

Master Your V2X Design & Validation Challenges - DSRC, C-V2X, eCall

Jian-Hua Wu / Alex Liang

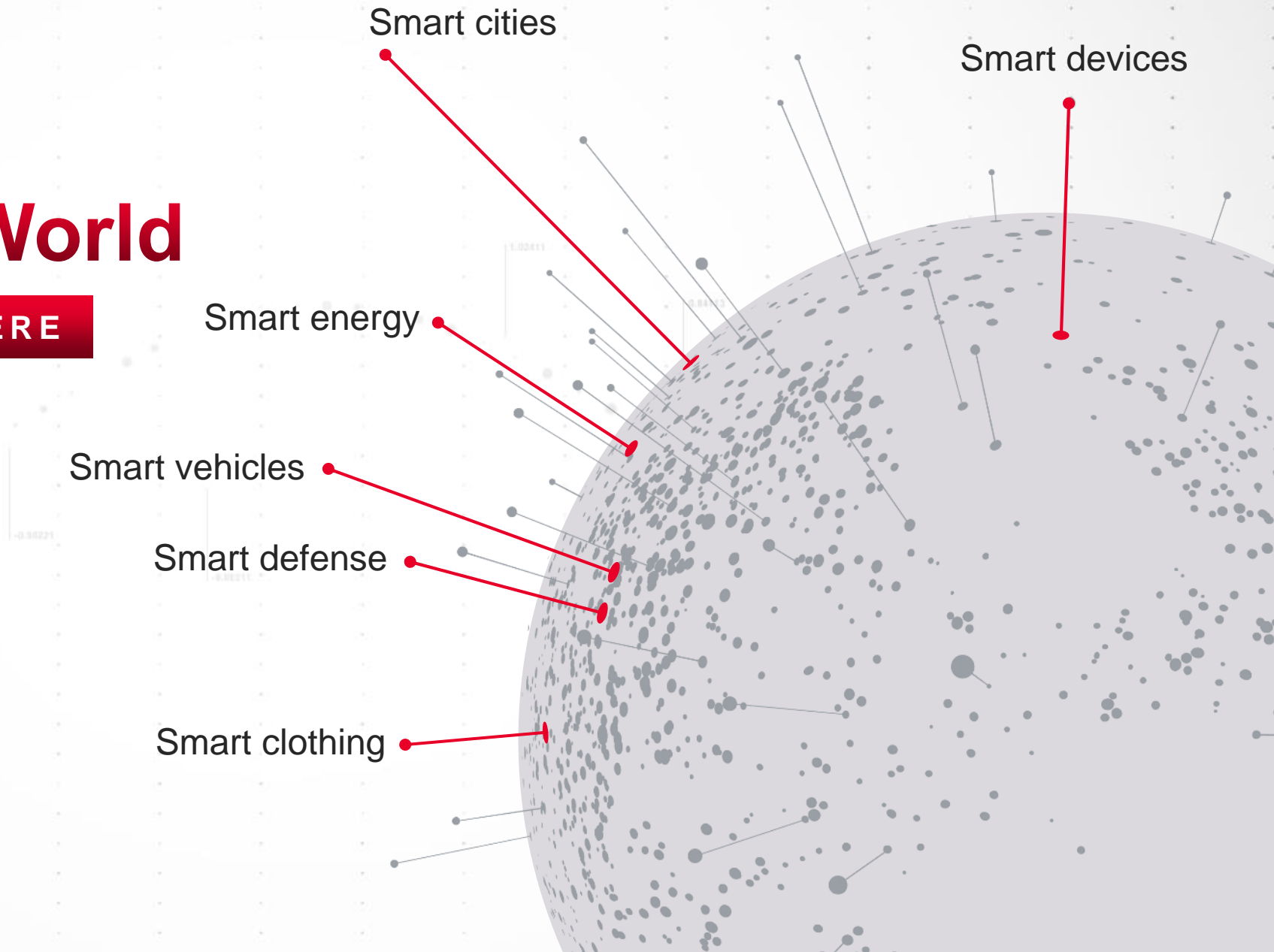
2019/1/15&16

Senior Project Manager / Senior Engineer



Technology Connects the World

INNOVATION IS EVERYWHERE



Technology Requirements Keep Advancing

MORE ELECTRONICS, MORE EFFICIENCY, MORE SENSORS



Electronics

- Better diagnostics
- Automotive Ethernet
- Infotainment



Batteries

- Longer range
- Higher densities
- More eco-friendly



Connectivity

- More information
- Better safety
- Easier navigation



Sensors

- Electro-mechanical
- Driver vision
- More autonomy

Evolution of Sensors in Vehicles



Mechanical Designs Starting in 1976

- Basic electronics
- Mostly mechanical
- No connectivity



Assisted Driving Starting in 1997

- Electronic safety systems
- Integrated electronics
- Electric control units
- Infotainment



Autonomous Coming Next

- Sensor fusions
- Autonomous processing
- Auto-charging technologies
- Multi-connectivity

Innovations Through Multiple Technology Domains

V2X (V2V/V2I/V2P/V2N)

Radar Collision
Avoidance

Electronic Stability
Control Module

Climate Control System

Infotainment/Navigation
Modules (DVD, eCalls, Hands
Free Telephony, GPS)

Anti brake Locking system
Tire Pressure Monitoring system

Emission Control Module

Power Steering Control
Rear-view camera
Backup sensors
Power Seat Control

Personnel Occupancy
Detection Systems (PODS)
for Air Bag systems

Remote Keyless Entry

Instrument Clusters

Fuel Injection Module
Power Train &
Engine Management
(MiL, SiL, HiL)

Adaptive Lightning Control

Hybrid Electric Vehicle
(HEV) / Electric Vehicle (EV)

V2X – Enhanced Safety, Enabling Higher Levels of Automation



Forward Collision Warning



Motorist Advisories and Warnings



Red Light Violation Warning



Connection Protection



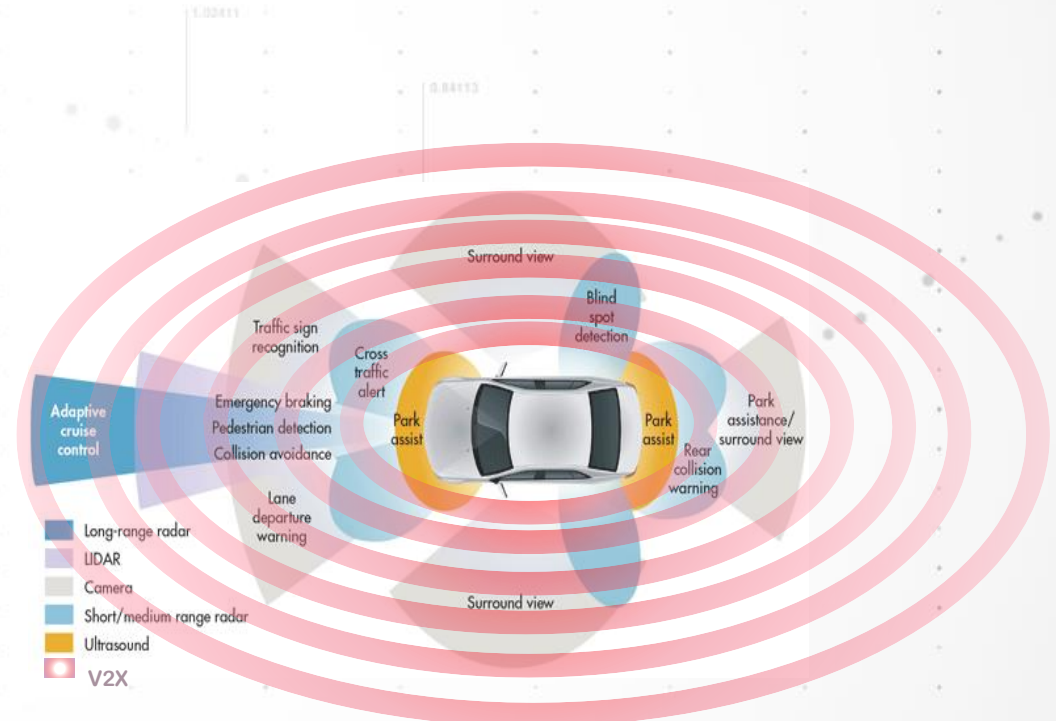
Eco-Traffic Signal Timing

V2V, V2I, V2P, V2N ...

Technology to enhance driving experience, prevent accidents and collisions, assist traffic flow, enable higher levels of automated driving.

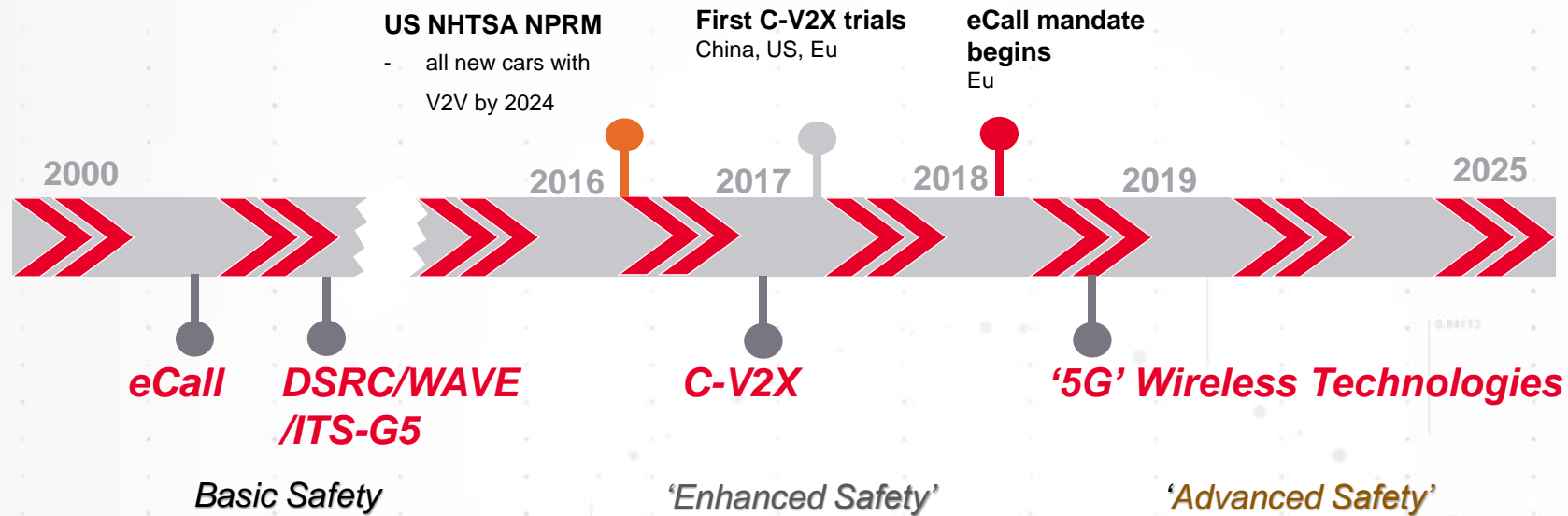
2 wireless technologies are currently being proposed -

- DSRC (based on IEEE 802.11p)
- C-V2X (based on 3GPP Rel-14 LTE-A Pro)



Secure V2X considered necessary for L3/L4 ADAS

V2X Technologies: Evolution



- **DSRC** - IEEE802.11p based
 - Based on 802.11a:
 - robust performance for short packets.
 - Products ready with actual deployments, extensive interop tests and field trials.(DOT/NHTSA)
 - Adopted or being considered by some regions.

- **C-V2X** – 3GPP LTE-based
 - Reuses LTE UL frame structure (Rel 14): require tight freq. & time sync.
 - Longer symbol and GI durations
 - Leveraging more recent PHY technologies: e.g. more advanced coding.
 - Improved air interface : Uplink: SC-FDM. Downlink: OFDM
 - Multi-antenna technology : Diversity, MIMO, Beam-forming
 - High spectrum flexibility : Flexible BW, FDD and TDD, new and existing bands
 - Still on going extensive field trials/testing.(more and more coming)
 - Qualcomm, Huawei and 5GAA are promoting heavily.



Test Challenges and Requirement for V2X (DSRC)

Wireless Communications System Lifecycle

WHERE DOES TESTING/MEASUREMENT CONTRIBUTE ?



- Simulation
- Channel Sounding & Modelling
- RF & modulation testing
- Channel Performance testing
- Base Station/ Network Emulation
- Congestion & Load testing
- Pilots/Trials
- Certification
 - Radio Conformance
 - Protocol Conformance
 - Interoperability
- Device Manufacturing Test & Calibration
- Infrastructure Coverage Planning
- Drive Test
- Virtual Drive Test

The bottleneck and test gap of this industry

KEY CHALLENGES OF V2X TESTING

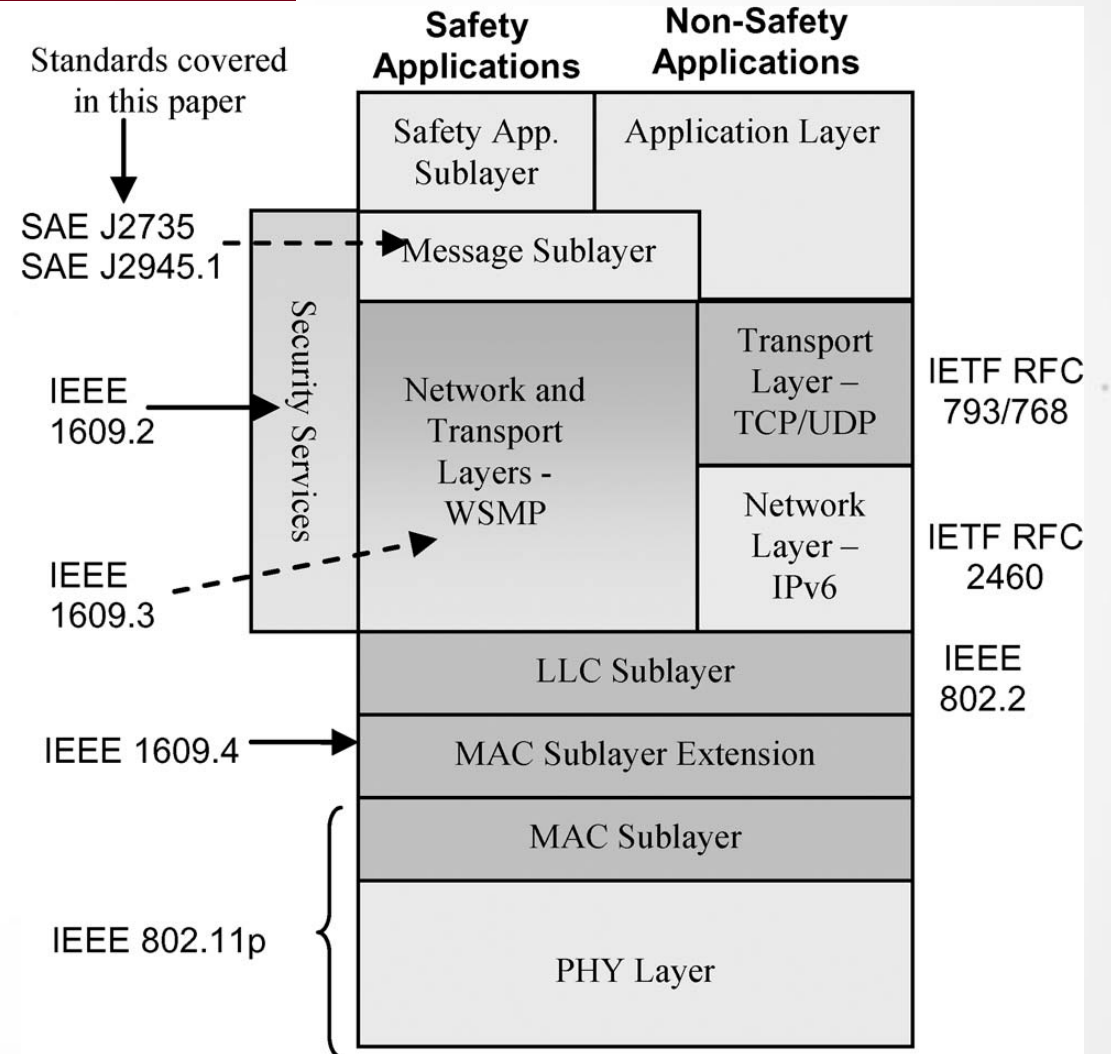
- System performance depends upon consistent implementation of Network Elements
 - Functional & Parametric Test of On Board & Roadside Units
 - Conformance Test : Device Certification
 - Multiple layers of standards : PHY layer to Protocol layer
 - Interoperability Testing
 - Assurance of functionality & performance of OBUs & RSUs through the manufacturing process
- System performance in real life conditions – pilots/trails
 - Field Testing
 - Loading, congestion handling

DSRC Operating Standards

COMMON VEHICLE LANGUAGE

- *SAE J2735 and J2945 define a standardized system of message sets for carrying information between vehicles.
- IEEE 802.11p is an approved amendment to the IEEE 802.11 standard to add wireless access in vehicular environments(WAVE).
- IEEE 1609 is a family of WAVE standards(P1609.0, P1609.1, P1609.2 etc) which supplement 802.11p with high layer messaging.

*SAE International is a U.S. based professional association and standards developing organization. SAE is an acronym for Society of Automotive Engineers. See www.sae.org



DSRC/WAVE



CERTIFICATION PROGRAM

- Test OBUs & RSUs against PHY and Protocol Requirements
 - IEEE 802.11p Physical Layer
 - IEEE 1609.2 Security/Certificates
 - IEEE 1609.3 Network (including WSA)
 - IEEE 1609.4 Multi-Channel Operations
 - SAE J2945.1 V-V BSMs Minimum Performance and Message Interoperability



- ‘Plugfests’ bring OBU & RSU vendors together with Test Labs & Test Equipment providers to verify Interoperability and readiness for Certification, and provide opportunities for testing with SCMS & Field Testing

E6953A DSRC CoC Certification Test Solution

IEEE802.11p, 1609.3, 1609.4, 1609.2, J2945/1 Tests Cases supported



- Compact PXIe hardware
 - Keysight VXT : RF measurements + GPS source
 - DSRC Transceiver Module
 - CoC Test Cases require only 1 module
 - Configurable as fully functioning OBU/RSU
 - add modules for multiple simultaneous RF channels
 - Keysight PXIe Frame, Controller, Freq Ref

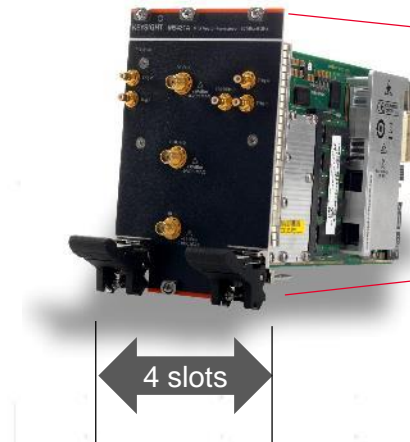
- Software
 - Certification Test Cases in Keysight Test Automation Platform
 - Test Case construction
 - Test Case sequencing
 - Pass/Fail
 - GUI
 - Controls Wave Channel Module & VXT
 - Single platform to be expanded for future V2X test needs
- Hardware & Software options covering
 - full CoC suite
 - RF only
 - Protocol only

Keysight V2X Test Platform

SIMPLIFYING RF TESTING

802.11p Test Cases RF measurements

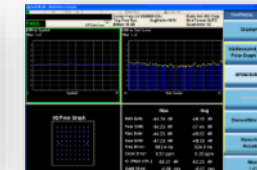
- using M9421A VXT hardware
 - Vector Signal Analyzer & Source
 - FPGA-Accelerated speed with high density & accuracy
 - Trusted X-Series software: industry tested algorithms, with code compatibility & bench top usability
 - N9077A measurement application
 - Graphical Vector Signal Analyzer
- N7617B Signal Studio
 - Arbitrary Waveform creation



Streamline Compliance Testing



Signal Studio



One-button X-Apps



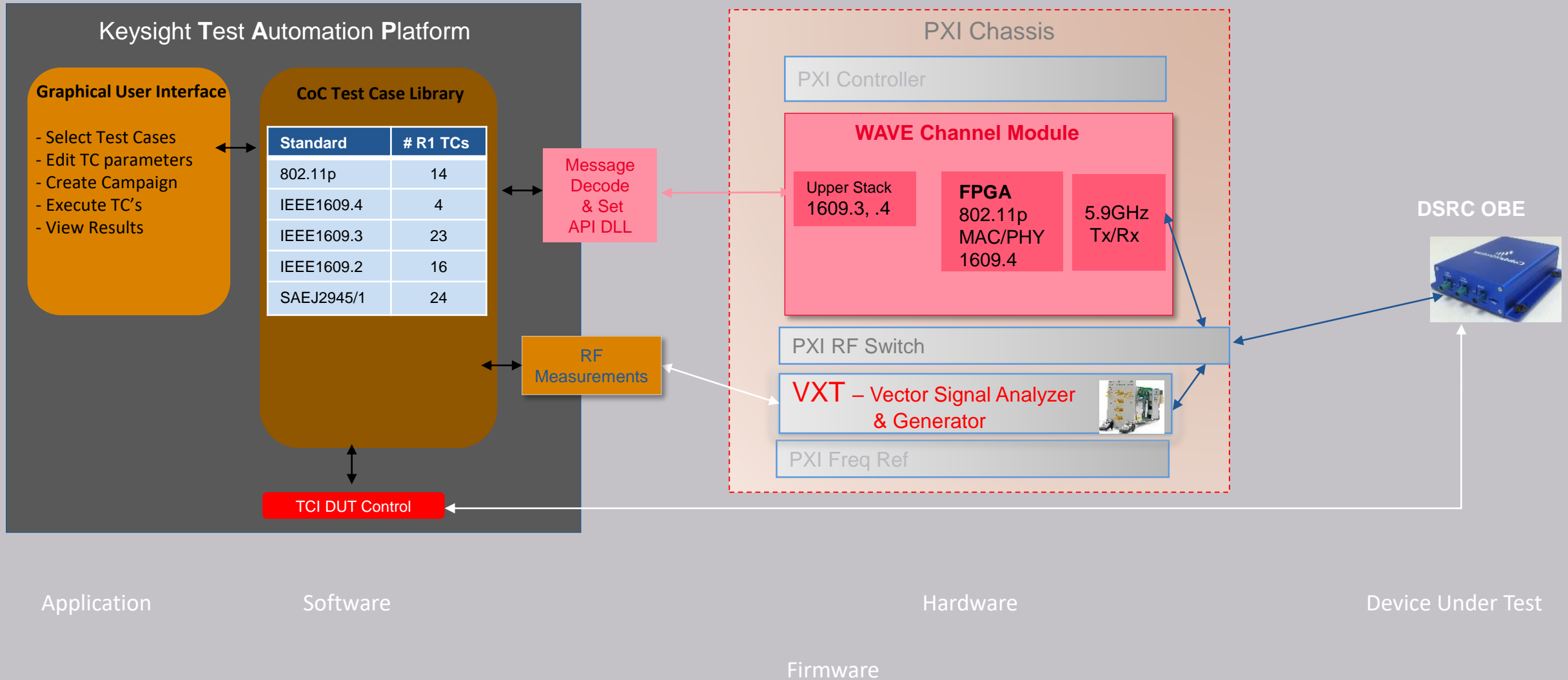
M9421A VXT Key Features

Frequency	60 MHz to 3.8 or 6 GHz
Bandwidth	40, 80 or 160 MHz
Modulated Output Power	+10 (HD) or +18 dBm
Memory depth	256 or 512 Msa
3 Ports	RF in & out, One Half Duplex (Optional)

Measurement integrity that ensures accurate, consistent results from R&D to Manufacturing

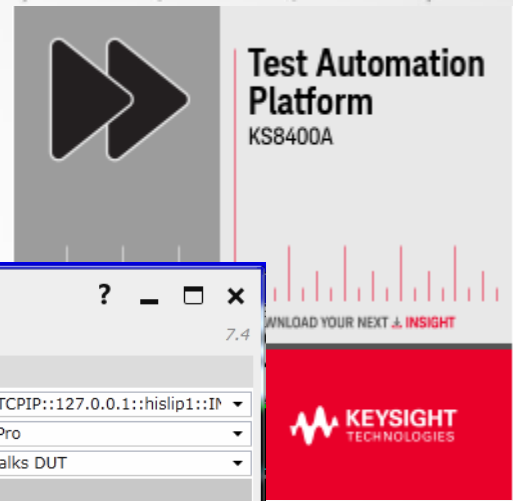
Keysight E6953A DSRC Certification Solution

Functional diagram



Keysight V2X Test Platform

Test Automation Platform



DSRC CoC Test Cases

- 802.11p
- IEEE1609.3
- IEEE1609.4
- IEEE1609.2
- J2945/1

Test Plans

- Parameter Sweep Loop
 - e.g. Channel, Data Rate

Reporting

- Summary and each TC results
- Full 'raw message' data
- Detailed & graphical PHY results



The screenshot displays the Keysight Test Automation Platform interface. The main window shows a test plan titled 'Untitled *' with a table of test cases. The table has columns for Step Name, Verdict, Duration, and Step Type. The test cases listed are:

Step Name	Verdict	Duration	Step Type
TP-80211-TXT-PHY-BV-01 (Spectrum Mask)	Pass	1.45 s	DSRC \ 802.11p \ TP-80211-TXT-PHY-BV-01
TP-80211-TXT-MAC-BV-01 (Tx MAC Validation)			DSRC \ 802.11p \ TP-80211-TXT-MAC-BV-01
TP-80211-TXT-PHY-BV-01 (Spectrum Mask) (1)			DSRC \ 802.11p \ TP-80211-TXT-PHY-BV-01
TP-80211-TXT-PHY-BV-02 (EVM Frequency Error)			DSRC \ 802.11p \ TP-80211-TXT-PHY-BV-02
TP-80211-TXT-PHY-BV-03 (EVM Symbol Clock Error)			DSRC \ 802.11p \ TP-80211-TXT-PHY-BV-03
TP-80211-TXT-PHY-BV-04 (EVM %RMS)			DSRC \ 802.11p \ TP-80211-TXT-PHY-BV-04
TP-80211-TXT-PHY-BV-05 (Spectral Flatness)			DSRC \ 802.11p \ TP-80211-TXT-PHY-BV-05
TP-80211-TXT-PHY-BV-06 (EVM Center Frequency Leakage)			DSRC \ 802.11p \ TP-80211-TXT-PHY-BV-06
TP-80211-TXT-PHY-BV-07 (Tx Power)			DSRC \ 802.11p \ TP-80211-TXT-PHY-BV-07
TP-80211-RXT-PHY-BV-01 (Rx Input Sensitivity)			DSRC \ 802.11p \ TP-80211-RXT-PHY-BV-01

The 'Log' window at the bottom shows the following entries:

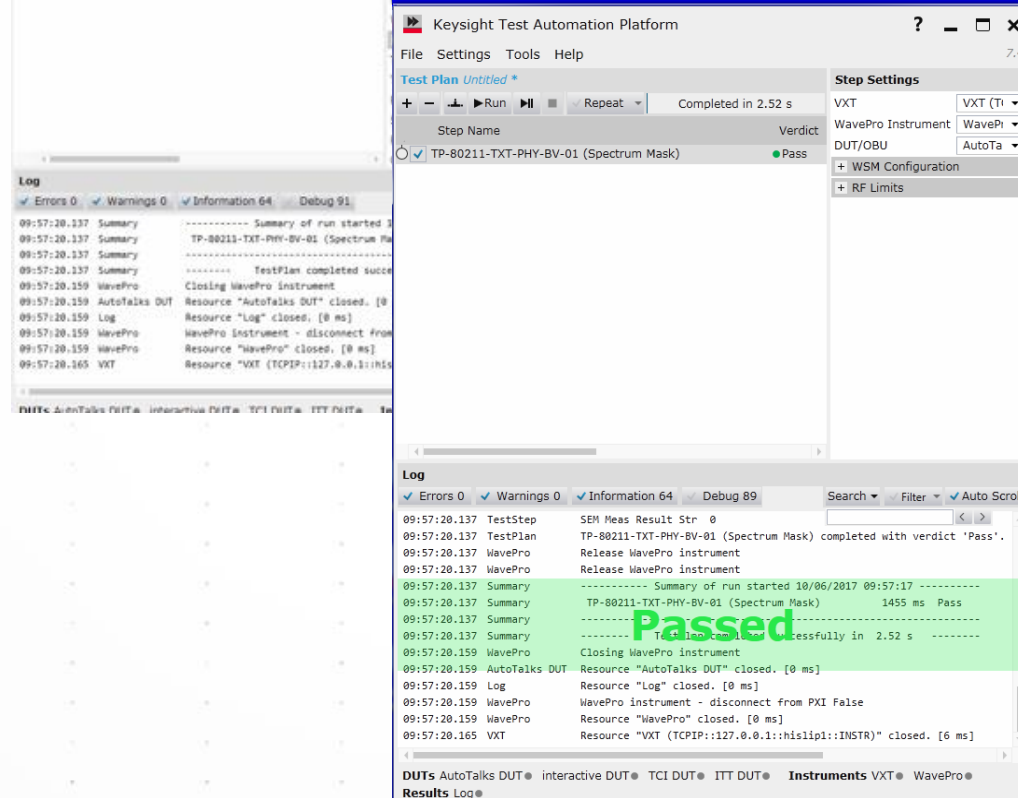
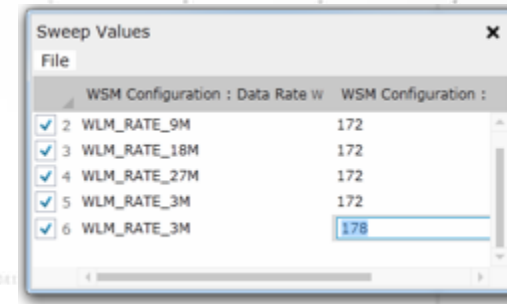
```
09:57:20.137 TestStep SEM Meas Result Str 0
09:57:20.137 TestPlan TP-80211-TXT-PHY-BV-01 (Spectrum Mask) complet
09:57:20.137 WavePro Release WavePro instrument
09:57:20.137 WavePro Release WavePro instrument
09:57:20.137 Summary ----- Summary of run started 10/06/2017
09:57:20.137 Summary TP-80211-TXT-PHY-BV-01 (Spectrum Mask)
09:57:20.137 Summary -----
09:57:20.137 Summary ----- TestPlan completed successfully in
09:57:20.159 WavePro Closing WavePro instrument
09:57:20.159 AutoTalks DUT Resource "AutoTalks DUT" closed. [0 ms]
09:57:20.159 Log Resource "Log" closed. [0 ms]
09:57:20.159 WavePro WavePro instrument - disconnect from PXI False
09:57:20.159 WavePro Resource "WavePro" closed. [0 ms]
09:57:20.165 VXT Resource "VXT (TCPIP::127.0.0.1::hislip1::INST
```


Keysight V2X Test Platform

Test Automation Platform

802.11p Test Cases

- RF Measurements
 - Test parameter setting, looping
 - Test Case Pass/Fail
 - Graphical VSA window
- Test Campaign Sequencing, Looping



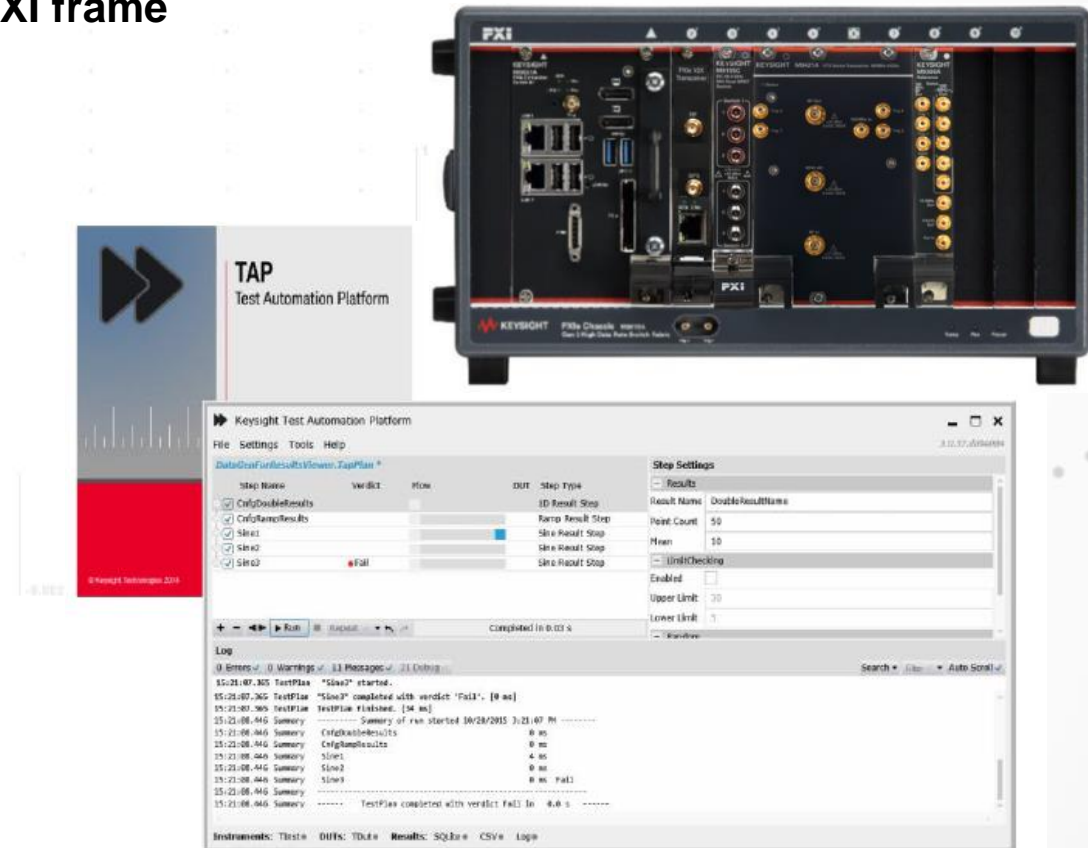
E6953A Keysight DSRC CoC Certification Tester

Covers all CoC Test Cases in single , integrated PXI frame

- 802.11p
- IEEE1609.3
- IEEE1609.4
- IEEE1609.2
- J2945/1

Up next

- Pre-Certification and Design Verification solution
- Parameter flexibility to create new 'TC's & scenarios
- Loading, congestion, application testing
- ITS-G5 (optional 18GHz SA for EN 302 571 5.3.4)
- C-V2X



802.11NGV



- The IEEE 802.11 Next Generation V2X (NGV) Study Group is exploring ways to leverage more recent 802.11 technologies to address new applications of wireless access in vehicular environments, where new requirements for higher throughput, improved reliability and efficiency, and/or extended range are anticipated.
- "To support advancements in driverless car technology, car-to-car and car-to infrastructure connectivity, as well as to enable more robust vehicular infotainment offerings, a higher, more reliable and efficient throughput as compared to IEEE 802.11p is foreseeable," said Bo Sun, chair, IEEE 802.11 Next Generation V2X (NGV) Study Group.
- Backward compatibility with 802.11p can't be compromised
 - Physical layer enhancements should be applied in very specific scenarios for assuring the backward compatibility
- 802.11p has a minor specification gap (diversity)
- Multi-channel use-cases will expand



Test Challenges and Requirement for V2X (C-V2X)

C-V2X

- ❑ Proposed to 3GPP, driven by Huawei and Qualcomm
- ❑ Uses existing LTE infrastructure to deliver V2X services
 - Claims lower cost for both infrastructure and vehicle
 - LTE-D2D used for V2V
 - Plans being developed to improve latency (currently est ~100ms)
 - C-V2X capability expected in 3GPP R14, mid 2017
- ❑ Growing support including 5G AA



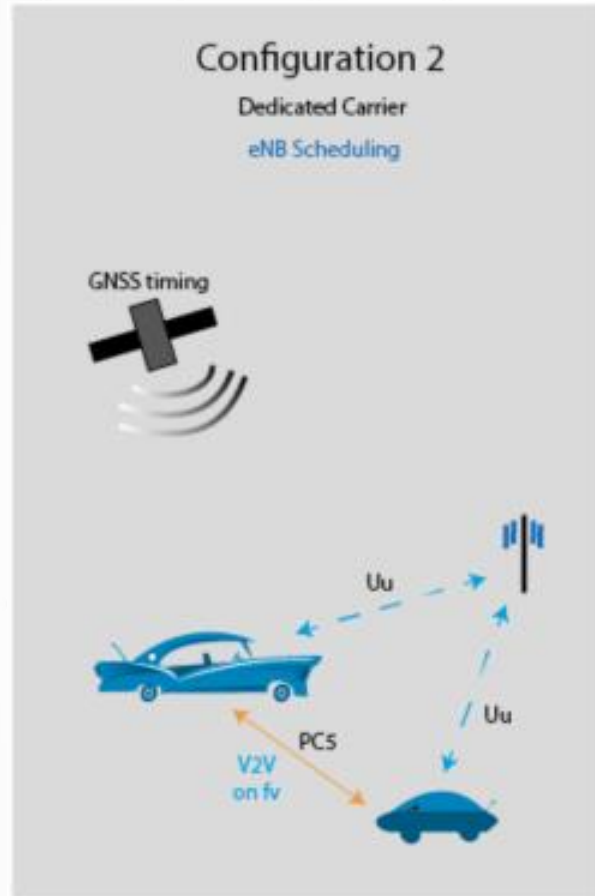
- ❑ Keysight supports and track LTE measurements, RF measurements likely similar to LTE/LTE-A



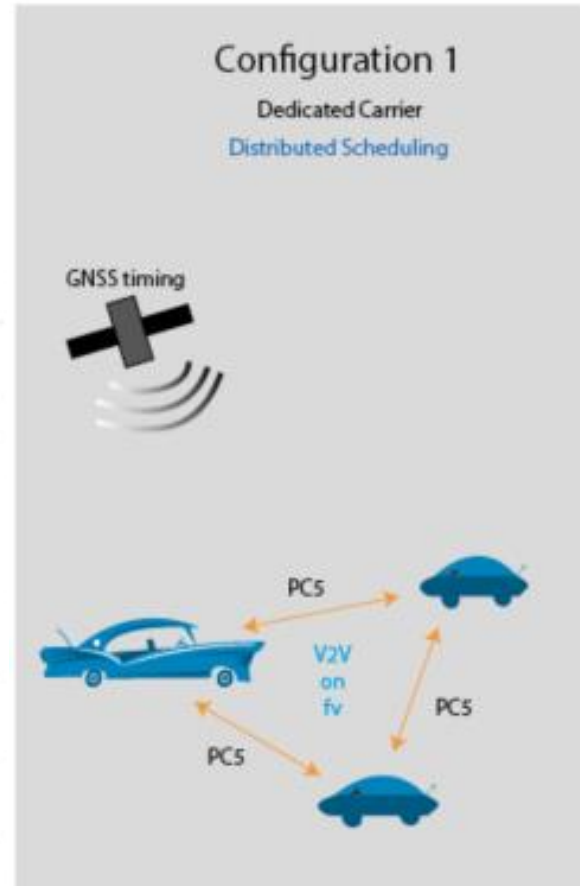
C-V2X Acronyms to Know

- UE- User Equipment
- E-UTRA – Network that the UE connects to
- Uu – Interface that allows for communication between a UE and the UTRA
- PC5 – Interface introduced under 3GPP Release 14 used specifically for C-V2X

C-V2X Mode 3 and Mode 4

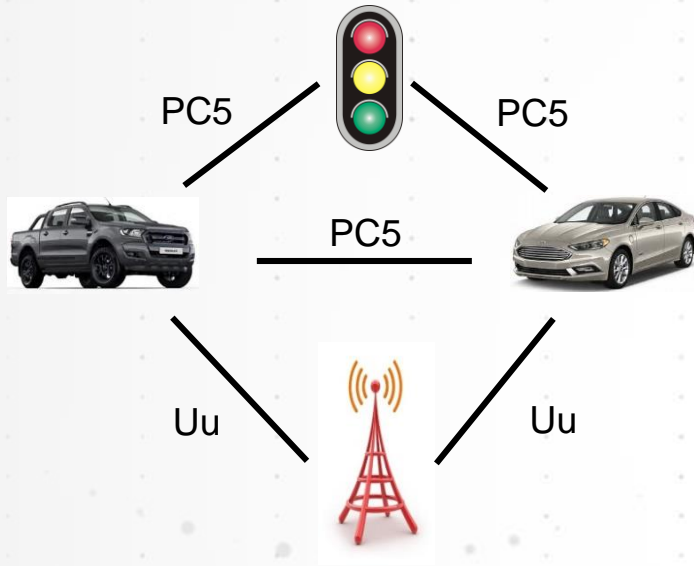


Mode 3



Mode 4

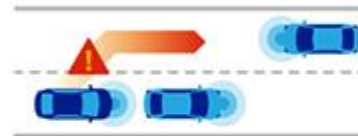
C-V2X Low Latency Communication



The PC5 interface was designed to make use of the 5.9 GHz band

Direct communications for active safety use cases

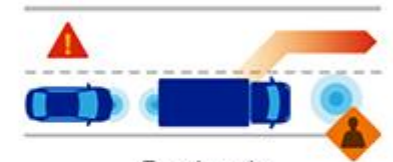
Low latency communication with enhanced range, reliability, and NLOS performance



Do not pass warning (DNPW)



Blind curve/
Local hazard warning



Road works warning



Intersection movement assist (IMA) at a blind intersection



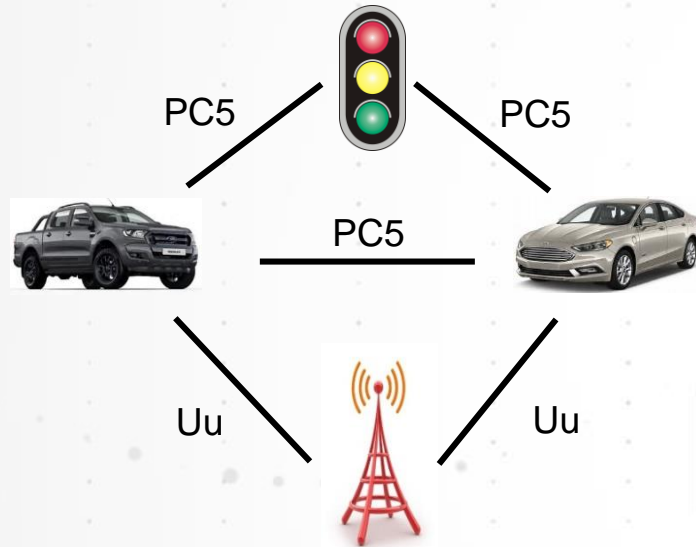
Vulnerable road user (VRU) alerts at a blind intersection



Left turn assist (LTA)

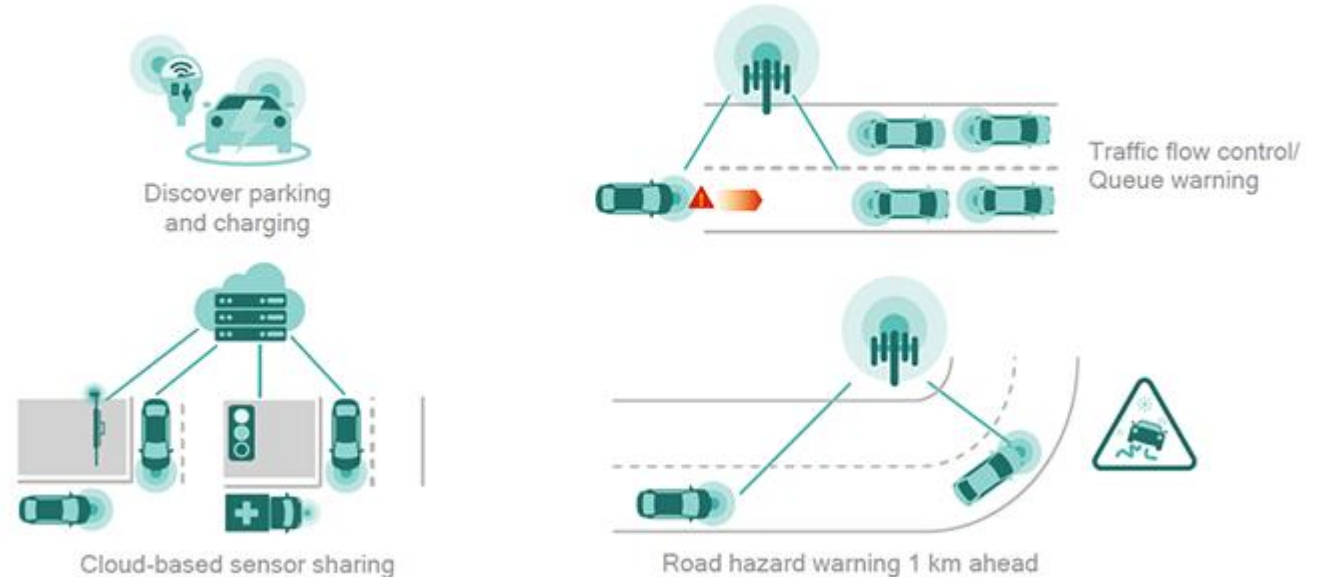
Credit: Qualcomm

C-V2X Latency Tolerant Communication



C-V2X is also capable of taking advantage of existing cellular networks to communicate when latency isn't an issue.

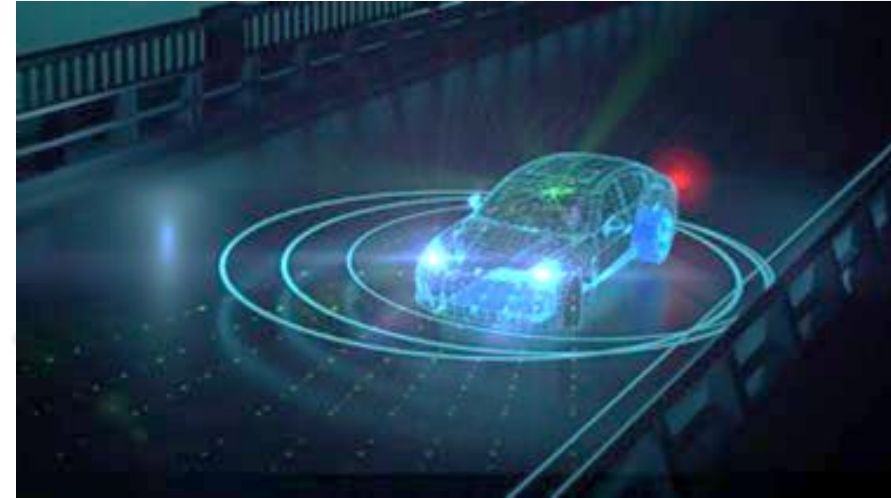
Network communications for latency tolerant use cases Suitable for telematics, infotainment and informational safety use case



Credit: Qualcomm

C-V2X supports the vision for AVs

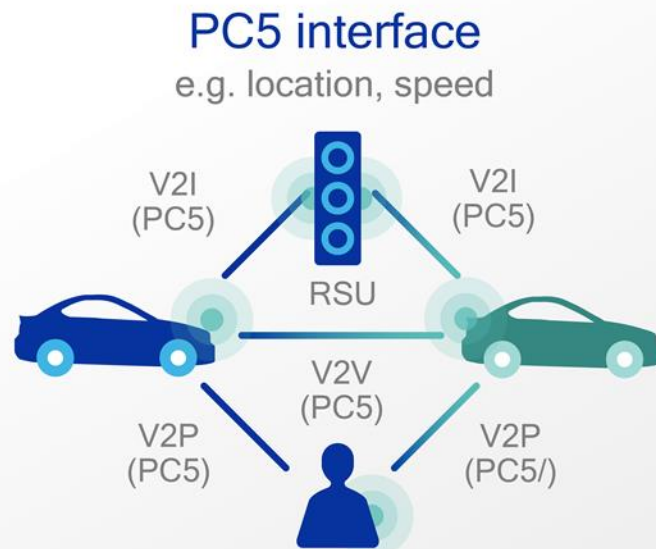
- **Vision:** Fewer accidents & greater road safety
- **Enabler:** Create greater on-board situational awareness
 - Observing
 - Foreseeing
 - Taking protective action
- **Foundation:** Dependable wireless technology
 - Superior range
 - Low latency
 - High-speed connectivity
- **Trend:** 5GAA membership → momentum behind C-V2X
 - Evolving from *basic* to *enhanced* to *advanced*
 - Achieving full autonomy



C-V2X Transmission Modes

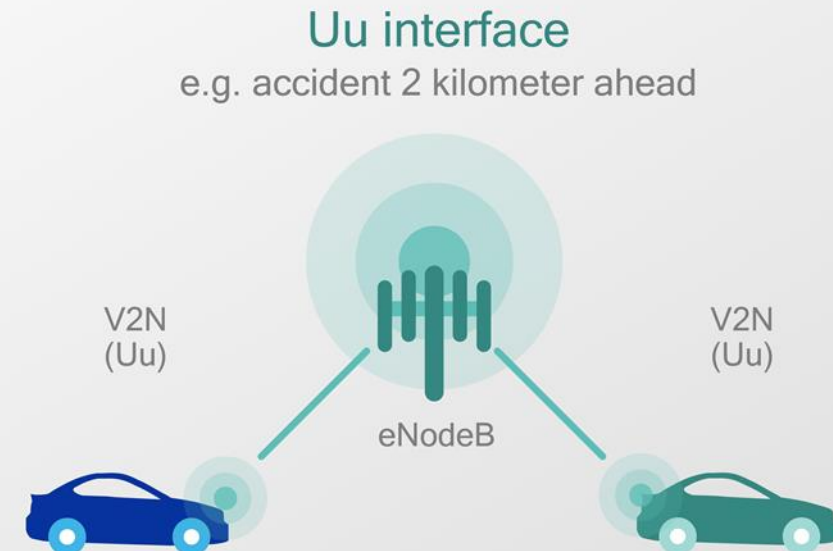
Direct Communications

V2V, V2I, and V2P on “PC5” Interface, operating in ITS bands (e.g. ITS 5.9 GHz) independent of cellular network



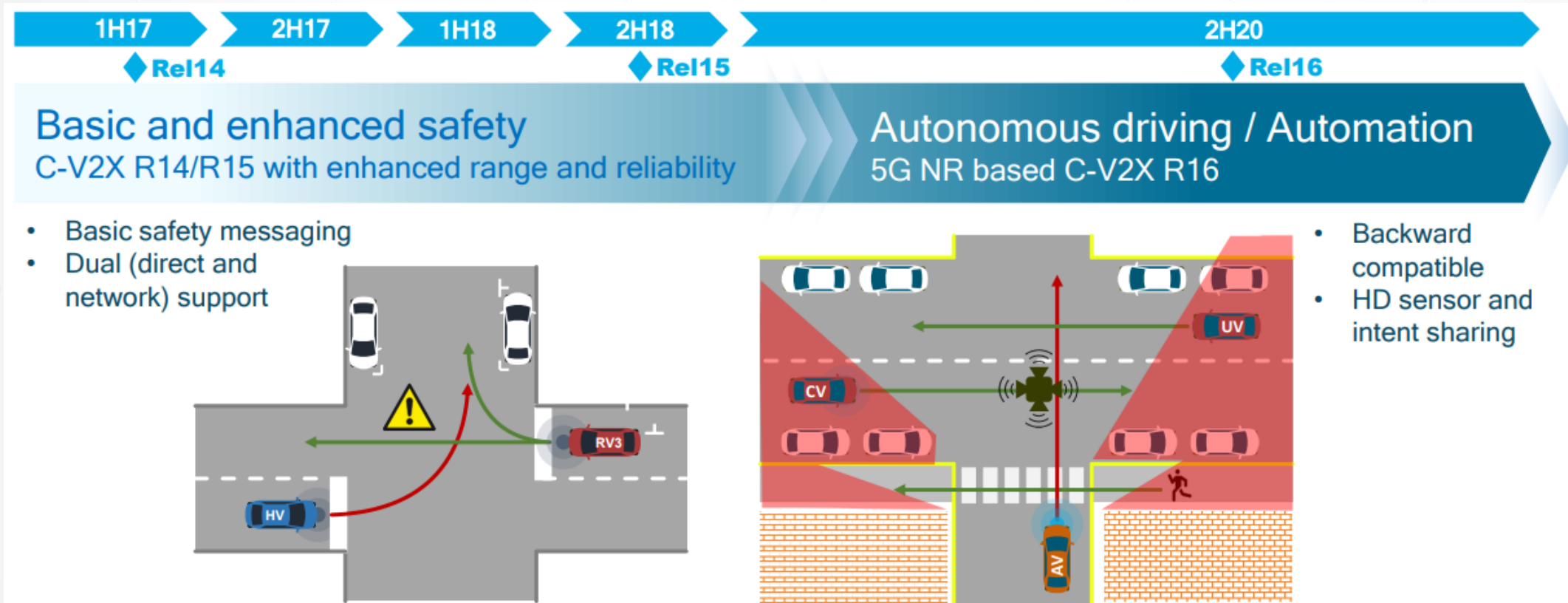
Network Communications

V2N on “Uu” interface operates in traditional mobile broadband licensed spectrum



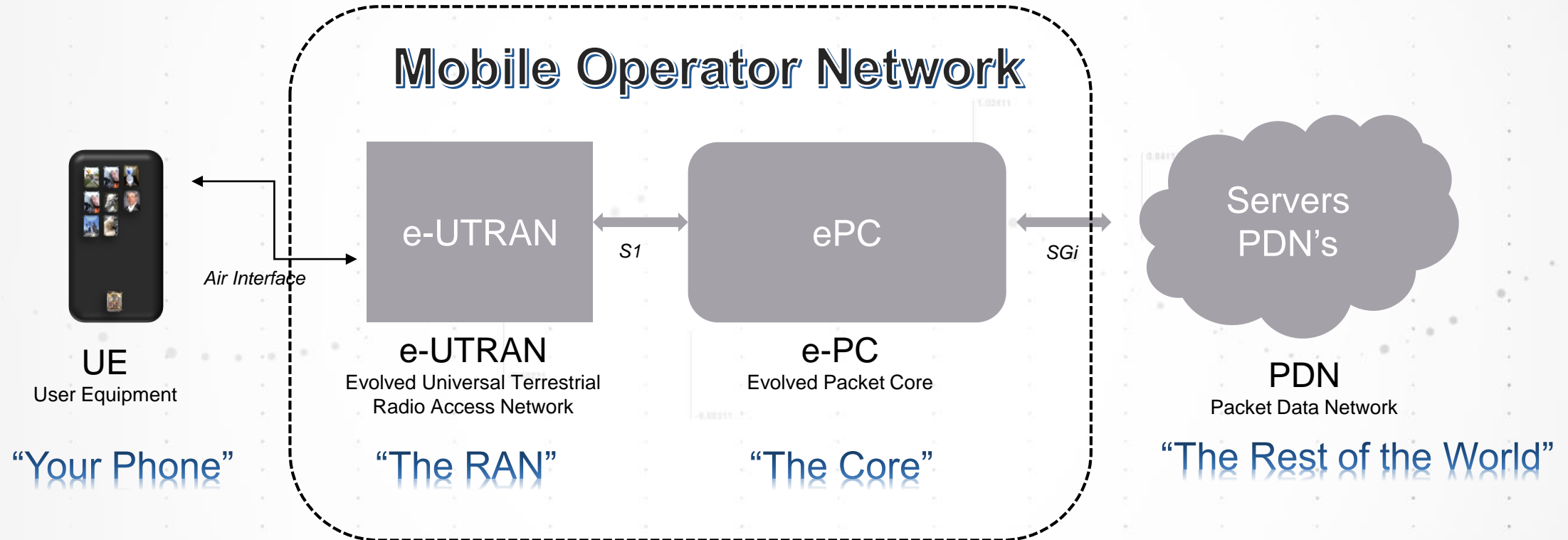
Courtesy of Qualcomm

R14 C-V2X is the first step towards 5G NR V2X



5G Changes the Entire Network

LTE ARCHITECTURE



Increasing Possibilities
UE, CPE, AR, VR, any number of "things"

5G RAN
5G
Radio Access Network

NGC
Next Generation Core

5G Terms

5G Framework for Automotive

COMBINATION OF ALL THREE

Mobile Broadband Access



- All data, all the time
- 2 billion people on social media

Massive Machine Communication



- 30 billion "things" connected
- Low cost, low energy

Mission-Critical Machine Communication



- Ultra high-reliability
- Ultra-low latency

Very High Data Rate In Congested Areas
Communications Optimized for Machines
High Reliability and Low Latency

5G & V2X Measurement Challenges

OVERALL AND C-V2X

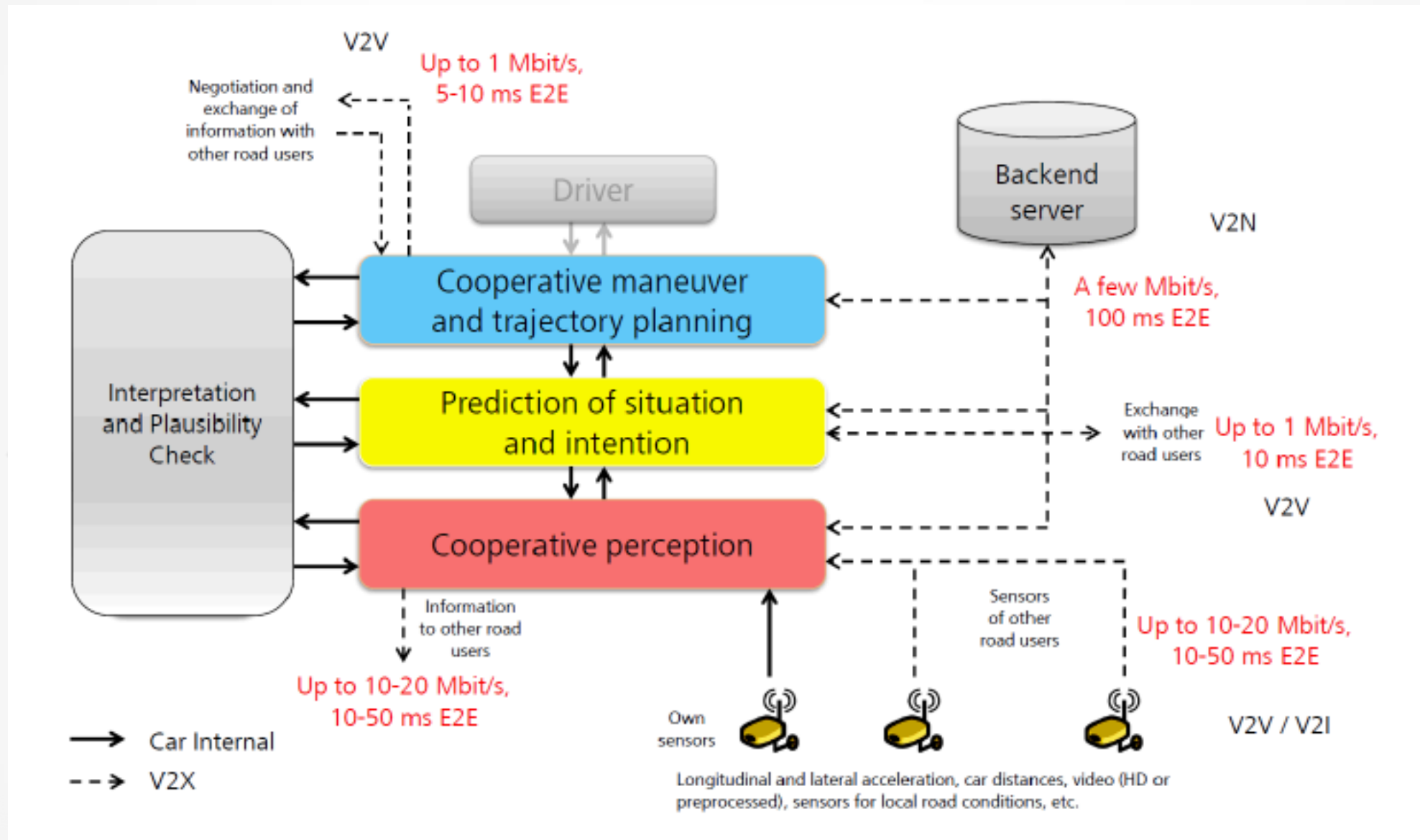
5G Overview

1. Measure, model, and emulate mmWave channels
2. Measure, model, and emulate wideband baseband
3. Measure and characterize chips & devices over-the-air
4. Emulate 5G network and device—characterize spectral efficiency gains
5. Simulate 5G NR signals, protocol stacks—prototype baseband and RF implementation effects to the system
6. Characterize phase, amplitude, and thermal effects of phased arrays
7. Emulate and evaluate end-to-end connections
8. Model, design, and troubleshoot mmWave components and subsystems
9. Characterize and troubleshoot high-speed digital interfaces in circuits and networks (from DigRF all the way to PAM4 and 400G)
10. Characterize interoperability/coexistence of wireless standards

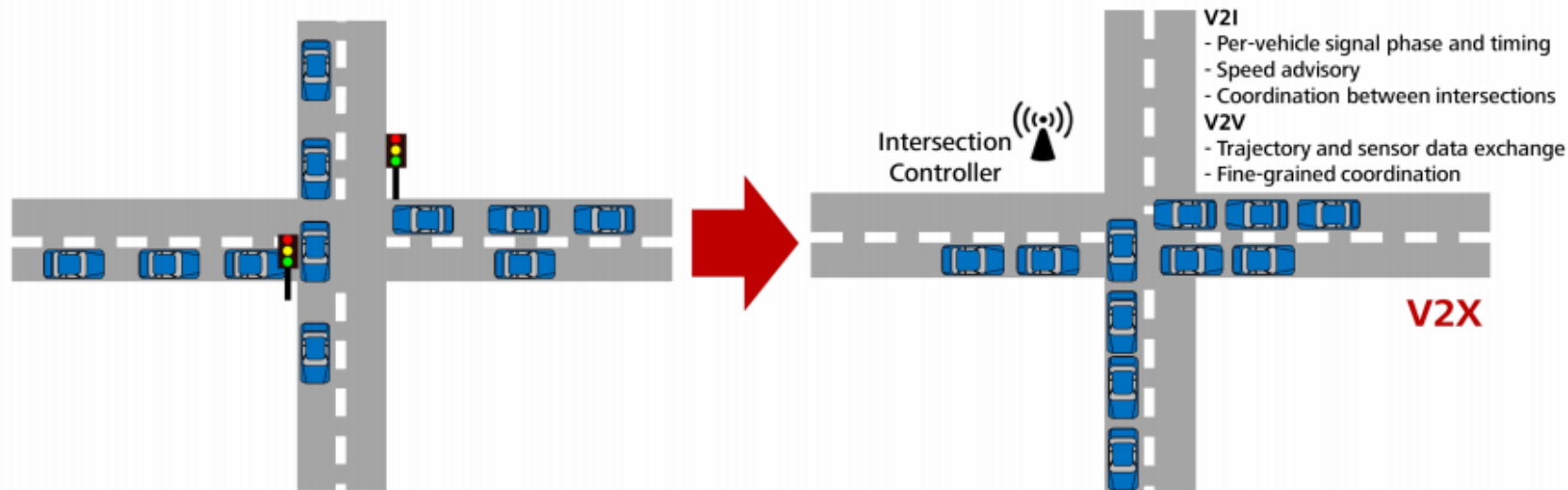
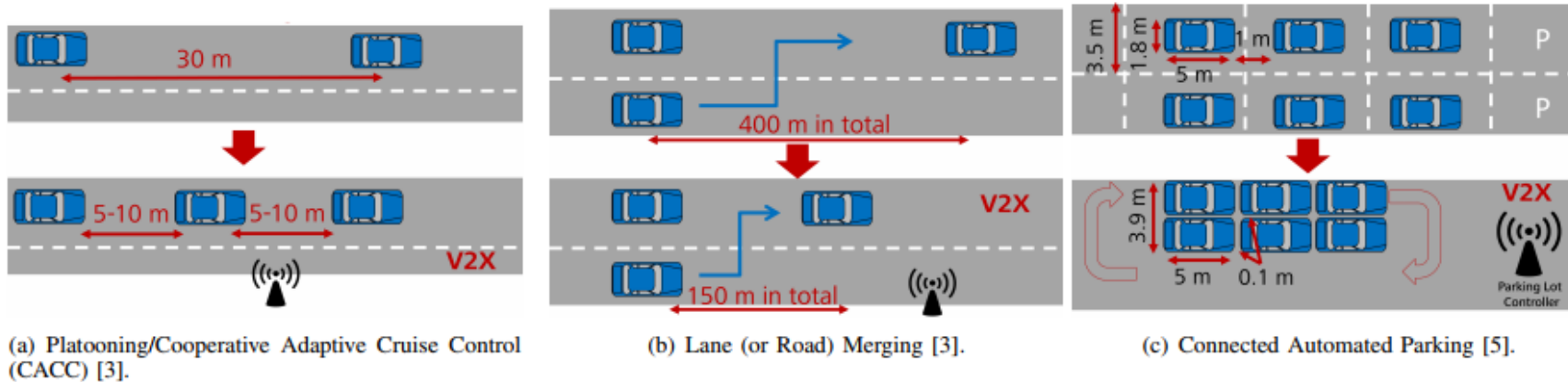
Key Measurements in V2x

- Latency
- Reliability (PER)
- Interference and Co-existence
- Range (Sensitivity)
- Congestion Control
- Maximum Relative Vehicle Speeds
- Dynamic Channel Impairments
- Data Throughput
- GNSS Accuracy
- Interoperability
- Certification Test (Dictated by Policy)
- Security
- Antenna Performance

Connectivity Demands of Future Connected Vehicles



Examples of 5G Automotive Use Cases



(d) Cooperative Intersection Control [3].

5G provides crucial capabilities

- **5G:** Reliable connectivity, fast data rates & ultra-low latency
- **Today:** C-V2X becomes key enabler of AV with 3GPP R15+
 - Stepping stone to Level 4 & Level 5 autonomy
 - Path to 5GAA *advanced* safety
- **Past:** LTE-Advanced Pro (4G)
 - Testers lack easy, cost-effective upgrades to 5G
 - Must replace to cover 5G R15, R16...
- **Implications:** Ignoring 5G increases costs, reduces opportunity
 - Limits ability to innovate & be first
 - Makes it harder to create strong differentiation

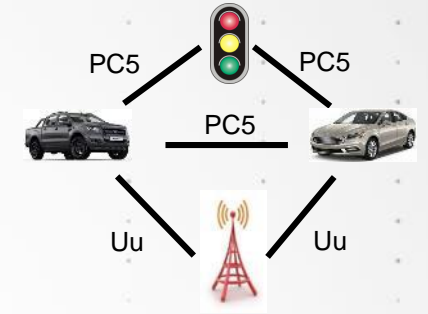


C-V2X Test System



UXM 5G Wireless Test Platform (E7515B)

- <6GHz Frequency range
- mmW Freq possible with remote radio heads



C-V2X Emulation via Test App

- Uu and PC5 interfaces
 - PSSS/SSSS (Synch), PSBCH (Broadcast), PSCCH (Control SCI), PSSCH (Data)
 - SIB21, RRC (Dedicated Msgs), DCI 5A
- Multiple UE emulation
- Functional & Protocol Test (L1/L2/L3) and modem bring-up
- RF Measurements: EVM, ACLR, OBW, SEM, Chan Power, Tx On/Off Mask
- GNSS via MXG (Optional)
- Pathwave Test Measurement Automation (Optional)

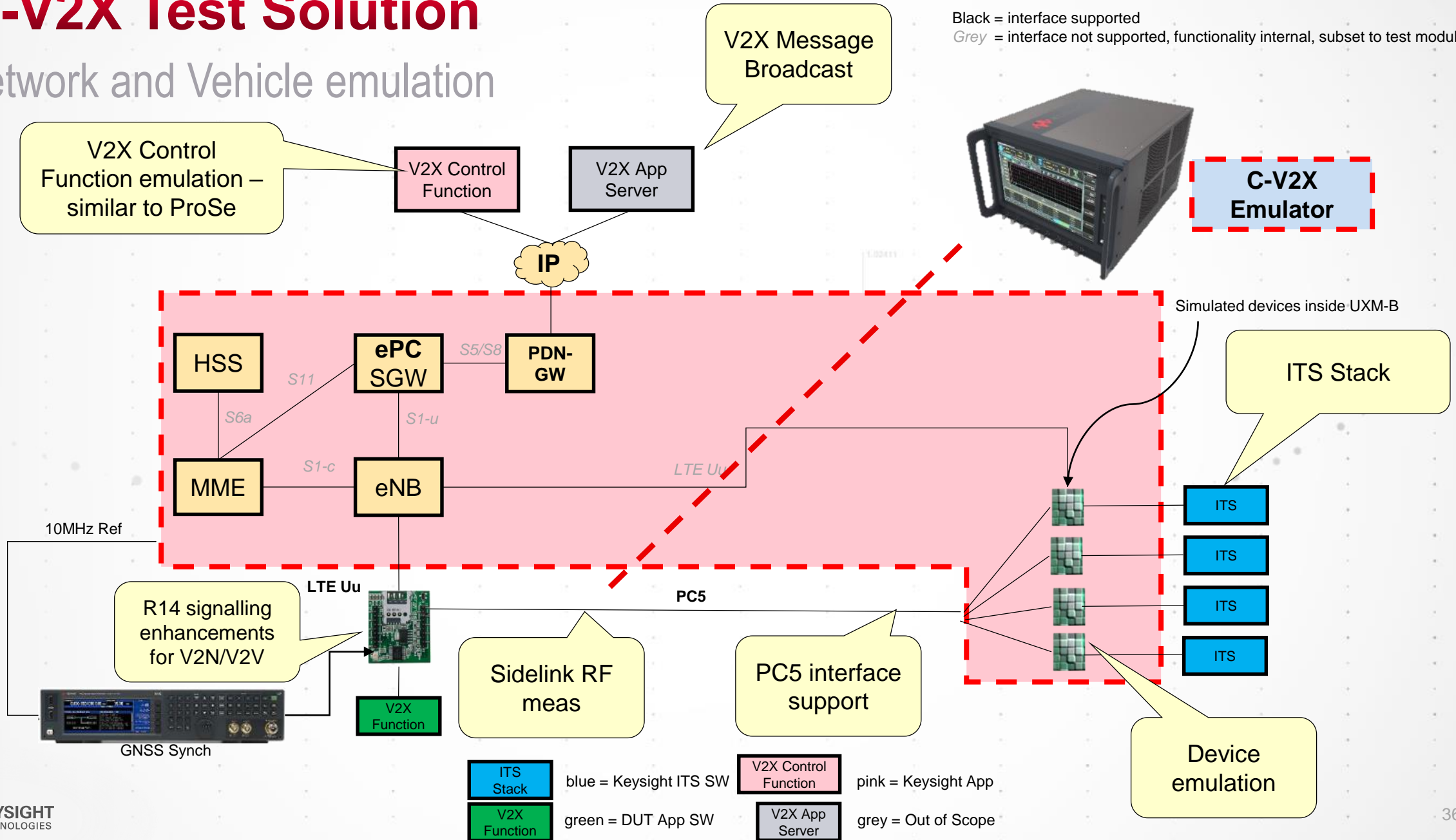
MXG GNSS Emulator (N5182B)

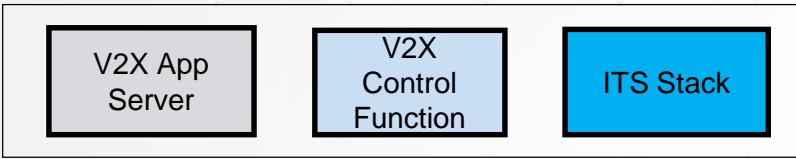
- 6GHz Freq Range
- Real-time creation of multi-satellite signals for GPS, GLONASS constellations (L1 with C/A code), Beidou (Compass), SBAS/QZSS with up to 40 channels, and Galileo (E1) with up to 16 channels for line-of-sight and multipath signals
- Add impairments such as multipath, pseudo-range error, and CW interference signals in real-time while the signal is playing

C-V2X Test Solution

Network and Vehicle emulation

Black = interface supported
 Grey = interface not supported, functionality internal, subset to test modules





• KeySight Test Automation Software

- Ready to use test sequences
- Modern Interface
- Complete Test report
- And more..

GNSS

IP Conn. (GNSS signal programming/loading)

LTE/C-V2X Test App

RF Measurements : X-Apps

Inter components (for TM3, sidelink configuration sharing, ... FFS)

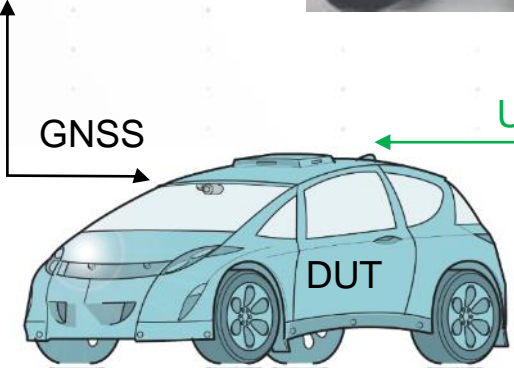
LTE Stack Sidelink Stack

DAQ configuration and Acquisition

Internal Trigger External TRG

Platform

GNSS -
Timing
Synchronisation
Position
Trajectory (dynamic)

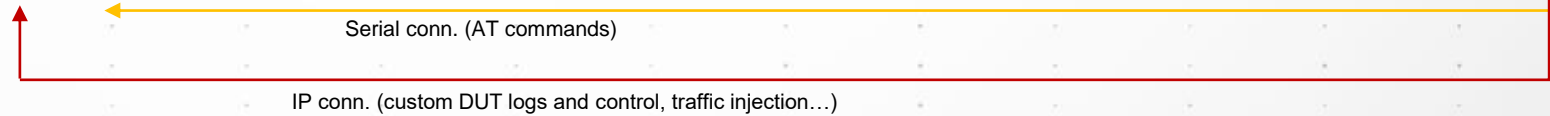


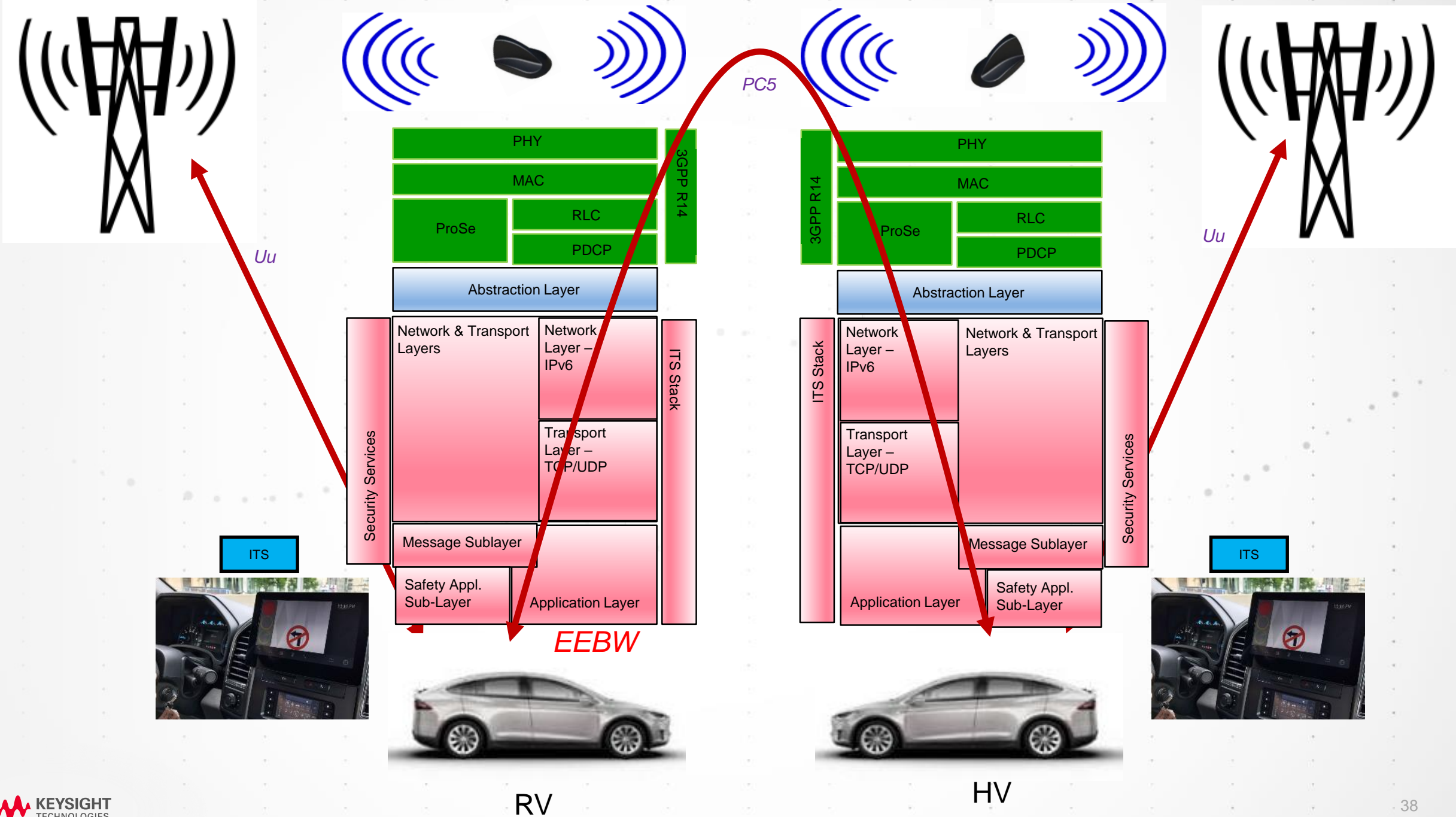
Uu

SIB 21
RRC (Dedicated Msgs)
DCI 5A
UL SPS (Multiple)

PC5

PSSS/SSSS (Synch)
PSBCH (Broadcast)
PSCCH (Control SCI)
PSSCH (Data)
DMRS





Invest for the present & future

- **Keysight C-V2X Toolset**
 - Only solution tracking the evolving C-V2X standard
 - Platform will support future releases of 5G NR V2X
- **Protects your initial investment**
 - Serves as 5G measurement platform
 - Has roadmap to 5G NR V2X
 - Provides foundation for C-V2X conformance test
- **Accelerates deployment of advanced safety features**
 - Level 4: High Automation (constrained operation)
 - Level 5: Full Automation (unconstrained operation)

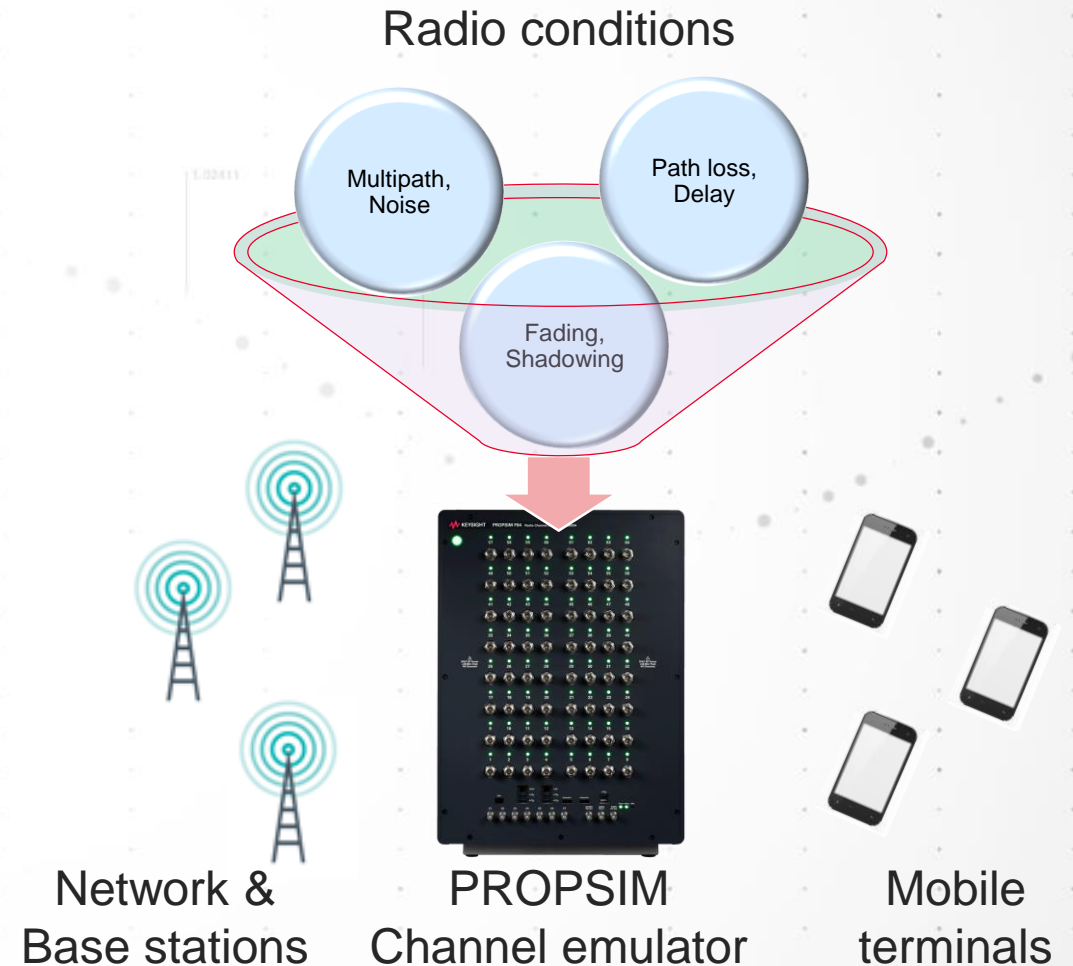
Address functional test, protocol test & RF

- **Supports RF, protocol & application-layer testing**
 - Covers both interfaces: User-to-UTRAN (Uu) & Direct Communication PHY sidelink (PC5)
 - Built on proven Keysight UXM 5G wireless test set
- **Simplifies C-V2X measurements with intuitive UI**
 - Addresses RF & protocol
 - Shortens learning curve
- **Includes GNSS emulator**
 - Uses Keysight N5182B MXG X-Series RF vector signal generator
- **Provides RF measurements of Tx & Rx characteristics**
 - *Tx*: power, error-vector magnitude (EVM), frequency accuracy, in-band emissions, adjacent channel leakage ratio (ACLR)
 - *Rx*: sensitivity, maximum input level, adjacent-channel selectivity

Introducing Channel Emulator

PROPSIM EMULATES COMPLEX REAL-WORLD RADIO CONDITION IN THE LAB

- Channel Emulator (CE) is a device which replaces wireless links with mathematical model of the radio conditions
 - Control the conditions over multiple test runs
 - Model extreme conditions
- Channel Emulator is used with real Radios
 - First prototypes can be already exposed to realistic field conditions



Virtual Drive testing

Challenges

Every car will be connected

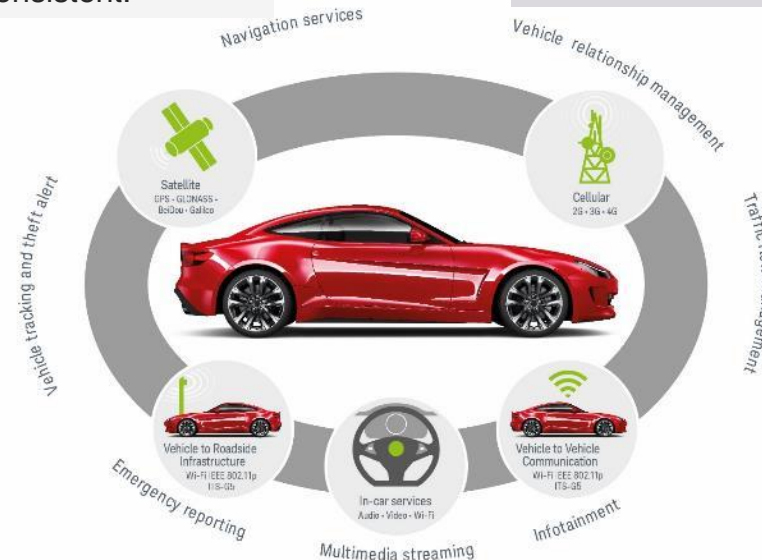
Car manufacturer must meet end-user-experience in demanding field environments like congested highways and remote areas

OEMs cannot execute expensive field trials for every new model in numerous field network conditions.

Responsibility for interoperability between infotainment, emergency and other systems stays on manufacturer. Fixing issues in final drive test phase is inefficient and expensive

Drive testing in the field

Testing in real environment is labor intensive and time consuming. At the same time results are inconsistent.



Solutions

Virtual Drive Testing Toolset

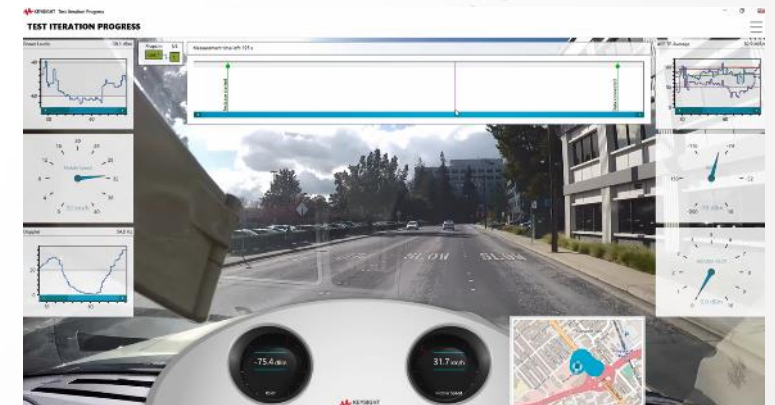
Automated End to End performance testing process across the entire organization from test management to execution
Test E2E Multi-cell mobility in realistic fading and interference conditions

Integrated virtual drive & indoor test solution

Propsim RF channel emulation, Anite 9000 Network Simulation, GNSS simulation, Device controls, real-time diagnostics monitoring, test result logging, test data analysis and test reporting with Nemo drive test tools

Real world connected car use cases

Ready to run eCall test cases and user defined field to lab test scenarios.
Build your drive test routes inside the lab to accelerate development cycles.



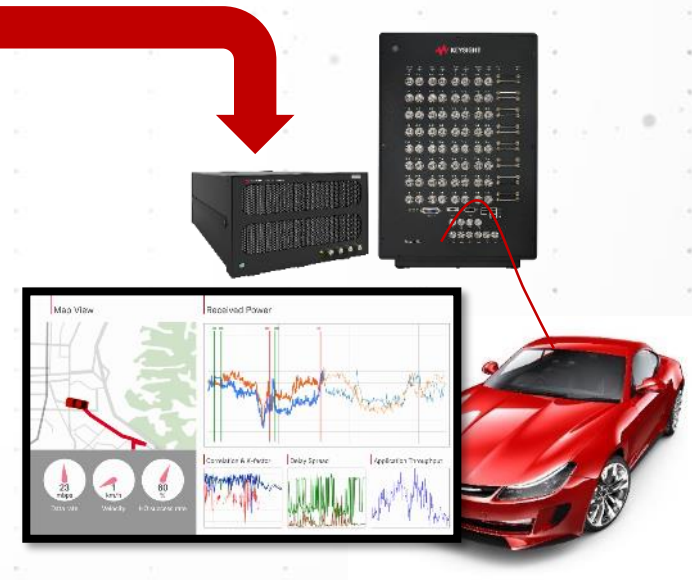
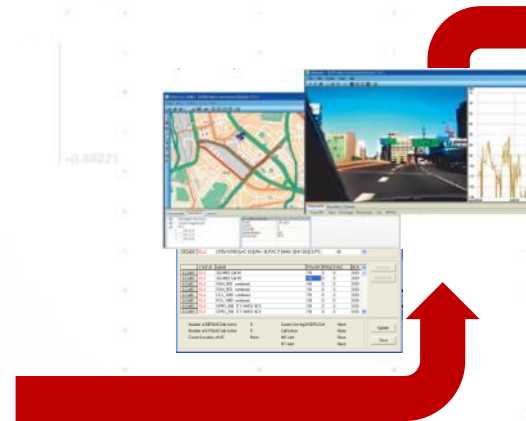
Keysight Virtual Drive testing Toolset

FROM FIELD TO LAB

Record network signalling and radio channel from live environment

Replicate the live network propagation, signalling and cell settings

Run test case with new VDT scenario

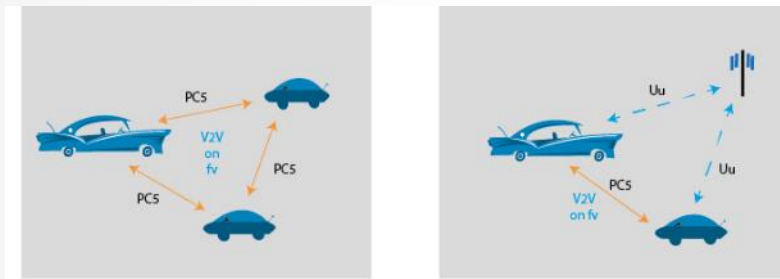


Summary

V2X CHANNEL SCENARIOS AND VIRTUAL DRIVE TESTING

V2X

- Prosim GCM tool
 - Supports V2V, V2P, V2I and V2N scenarios
- Test reliability of communications under speed, interference, high number of nodes w/wo cellular network precense



Virtual Drive Testing

- Automated End to End performance testing process across the entire organisation from test management to execution
- Integrated virtual drive & indoor test solution
- Ready to run eCall & ERA Glonass test cases and user defined field to lab test scenarios based on real world connected car use cases



Test Challenges and Requirement for V2X (eCall)

E6950A eCall/ERA-GLONASS Test Solution NG-eCall Update

The interoperable EU-wide eCall



MANDATE ECALL IN ALL NEW TYPES OF M1 AND N1 VEHICLES (PASSENGER CARS AND LIGHT DUTY VEHICLES).

- **eCall 112-based emergency assistance from your vehicle**
 - eCall is a system used in vehicles across the **EU** which automatically makes a free 112 emergency call if your vehicle is involved in a serious road accident. You can also activate eCall manually by pushing a button.
- **More countries will benefit from reduced emergency response times for road traffic accidents.**
 - The United Nations (UN) also announced the UN Regulation on **Accident Emergency Call Systems (AECS)**, effective June 2018. AECS aims to improve interoperability between existing emergency call systems, enabling the scaling-up of the technology.
 - AECS aligns the “ERA-GLONASS” emergency call system in use in the Russian Federation with the European Union’s “eCall”, which is set to become compulsory for all new cars sold in the EU from April 2018.

From : <https://europa.eu>

From : <https://www.unece.org>

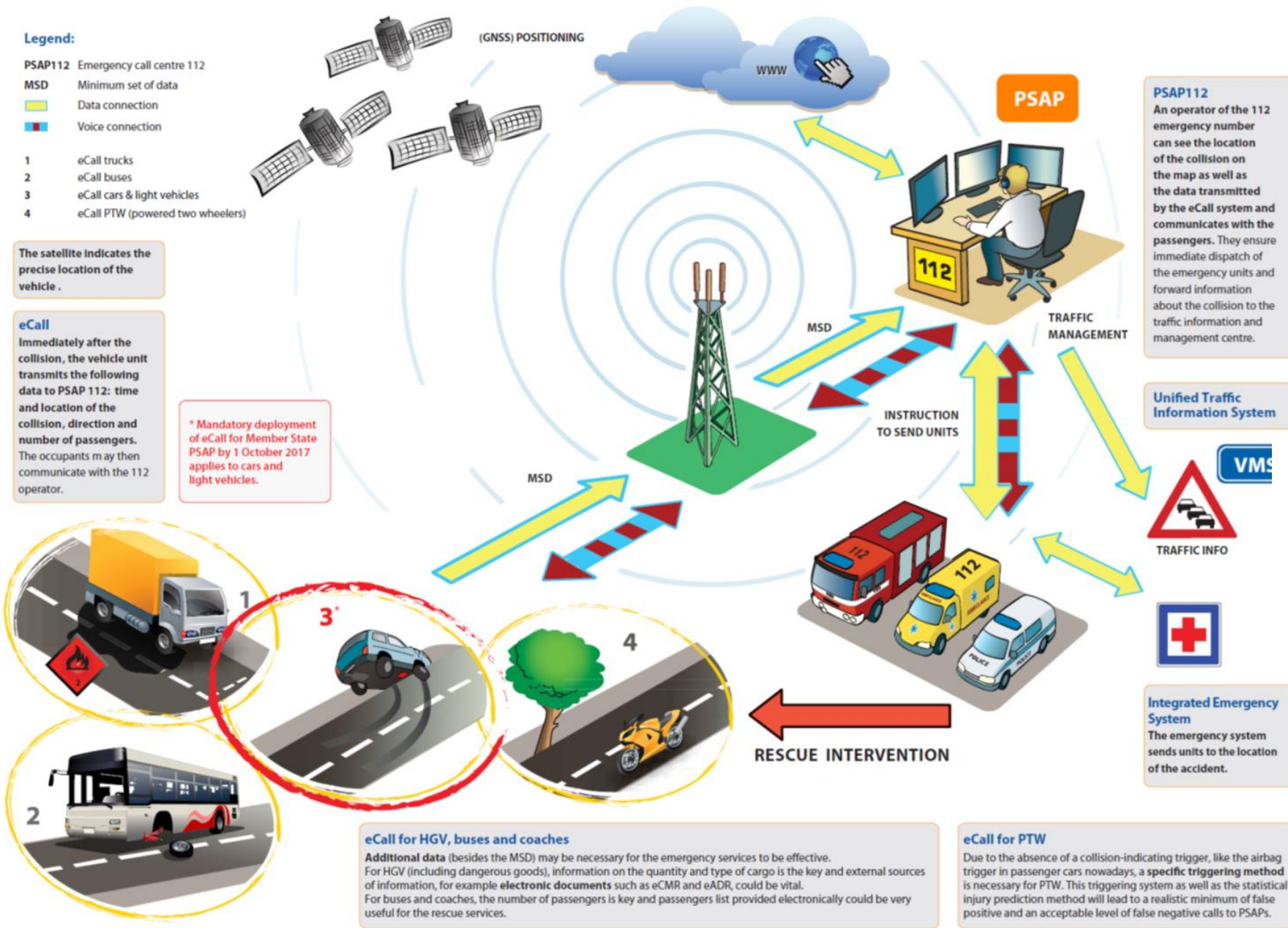
Legend:

- PSAP112 Emergency call centre 112
- MSD Minimum set of data
-  Data connection
-  Voice connection
- 1 eCall trucks
- 2 eCall buses
- 3 eCall cars & light vehicles
- 4 eCall PTW (powered two wheelers)

The satellite indicates the precise location of the vehicle.

eCall
Immediately after the collision, the vehicle unit transmits the following data to PSAP 112: time and location of the collision, direction and number of passengers. The occupants may then communicate with the 112 operator.

* Mandatory deployment of eCall for Member State PSAP by 1 October 2017 applies to cars and light vehicles.



PSAP112
An operator of the 112 emergency number can see the location of the collision on the map as well as the data transmitted by the eCall system and communicates with the passengers. They ensure immediate dispatch of the emergency units and forward information about the collision to the traffic information and management centre.

Unified Traffic Information System

VMS
TRAFFIC INFO

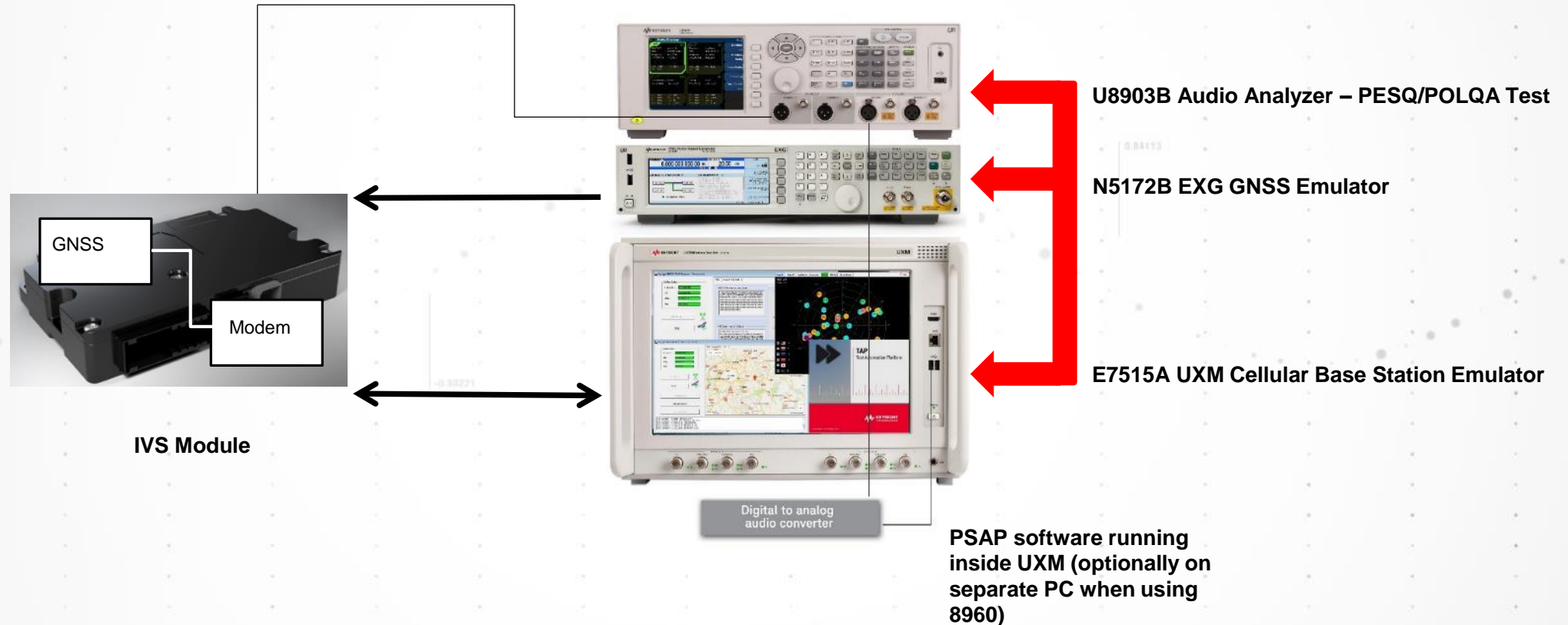
Integrated Emergency System
The emergency system sends units to the location of the accident.

eCall for HGV, buses and coaches
Additional data (besides the MSD) may be necessary for the emergency services to be effective. For HGV (including dangerous goods), information on the quantity and type of cargo is the key and external sources of information, for example electronic documents such as eCMR and eADR, could be vital. For buses and coaches, the number of passengers is key and passengers list provided electronically could be very useful for the rescue services.

eCall for PTW
Due to the absence of a collision-indicating trigger, like the airbag trigger in passenger cars nowadays, a specific triggering method is necessary for PTW. This triggering system as well as the statistical injury prediction method will lead to a realistic minimum of false positive and an acceptable level of false negative calls to PSAPs.

Keysight E6950A eCall Conformance Test System

VERIFY IVS MODULE FUNCTIONALITY TODAY



What is NG-eCall?

OVERVIEW

- Next-Gen eCall moves from 2G/3G to 4G
 - Requires 3GPP Release 14 on UXM (available now!)
- Based on 3GPP Release 14, December 2016
- Current IETF draft RFC 8147
 - MSD transfers in INVITE and INFO SIP messages
 - In-Band MSD over VoLTE/RTP used if SIP MSD fails
 - CSFB used in the event where eCall over IMS is not supported
- PSAP interworks with Keysight IMS/Server (E6966B)
 - IMS Server terminates the VoLTE (Voice Over LTE) call and forwards the critical positioning information etc. to the PSAP.

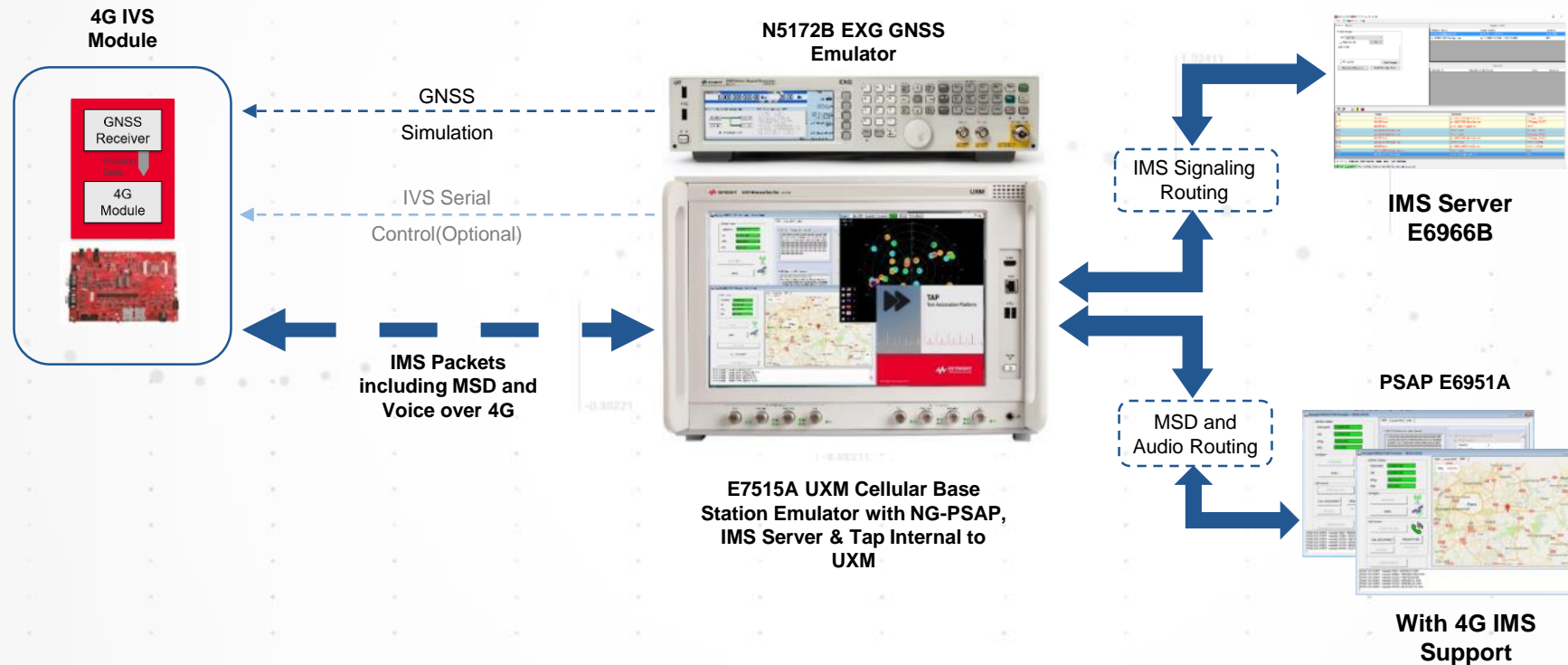
Why Next Generation eCall?

MAIN DIFFERENCE OF NG112 ECALL

eCall today	NG112 eCall
<ul style="list-style-type: none">• Accident	<ul style="list-style-type: none">• Accident
<ul style="list-style-type: none">• IVS calls 112 centre via GSM• Setup voice channel• Send MSD via in band modem	<ul style="list-style-type: none">• IVS calls 112 centre via VoIP (MSD is send with call setup message)• Emergency calls over LTE• Setup of voice channel
<ul style="list-style-type: none">• Connect driver with 112 centre operator• Operator can talk driver and see MSD data.	<ul style="list-style-type: none">• Connect driver with 112 centre operator• Operator can talk to driver ans see MSD data.

Keysight E6950A eCall Test Solution

VERIFY NG ECALL MODULE FUNCTIONALITY – UXM E7515A



NG eCall Solution configuration

CONFIG FOR ECALL/ERA-GLANASS/NG ECALL

*** Required Option**

- UXM wireless test set, E7515A, Hardware

Option	Description
E7515A-504*	Frequency Range 300MHz to 3.8GHz
E7515A-RA1*	RF up-down converter A
E7515A-BA1*	Digital baseband transceiver A
E7515A-RB1	RF up-down converter B
E7515A-BB1	Digital baseband transceiver B
E7515A-L01	Protocol logging data source

Note: Testing of NGeCall with a E5515AC/E is not possible as it does not support LTE/4G connections.

- EXG, N5172B, GNSS Sig Gen

Option	Description
N5172B*	Vector Signal Generator
N5172B-503*	Frequency Range, 9 kHz to 3 GHz
N5172B-653*	ARB Baseband Generator (60 MHz RF bandwidth, 32 Msa)
N5172B-660*	Upgrade Baseband Generator with Real-Time Capability
N5172B-022*	Upgrade baseband generator memory from 32 Msa to 512 Msa
N7609EMBC-1FP*	Signal Studio for Global Navigation Satellite Systems, Node-locked perpetual license

- UXM wireless test set, Software

Option	Description
E7535A-1FP*	FDD/TDD TA suite, fixed perpetual license
E7530A-FFP-OP1*	IP data, fixed perpetual license
E7530A-FFP-OH1	Handover, fixed perpetual license

- IMS Server, E6966B

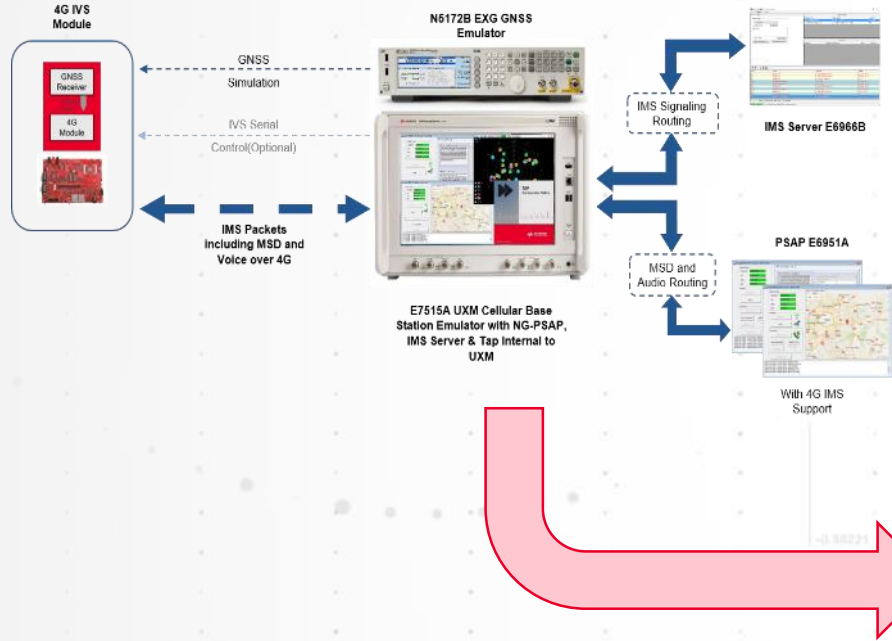
Option	Description
E6966B-1TP*	IMS-SIP server emulator, transportable, perpetual license*

- PSAP Software, E6951xA

Option	Description
E69511A-1FP	PSAP software for eCall, node-locked, perpetual license
E69512A-1FP*	PSAP software for ERA-GLONASS, node-locked, perpetual license(including E69511A-1FP feature license)
E69513A-1FP	PSAP software for Live Network Mode, node-locked, perpetual license
E69514A-1FP*	PSAP software for Next Generation eCall, node-locked, perpetual license(Require E69512A)

PSAP IMS/NGeCall Mode

SUCCESSFUL CALL START THE IMS/NGE CALL



The screenshot shows the E6951A Keysight PSAP Emulator software interface. The 'IMS/NG-eCall' tab is selected and highlighted with a red box. The interface is divided into several sections:

- Call Box Status:** Shows the instrument as 'IMS-SERVER', call state as 'CONNECTED', eFlag as 'eCall(IMS) Auto', and MSD as 'DECODED (IMS)'. All status indicators are green.
- Configure:** Includes buttons for 'INITIALIZE..' and 'GNSS...'. A radio tower icon is visible next to the 'GNSS...' button.
- Call Control:** Includes buttons for 'START IVS CALL', 'CALL DISCONNECT', 'REQUEST MSD', 'RE-DIAL', and 'CLEAR RESULTS'. A green telephone handset icon is next to the 'START IVS CALL' button. A 'Re-dial (T9)' label is below the 'REQUEST MSD' button.
- Server Information:** Shows fields for Server IP (127.0.0.1), WCF Port (8240), Server Port (5060), Virtual Client Port (9000), and Server Attached (Connected).
- Server Controls:** Includes 'IVS MSD Push' (unchecked), 'Enable IMS Mode' (checked), and a 'Disconnect' button.
- IVS Information:** Shows fields for IVS URI (< sip: +10000000001 >), IVS IP (192.168.1.5), and IVS Port (6000).
- Last SIP Message:** Includes an 'Open Message Log' button and a text area displaying SIP message details:

```
ACK sip:156.141.115.35:9000 SIP/2.0
Via: SIP/2.0/UDP 156.141.115.35:5060;branch=z9hG4bK2F480FE9
Via: SIP/2.0/UDP 156.141.115.35:6000;branch=z9hG4bK2E200ADD
Max-Forwards: 70
From: "MyDisplayName 1" < sip: +10000000001@156.141.115.35:6000 >;tag=0c075717
To: < sip: virtualclient@keysight.com >;tag=T4E038BDD
Call-ID: vw7m9jza02s1G6yYTT30Xw..
CSeq: 1 ACK
Contact: < sip: frazer@156.141.115.35:6000;transport=UDP >
Content-Length: 0
P-Asserted-Identity: MyDisplayName1 < sip: +10000000001@156.141.115.35:6000 >
```

Setting SIB1 on UXM Base Station Emulator

The screenshot displays the Keysight E7530A LTE/LTE-A Pro Test Application interface. At the top, two radio configurations are shown: Radio 1 (ON) and Radio 2 (OFF). Radio 1 is configured for PCC/FDD with a power of -85.00 dBm/15kHz, DL EARFCN 65986, UL EARFCN 131522, 10 MHz bandwidth, and Band 65. Radio 2 is configured for SCC/FDD with a power of -85.00 dBm/15kHz, DL EARFCN 300, UL EARFCN 18300, 10 MHz bandwidth, and Band 1.

The 'Message Summary' tab is active, showing a table of received messages:

Cell	Time	Dir	Message
1	14:50:36.646	DL	System Information Block (SIB1)
1	14:50:36.646	DL	System Information Block (SIB2, SIB3)
1	14:50:36.646	DL	System Information Block (SIB4, SIB6, SIB7)

The XML content of the SIB1 message is displayed below the table. Two sections are highlighted with orange boxes:

```
<eCallOverIMS-Support-r14> true </eCallOverIMS-Support-r14>
```

```
<tdd-Config-v14xy>
```

The bottom of the interface shows a navigation bar with tabs for System, Cell, PHY, Scheduling, MAC/RLC/PDCP, RRC/NAS, UE Info, IMS, BLER/Tput, CSI, Tx Meas, and Assisted Tx Meas. A settings gear icon is also present.

NG eCall standards

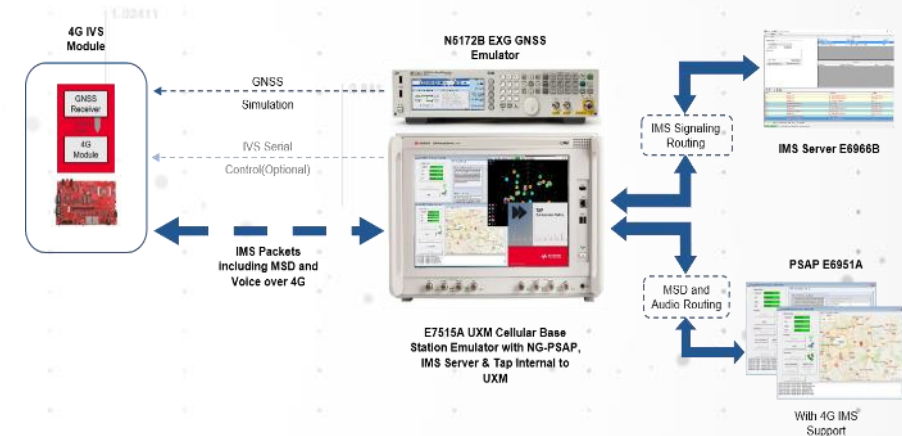
Base documents

Documents	Title	Current Status
RFC8147	Next-Generation Pan-European eCall	Published
ETSI TS 123 167 V14.6.0 (2018-09)	IP Multimedia Subsystem (IMS) emergency sessions	Published
ETSI TS 124 229 V14.8.0 (2018-06)	IP Multimedia Subsystem (IMS) emergency sessions IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3	Published
CEN EN 16062	Intelligent transport systems - ESafety - eCall high level application requirements (HLAP) using GSM/UMTS circuit switched networks	Published
CEN EN 16072	Intelligent transport systems - ESafety - Pan-European eCall operating requirements	Published
ETSI TS 103 428 V1.1.1 (2016-06)	eCall HLAP Interoperability Testing	Published

Interop Testing - Proposal

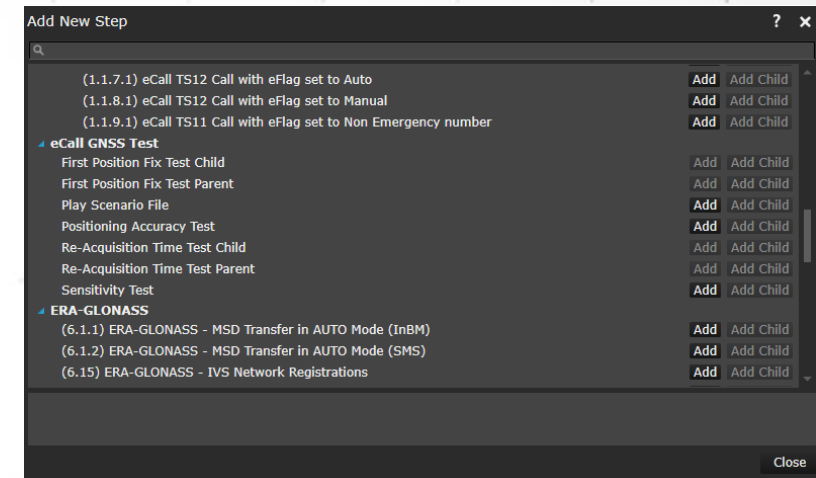
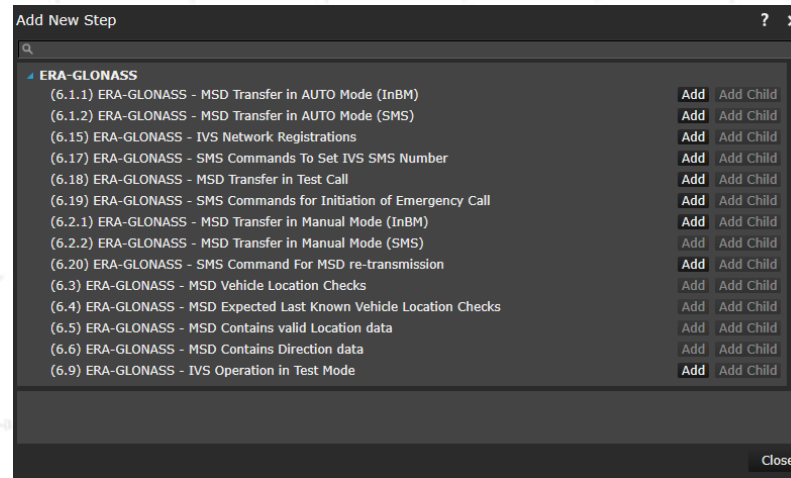
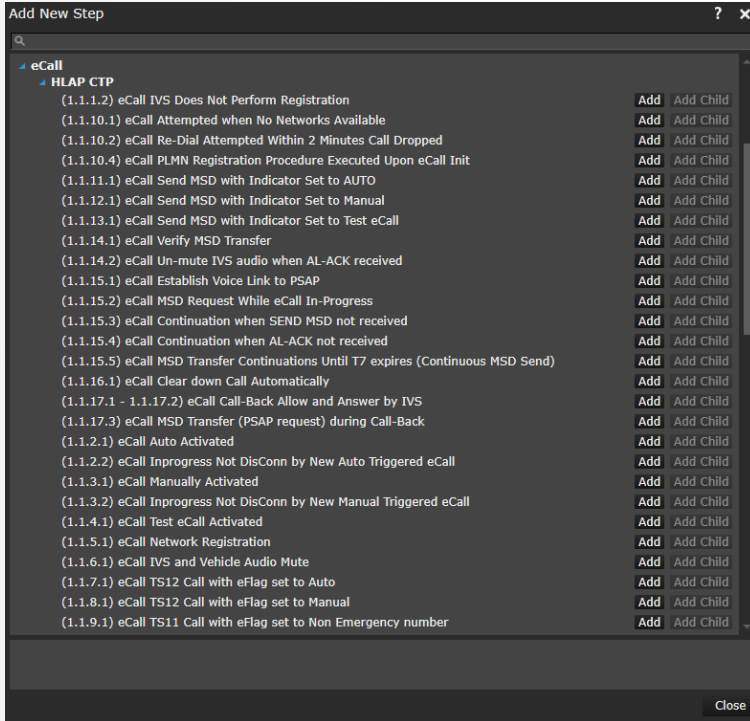
SUGGESTED INTEROP TEST PROCEDURE

1. LTE Cell access – Test if NG-IVS recognizes SIB 1 (NGeCall capable cell)
2. IMS Emergency Registration should then occur
3. SIP Invite containing MSD from NG-IVS
 - a. Check for eFlag via URN decode
 - i. Auto/Manual/Test Number
 - b. 200 OK eCall MIME body part
 - i. ACK = TRUE/FALSE/Not Present
 - c. After successful MSD decode - voice connection established and maintained
4. Assuming successful MSD decode and voice connection
 - a. SIP Info request to update MSD (similar to Request MSD on 2G/3G)
 - i. 200 OK/Timer tbd/Voice connection maintained
 - b. End call
 - c. Redial then SIP info procedure for MSD
5. Possible Failure Modes ...
 - a. If LTE Cell signals NG supported ... but MSD fails 200 OK (NACK)
 - i. MSD transferred over VoLTE (in band audio)
 - ii. MSD resend/update – sent over audio
 - iii. MSD resend/update using SIP Info
 - b. If LTE Cell reports that NGeCall is not supported ...then
 - i. IVS module can reselect another LTE cell
 1. **(UXM HAS 2 CELLS SO THIS CAN BE TESTED)**
 - ii. IVS may decide to opt for 2G/3G
 1. **CS FALLBACK**
 2. **IVS RESELECTION**



eCall/ERA-GLONASS Automated Test

TAP AUTOMATION



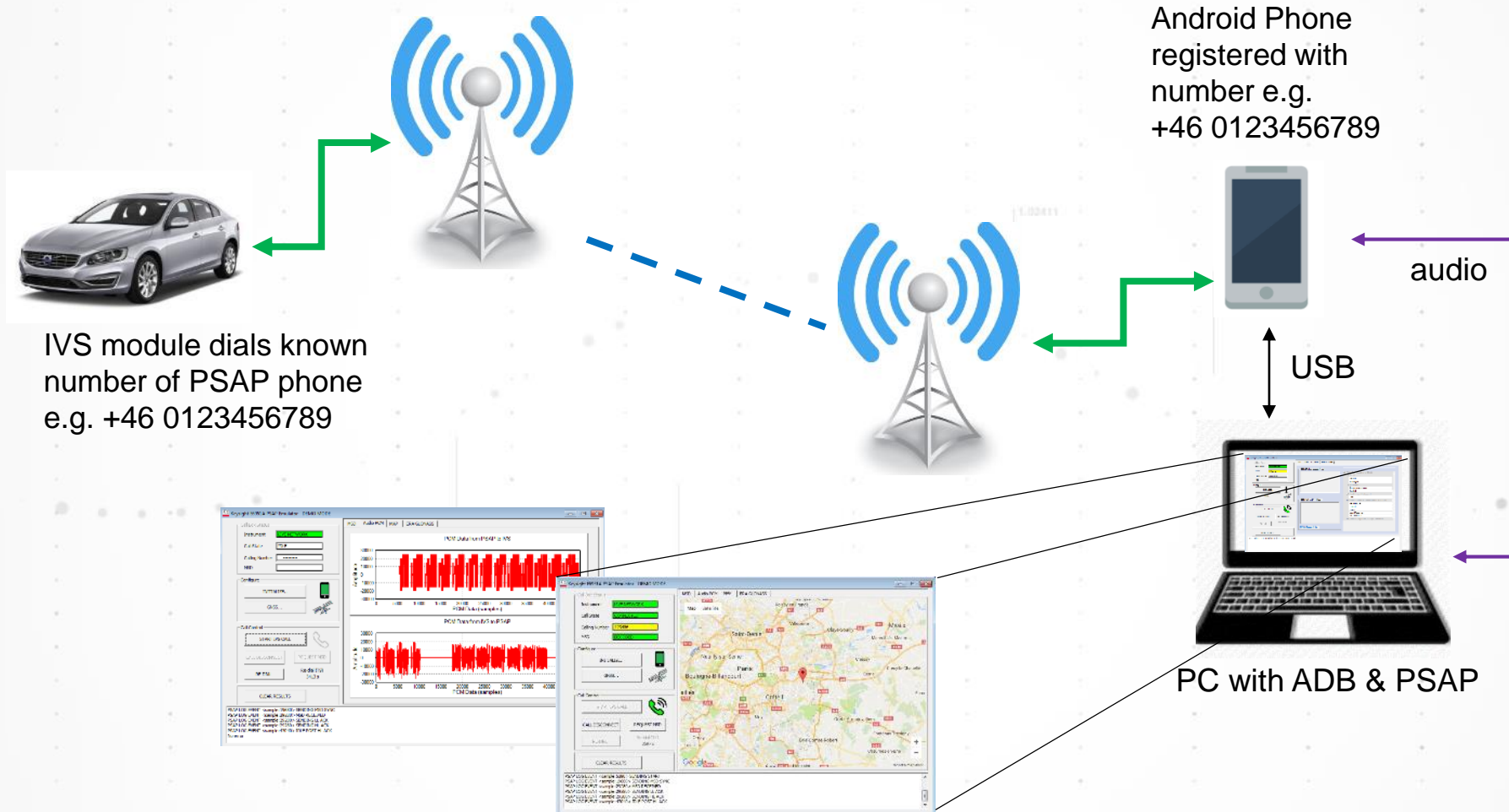
eCall Test Cases
ETSI TS 103 412

ERA-GLONASS Test Cases
GOST R 33467 → (was R-55530)

eCall scenarios for GNSS testing
(ANNEX VI of EU 2017/79 regulation)

- 2.2.2. Assessment of positioning accuracy in autonomous static mode (static).
- 2.2.3. Assessment of positioning accuracy in autonomous dynamic mode (dynamic).
- 2.2.4. Movement in shadow areas, areas of intermittent reception of navigation signals and urban canyons (dynamic).
- 2.2.5. Cold Start time to first fix test (static)
- 2.2.6. Test of re-acquisition time of tracking signals after block out of 60 seconds (static)
- 2.2.7. Test of GNSS receiver sensitivity in cold start mode, tracking mode, and re-acquisition scenario (static).

eCall Live Network Test - PSAP and Android Phone



Test the Future, Today.

WHY CHOOSE KEYSIGHT?

- **Summary**

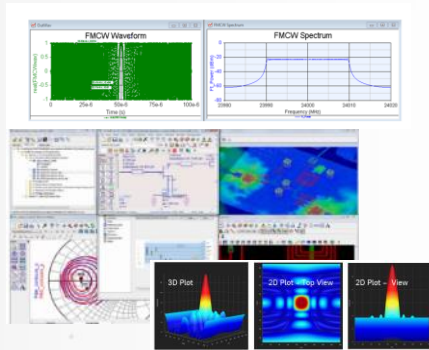
- Keysight support successful deployment of eCall.
 - Keysight **E7515A UXM** Wireless Test Set support **wide range of complex network operations.**
 - Achieve **greater confidence in RF performance**
 - Efficiently **verify performance of user equipment in an all-IP IMS-SIP test environment** using **E6966B IMS-SIP server/client** pair for testing voice, video, SMS and supplementary services on all-IP networks. Now with optional EVS Enhanced Voice Services Codec
 - Emulate realistic over-the-air (OTA) eCall parameters **using PSAP Live Network Test mode.**
 - Automated test Cases for eCall and ERA-GLONASS
 - Keysight eCall PSAP software certified by NavCert*.
 - Keysight eCall/ERA-GLONASS test solution earned ERA-GLONASS certification from Rosstandart**.
- ***Complete your certification and regression test using Keysight eCall conformance test solution.***

* NavCert is Notified Body (NB2603) for the European Electronic Toll System (EETS) based on EU-Directive 2004/52/EC (EETS).

** The Federal Agency for Technical Regulation and Metrology (Rosstandart) is a federal executive body providing government services and managing state property in the field of technical regulation and ensuring uniformity of measurements.

Keysight Wireless Solutions

OVER WHOLE DESIGN AND TEST LIFECYCLE



SystemVue Simulation SW



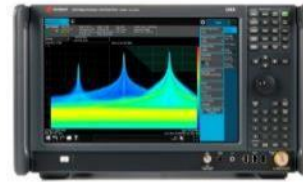
89600 VSA SW with WLAN option



MXA Signal Analyzer



PXA Signal Analyzer



UXA Signal Analyzer



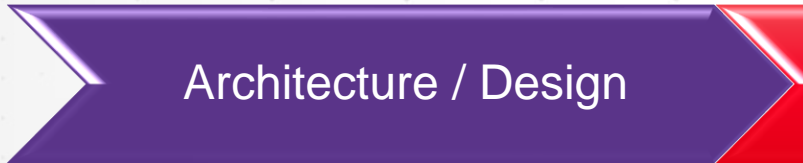
FieldFox N991xA



PXI VXT M9421A



Power Sensor and Meter



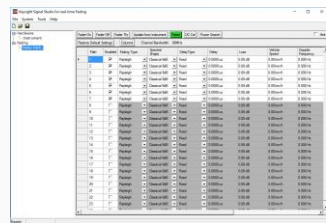
Architecture / Design



Development



Validation & Mfg.



N7605C SignalStudio for Real-time Fading



N5182B MXG Signal Generators



PROPSIM Channel Emulator



E6953A DSRC COC Certification Solution



E7515B UXM 5G



M9421A PXI VXT

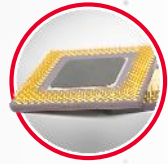


E6640A EXM

From Design Simulation, Signal Generation & Analysis, R&D to Manufacturing Tests

Keysight Now Provides Insight Across the Entire Stack

■ Keysight Classic ■ Ixia ■ Anite



**COMPONENTS &
CHIPSETS**



DEVICES



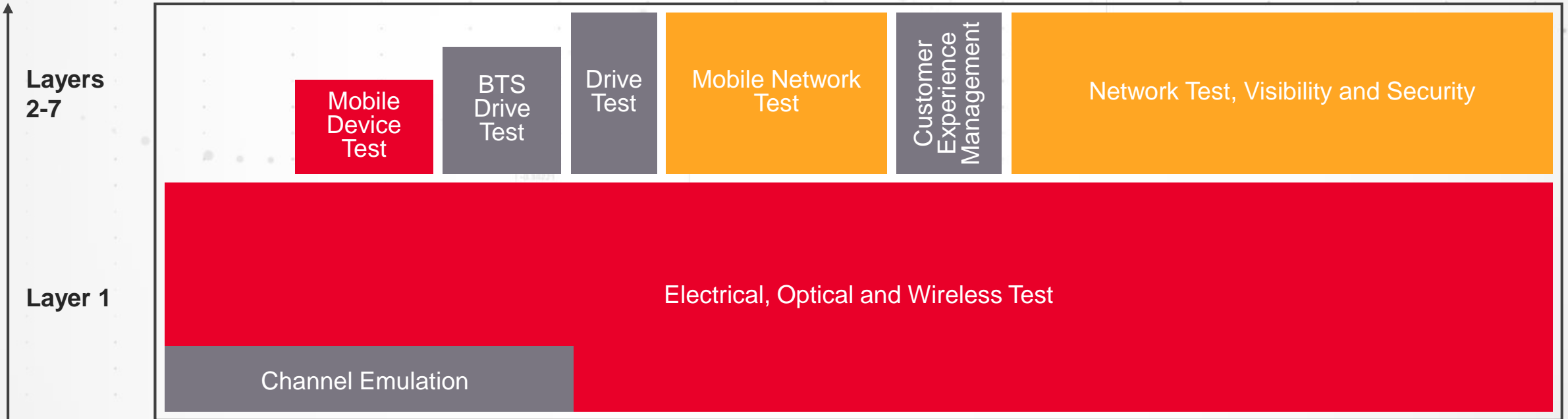
BASE STATIONS



**HYPERSCALE AND
DATA CENTERS**



ENTERPRISE



LEADER IN AUTOMOTIVE & ENERGY

Collaborations

ETSI, 3GPP, 5GAA,
IWPC, Autotech
Council, Car 2 Car,
and more

R&D Centers

in Germany, Detroit,
, Bay Area, and
Singapore

Over
50 Solutions

launched in
2017 alone

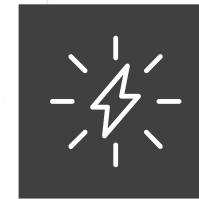


We Are at the Heart of the Revolution

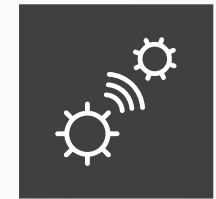
Accelerating Innovation to
Connect and Secure the World



WIRELESS



ENERGY



IOT



AUTOMOTIVE



**AEROSPACE
& DEFENSE**



**NETWORKING/
CLOUD**

