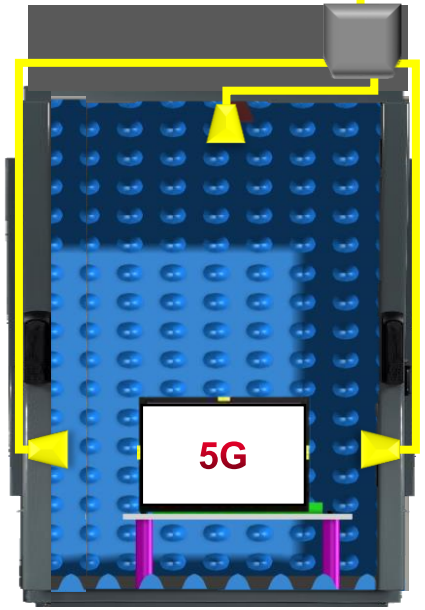
Optimize 5G Device MFG

KEY CHALLENGES

- Quickly deploy new 5G production lines
  - Leverage work across workflow stages
  - Utilize industry proven solutions
- Efficiently ramp to high volume
  - Optimize test plans for speed
  - Customize scripts, automate efficiently and debug quickly
- **Test FR2 over the air**
  - Rapidly adopt and deploy new radiated test techniques
  - Minimize costs due to more floor space, higher frequency and bandwidth, and longer test times
  - Accurately compensate for loss with system calibration

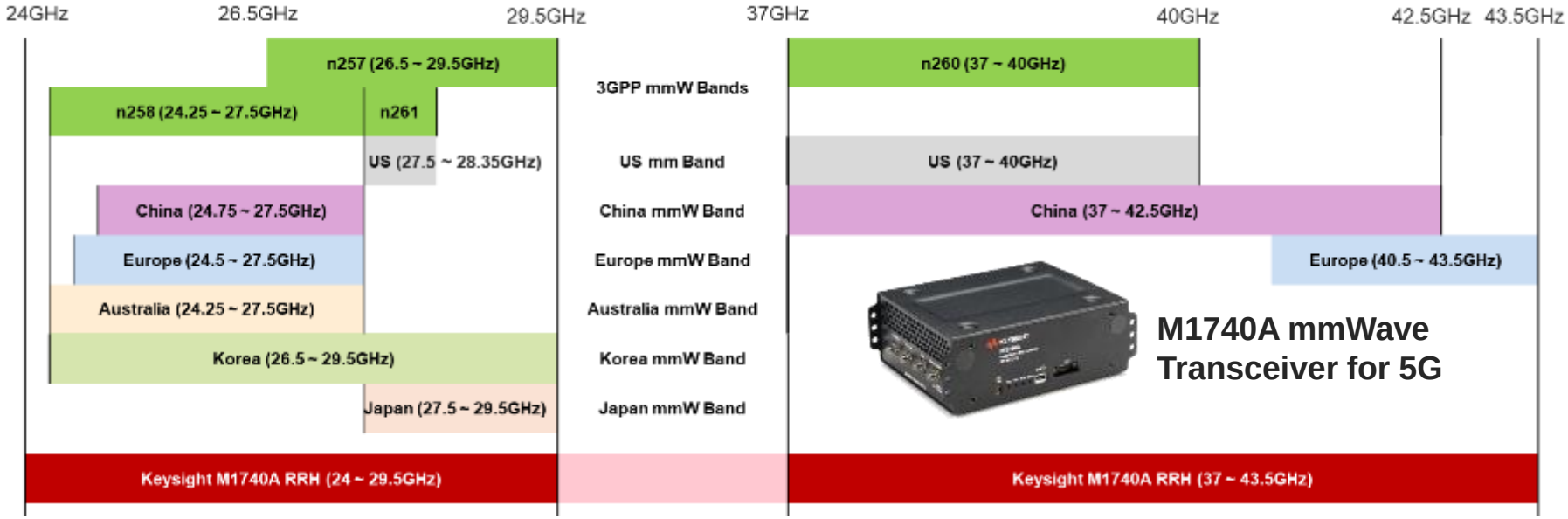
Test FR2 over the air

MINIMIZE COSTS, FLOOR SPACE & UNCERTAINTIES



Flexible Layout & Minimize mmW Cable Length

- mmWave Transceiver design for FR2 testing
- N-Type Cables between RRH and EXM for flexible layout
- Shortest mmW Cable Fixed between Chamber wall to Horn
- mmW Chamber with mmW Switch supporting UE supporting multiple AiP Modules & Dual Polarization

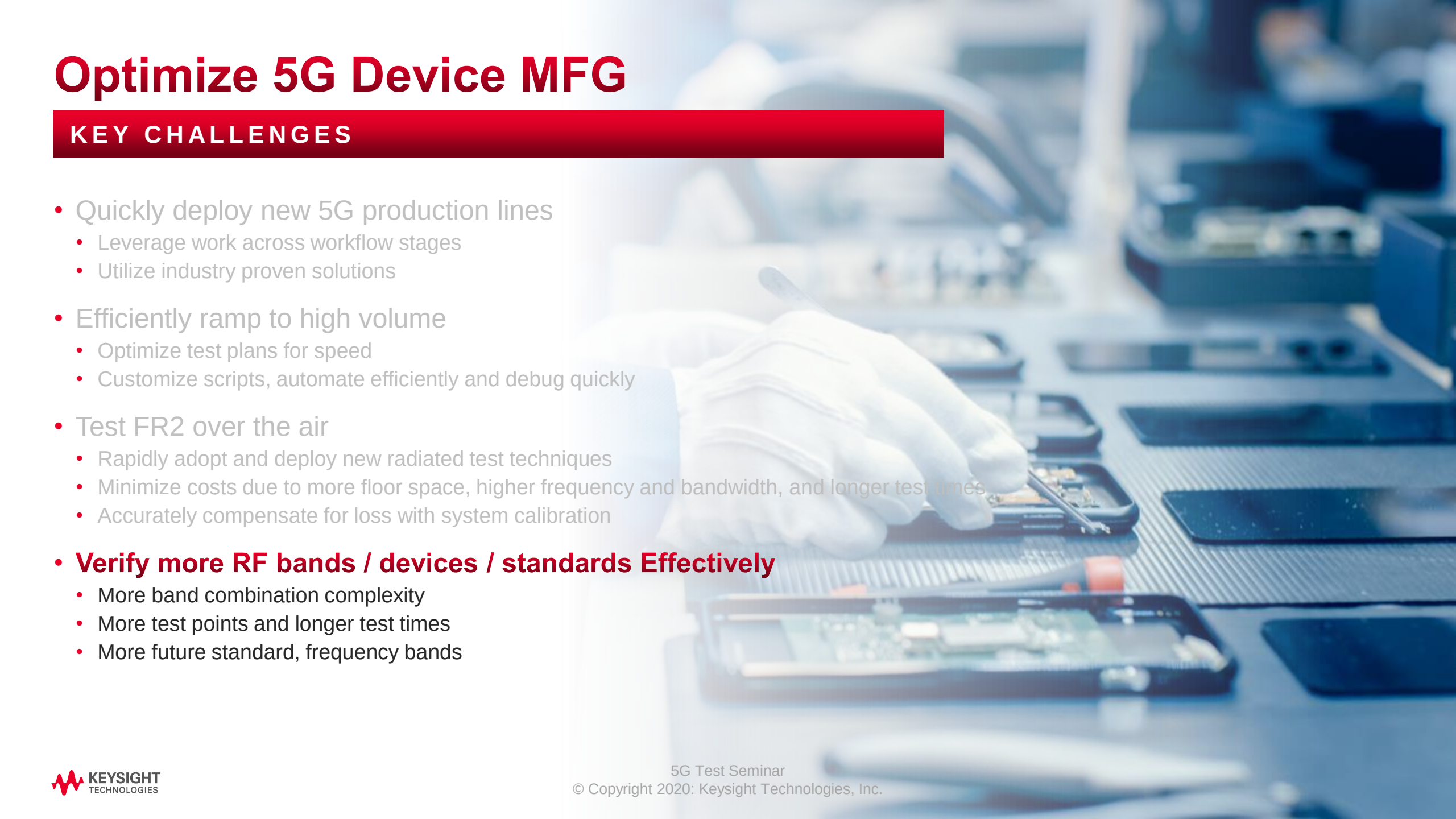


M1740A mmWave Transceiver for 5G

Optimize 5G Device MFG

KEY CHALLENGES

- Quickly deploy new 5G production lines
  - Leverage work across workflow stages
  - Utilize industry proven solutions
- Efficiently ramp to high volume
  - Optimize test plans for speed
  - Customize scripts, automate efficiently and debug quickly
- Test FR2 over the air
  - Rapidly adopt and deploy new radiated test techniques
  - Minimize costs due to more floor space, higher frequency and bandwidth, and longer test times
  - Accurately compensate for loss with system calibration
- **Verify more RF bands / devices / standards Effectively**
  - More band combination complexity
  - More test points and longer test times
  - More future standard, frequency bands

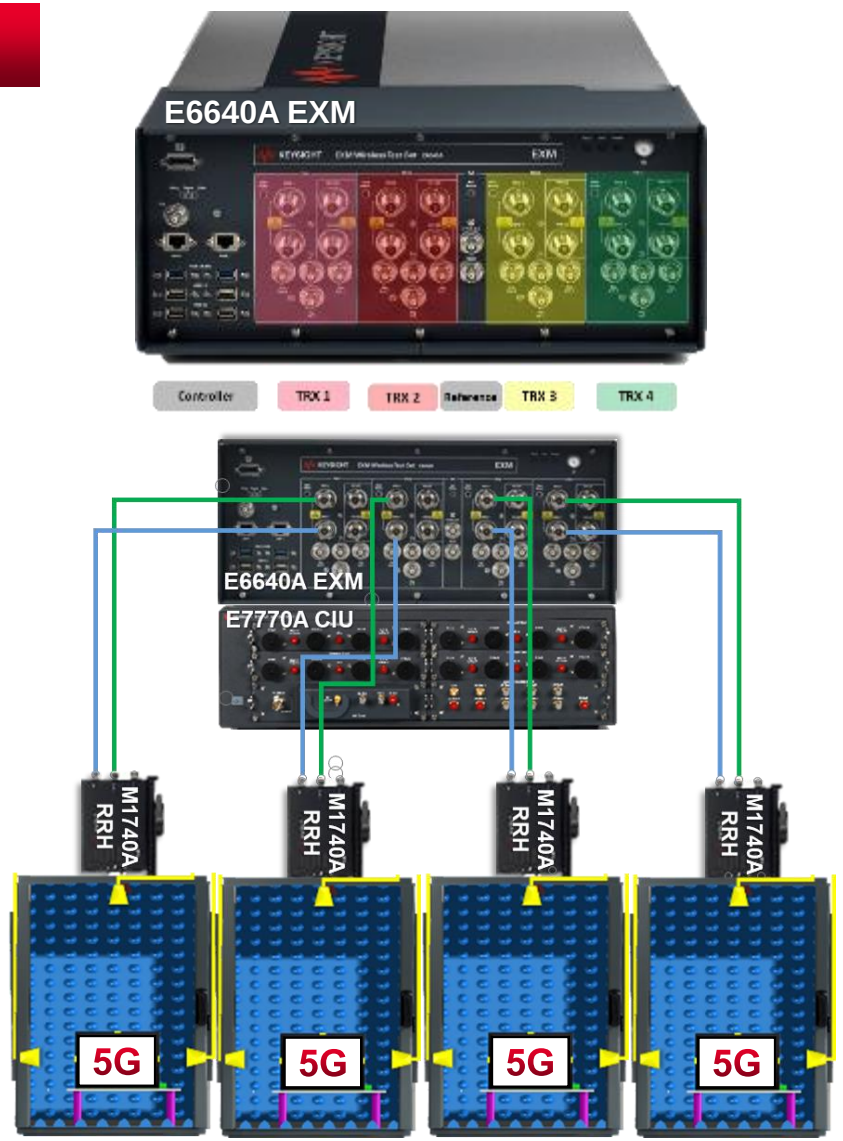


Verify more devices effectively

MULTIPLE DEVICES TESTING – MULTI-VSA/VSG

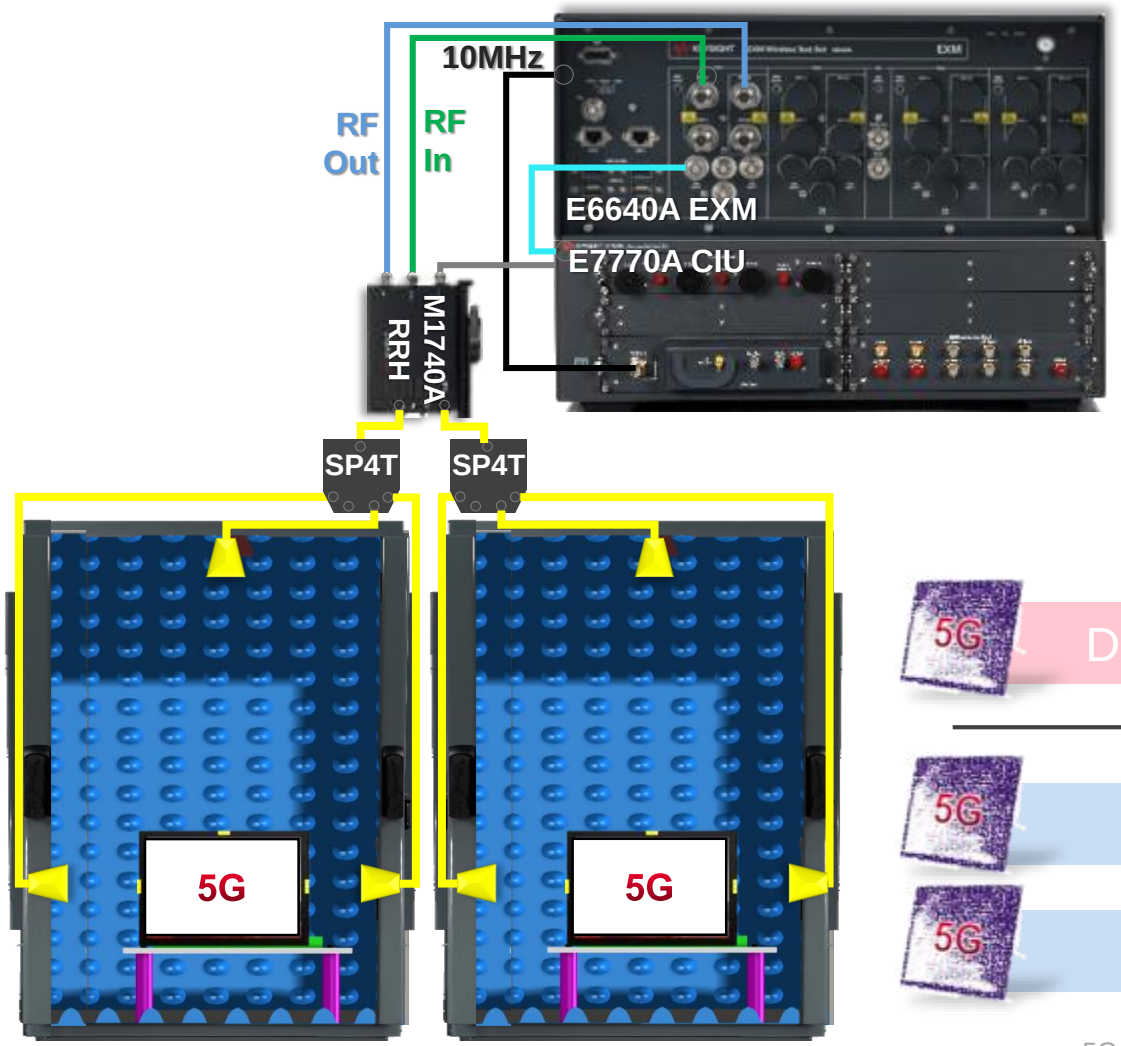
Key Advantages

- ✓ Smaller Footprint with higher port density to increase manufacturing volume per unit area
- ✓ Flexible TRX Port Expansion for future plan



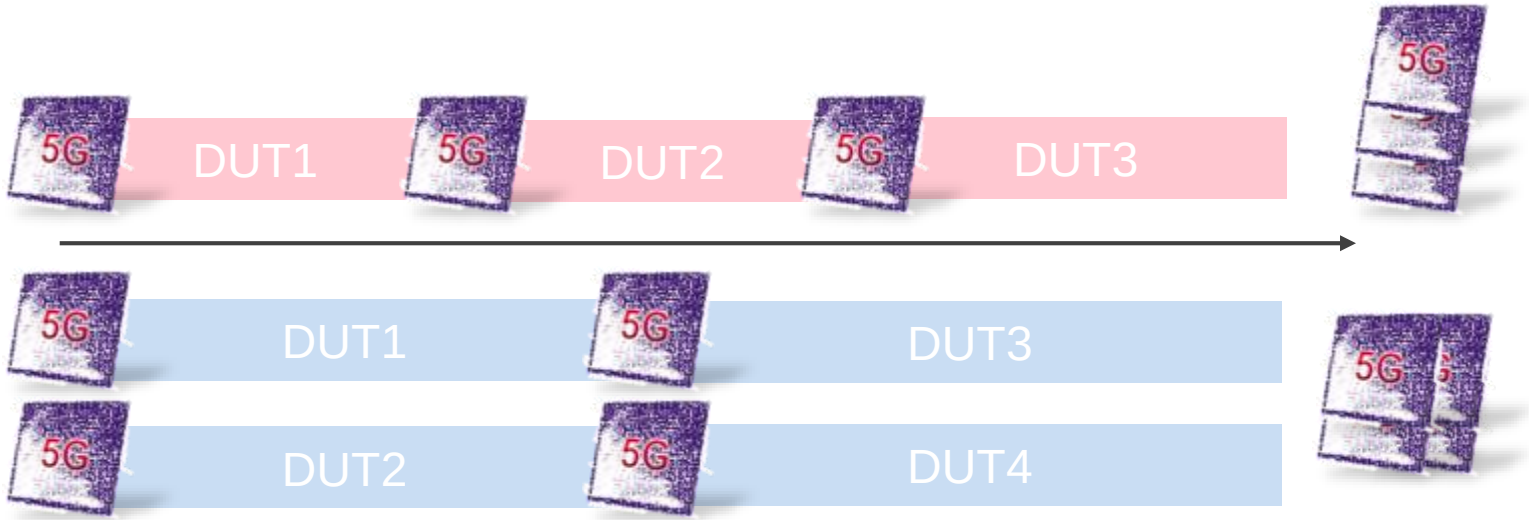
Verify more devices effectively

MULTIPLE DEVICES TESTING – SINGLE VSA/VSG



Key Advantages

- ✓ N-Type Cables between RRH and EXM for flexible layout
- ✓ Shortest mmW Cable Fixed between Chamber wall to Horn
- ✓ mmW Chamber with mmW Switch supporting UE supporting multiple AiP Modules even Dual Polarization
- ✓ **T'put Multiplied by adding 2nd Chamber with fast switching test between 2 DUTs**



Verify legacy & future standards effectively

MULTIPLE RADIO STANDARD TESTING

Legacy Radio Standard Support Required

- E6640A EXM Wireless Test Set support cellular format from 2G, 3G,4G to 5G and wireless connectivity format from Bluetooth, 802.11b/g/ac to 11ax

- WLAN 802.11a/b/g/n/j/p/ac/ah/ax
- Bluetooth 1.0 to 5.0
- ZigBee, Z-wave, Thread PHY 802.15.4, WiSUN (MR-FSK)
- Digital video, FM, Mobile WiMAX
- Multi-Satellite GNSS: GPS, Galileo, GLONASS, BeiDou, SBAS, QZSS

- LTE/LTE-A FDD/TDD,
- HSPA+, W-CDMA
- 1xEV-DO, cdma2000
- GSM/EDGE/EDGE
- TD-SCDMA/TD-HSPA

- NB-IoT / CAT-M

- 5G NR FR1/FR2

Future Proof for Wider Bandwidth & Frequency

- RRH to extend FR2 Band over 43.5GHz possible
- How to support 6GHz (5.925 ~ 7.125GHz) band?
- How to support 320MHz Bandwidth, e.g. 802.11be?

Today	Next	Tomorrow
802.11ax	802.11ax	802.11be
2.4, 5 GHz bands	2.4, 5, **6 GHz** bands	2.4, 5, 6 GHz bands
160MHz BW	160 MHz BW	**240, 320 MHz** BW
1024QAM	**4096QAM**	4096QAM

Introducing S8780A Wireless Device Solution

FOR WI-FI 5/6E, 802.11AX/BE, BT5.0, 2/3/4/5G

800 MHz bandwidth, 32 ports, 7.3 GHz

802.11a/b/g/n/p > 802.11ac/ax > Wi-Fi 6E > 802.11be

BT > BT 5.0 > BT 5.1

2G > 3G > 4G > 5G

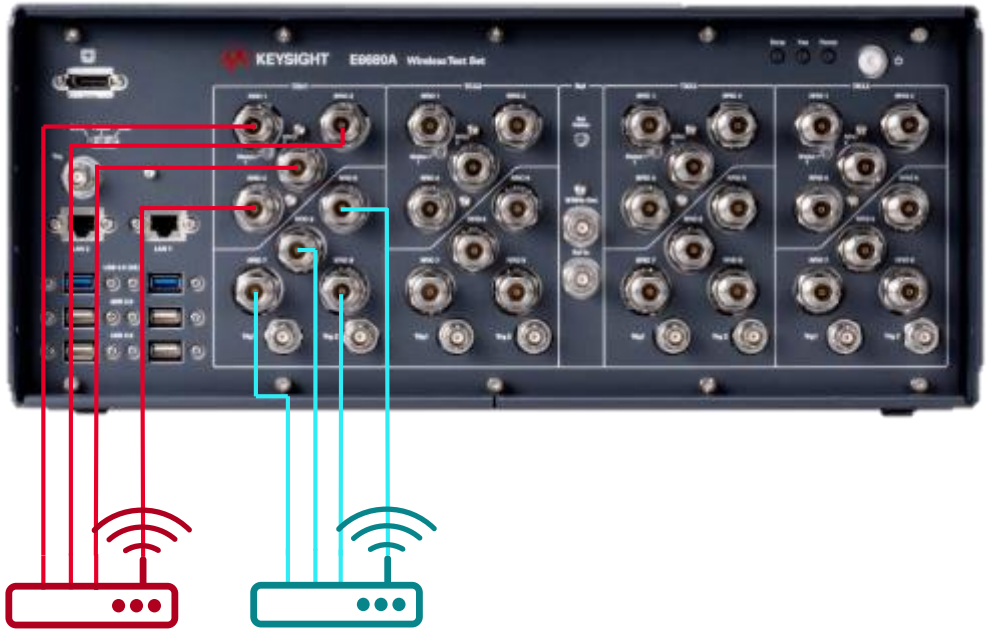
Keysight's S8780A uses new hardware, the E6680A Wireless Test Set, optimized for calibration and verification test while looking to the future with a wideband test solution for 5G NR, Wi-Fi 6E & 802.11be devices. The hardware and software support:

- ✓ 200, 400, or 800 MHz bandwidth
- ✓ 380 MHz to 7.3 GHz frequency range
- ✓ Up to 4096QAM
- ✓ MU-MIMO and OFDMA with statistics and RF performance for each user
- ✓ Up to 4x4 MIMO and 8x8 switched MIMO
- ✓ Dual-band and triple-band simultaneous testing
- ✓ Power, transmit spectral mask, spectral flatness, EVM measurements and analysis

Introducing S8780A Wireless Device Solution

MORE ADVANCED SCENARIOS FOR MULTI DEVICES

- Calibrate and verify each individual Tx and Rx path, up to eight connections
  - Maximize output power by configuring ports for half duplex
  - Maximize flexibility by configuring ports for full duplex
- Calibrate and verify up to two devices per transceiver by broadcasting on four ports and using internal switching
- Test twice as many devices per TRX

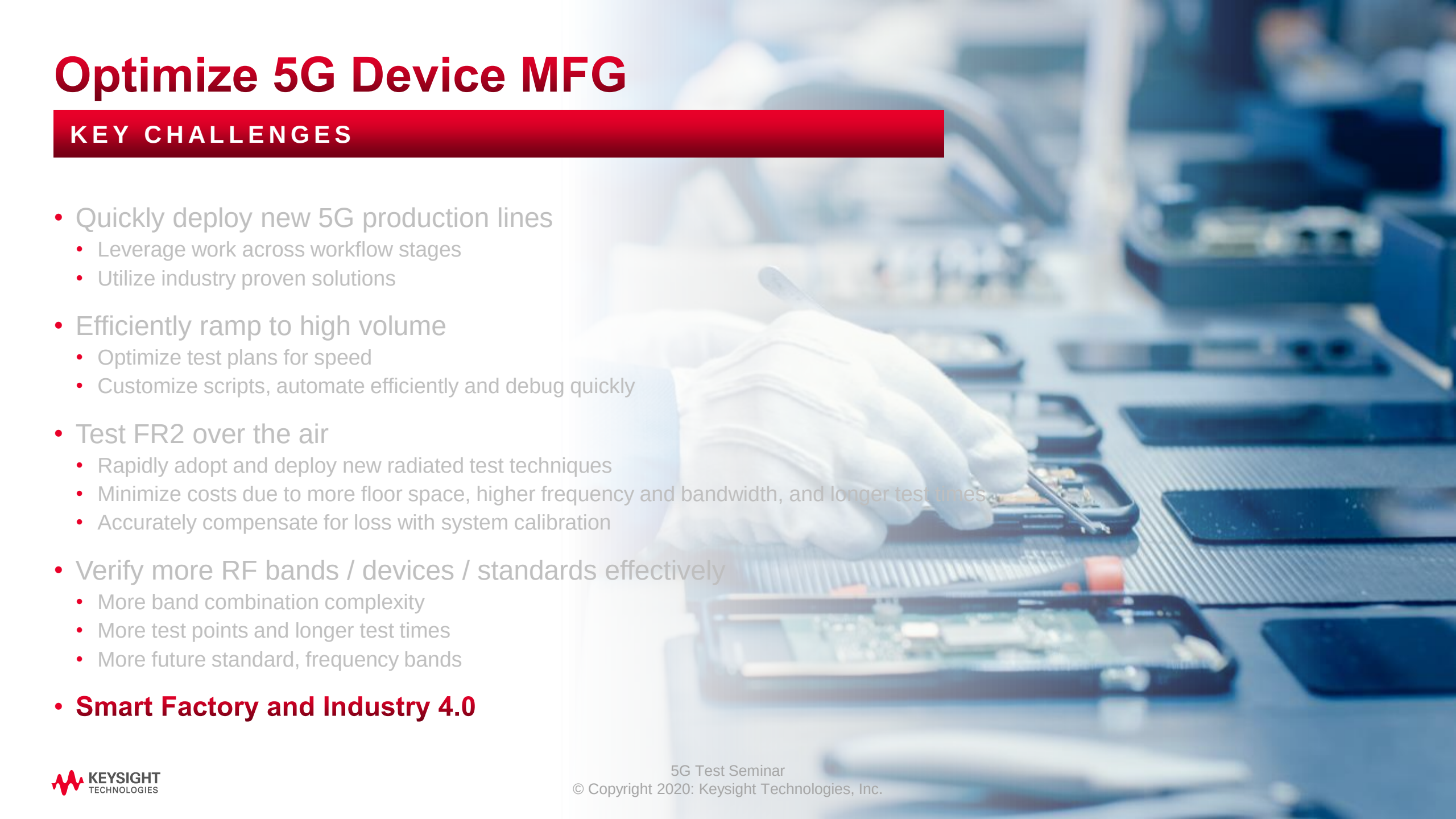


Tx test: Using internal switching through 8 ports, measure Transmit power, Transmit spectrum mask, EVM,…

Rx test: Broadcast signal on 4 ports to calibrate received power, use internal switching on the other 4 ports to measure sensitivity

Optimize 5G Device MFG

KEY CHALLENGES



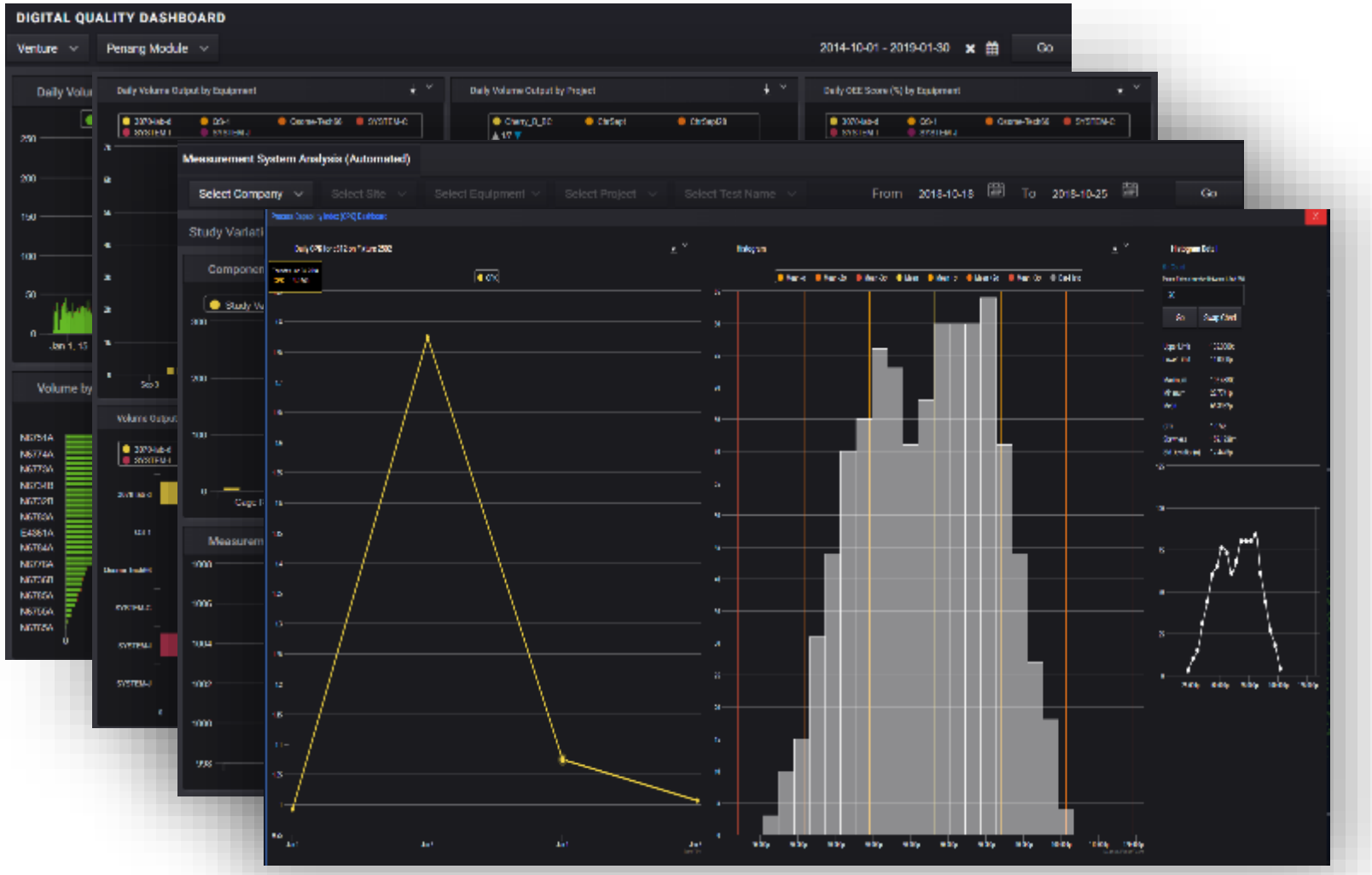
- Quickly deploy new 5G production lines
  - Leverage work across workflow stages
  - Utilize industry proven solutions
- Efficiently ramp to high volume
  - Optimize test plans for speed
  - Customize scripts, automate efficiently and debug quickly
- Test FR2 over the air
  - Rapidly adopt and deploy new radiated test techniques
  - Minimize costs due to more floor space, higher frequency and bandwidth, and longer test times
  - Accurately compensate for loss with system calibration
- Verify more RF bands / devices / standards effectively
  - More band combination complexity
  - More test points and longer test times
  - More future standard, frequency bands
- **Smart Factory and Industry 4.0**

5G Device Manufacturing Test Challenges

MOVING TOWARD INDUSTRY 4.0

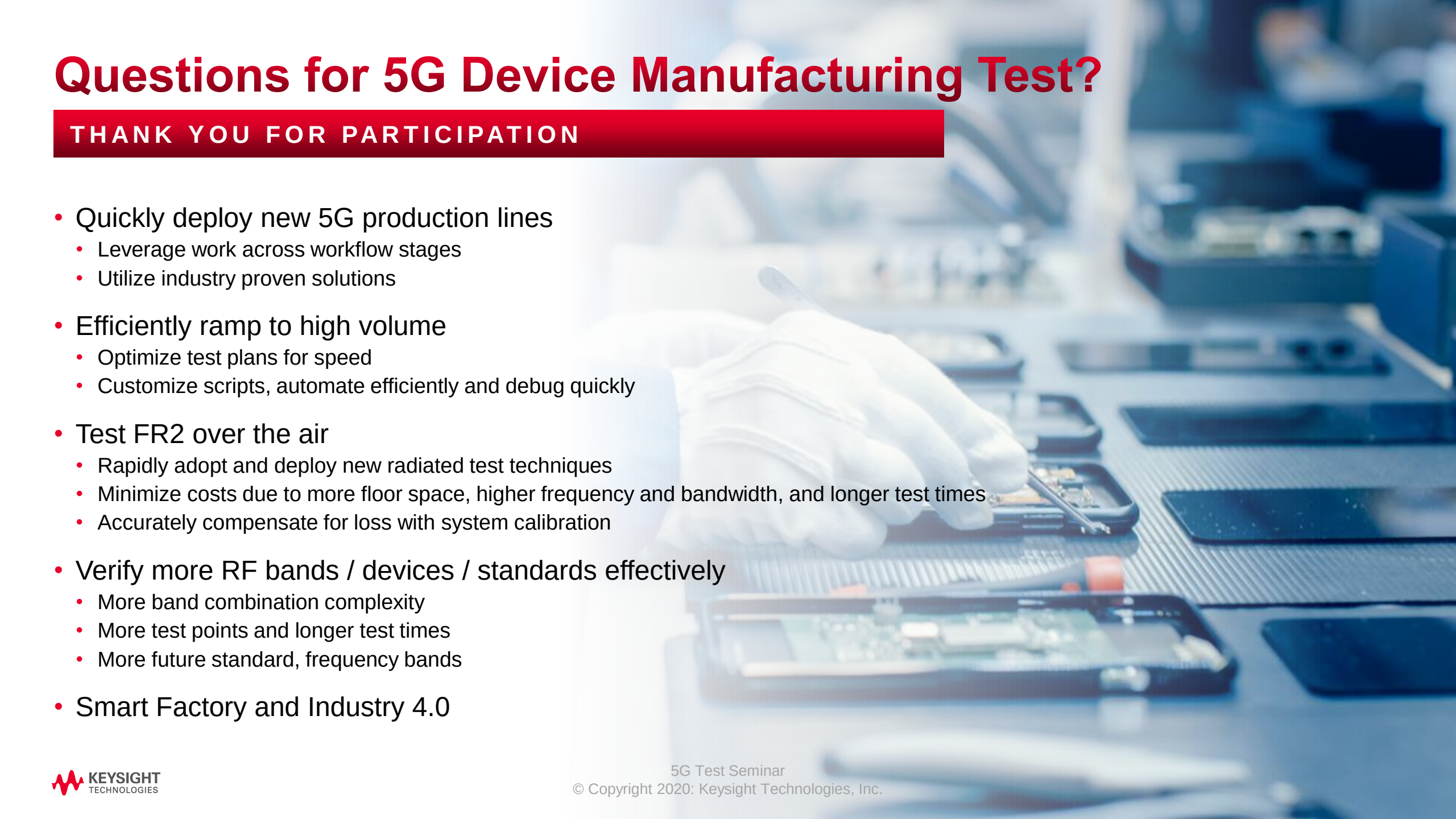
PATHWAVE
Manufacturing Analytics

- Analytics as a Service software with Real-Time, Actionable Insights and accelerate time-to-market
- Industry 4.0 ready solution for manufacturing vision to Smart Factory
- Real time anomaly detection and predictive alert allow customer to make decision accurate and faster



Questions for 5G Device Manufacturing Test?

THANK YOU FOR PARTICIPATION



- Quickly deploy new 5G production lines
  - Leverage work across workflow stages
  - Utilize industry proven solutions
- Efficiently ramp to high volume
  - Optimize test plans for speed
  - Customize scripts, automate efficiently and debug quickly
- Test FR2 over the air
  - Rapidly adopt and deploy new radiated test techniques
  - Minimize costs due to more floor space, higher frequency and bandwidth, and longer test times
  - Accurately compensate for loss with system calibration
- Verify more RF bands / devices / standards effectively
  - More band combination complexity
  - More test points and longer test times
  - More future standard, frequency bands
- Smart Factory and Industry 4.0


KEYSIGHT
TECHNOLOGIES