Intelligent Connected Vehicle (V2X) Introduction and Measurement Solution

车联网简介与测试方案

KEYSIGHT TECHNOLOGIES

HARDWARE + SOFTWARE + PEOPLE = INSIGHTS

Agenda

- Wireless Technologies Application in Automotive
  - E-call
- Wireless Technologies Verification in Automotive
  - 802.11p Test Requirement and Keysight Solutions
  - Bluetooth Test Requirement and Keysight Solutions
  - NFC Test Requirement and Keysight Solutions
- Virtual Drive Testing in Automotive
- Wireless Technologies in Automotive Summary

eCall 相关法案

欧盟议会eCall法案，2018年四月起所有的新车均需配备eCall技术
在发生严重事故时，eCall 自动拨打112（欧盟的紧急情况号码）

eCall 相关法案

Russia says ERA-GLONASS eCall is "fully operational"

By Telematics News Published: 20 January 2015
Posted in: eCall, Russia, Telematics

The ERA-GLONASS National Accident Emergency Response System commenced full operation in January 2015; Russian Prime Minister Dmitry Medvedev signed a corresponding Government Resolution, dated 26 December 2014. GLONASS Union is the exclusive general contractor for building and deploying the System.

The System began receiving the first alerts from the start of the year. Additionally, live system tests were held in the Russian regions for two weeks in January. The System demonstrated its full operational capabilities; all alerts were properly processed and transmitted to the emergency services.

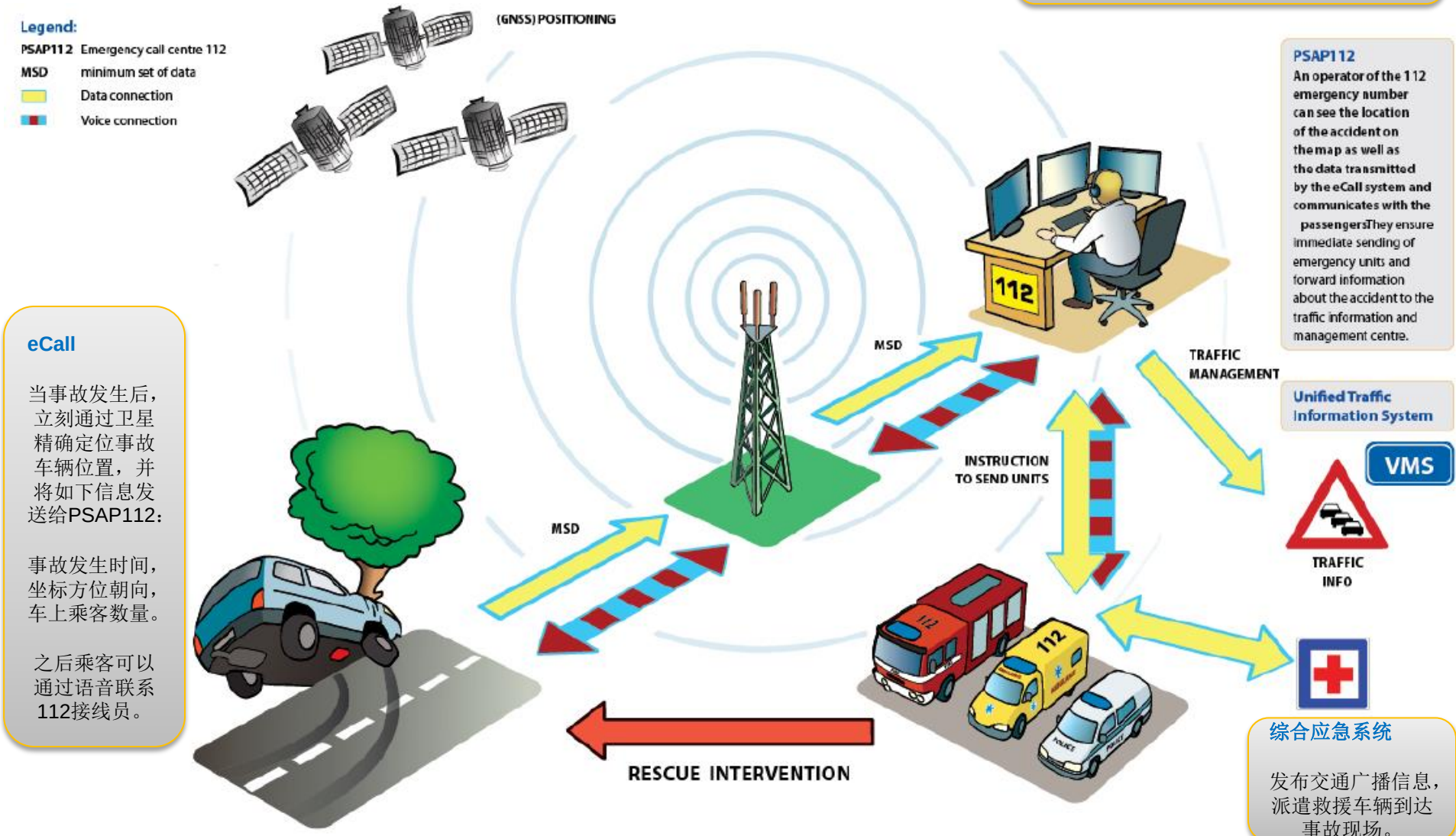
According to the Customs Union Technical Regulations, from 1 January 2015 all new vehicles, undergoing Customs Union Type Approval procedure for the first time, must be equipped with on-board ERA-GLONASS terminals. Starting in 2017, all new vehicles entering service in Customs Union member states will be equipped with the terminals. Owners of existing vehicles can already opt to purchase an ERA-GLONASS terminal, have it installed at a certified service center, and register with the GLONASS System.

俄罗斯从2017年起，每部新车必须装备ERA-GLONASS终端，用于紧急救援。

ERA emergency response system
GLONASS

eCall - 工作流程

PSAP：Public Safety Answering Point
公共安全应答处置点
MSD：Minimum Set of Data
精简化数据



eCall

当事故发生后，立刻通过卫星精确定位事故车辆位置，并将如下信息发送给PSAP112：

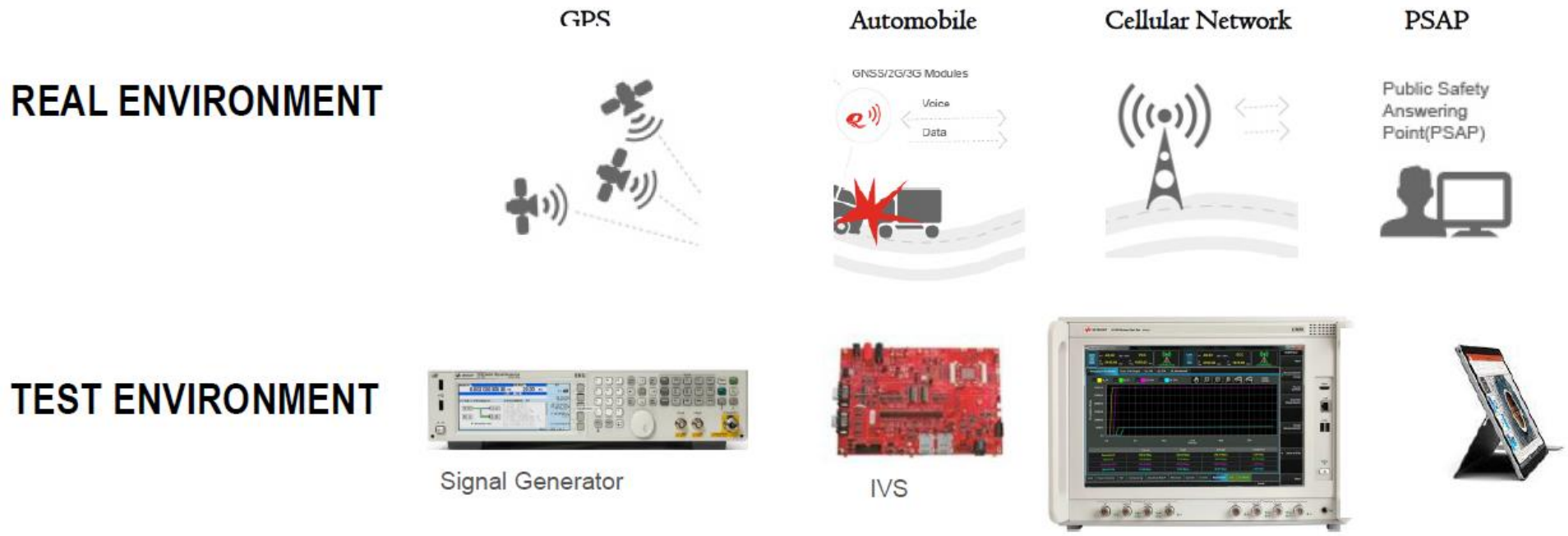
事故发生时间，坐标方位朝向，车上乘客数量。

之后乘客可以通过语音联系112接线员。

综合应急系统

发布交通广播信息，派遣救援车辆到达事故现场。

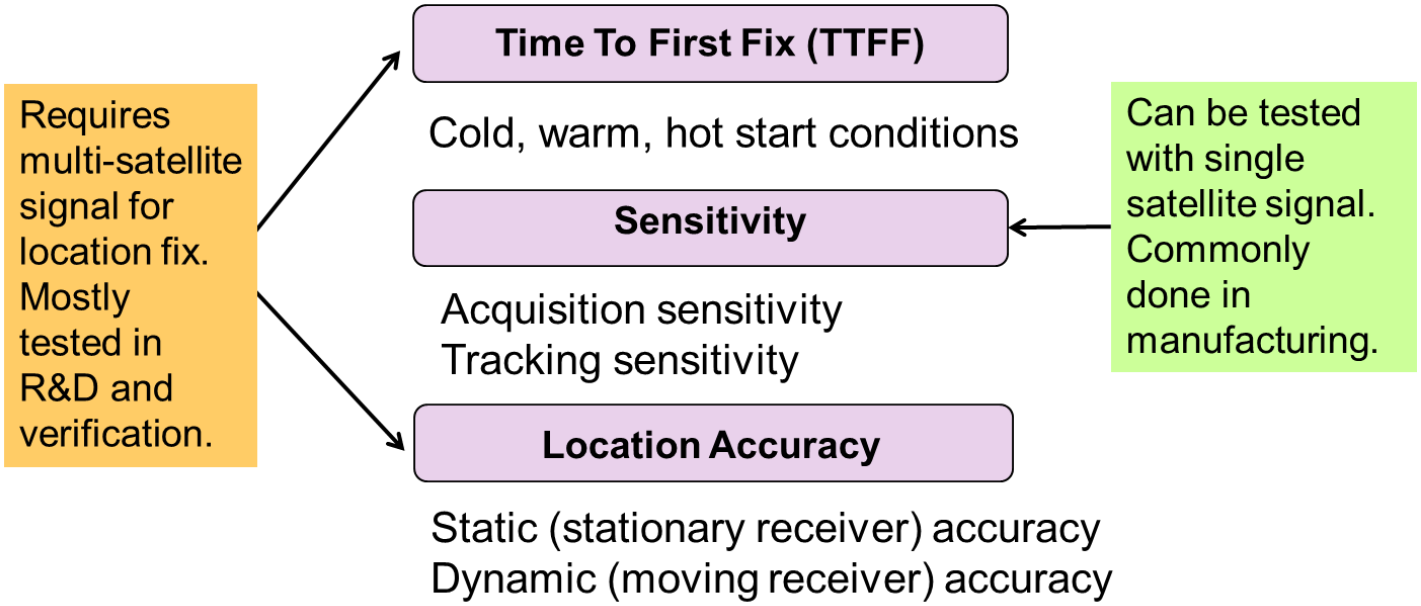
eCall - 测试解决方案



全球卫星导航系统

- **应用场景**
  - 为驾驶者提供导航服务
  - 提供位置信息 (ex. Location based service, eCall)
- **测试用例**
  - 包含对卫星导航系统的接收机验证：

    首次定位时间，接收灵敏度，位置精度等。



Global Navigation Satellite Systems

Global Positioning System (GPS)

- Operated by United States
- Fully operational since 1994
- Block IIF and Block III satellites being launched to provide additional signals and services

GLObal **NA**vigation **S**atellite **S**ystem (GLONASS)

- Russian system first launched by Soviet Union in 1982
- Became fully operational in October 2011
- GLONASS-K satellites being launched to provide additional signals

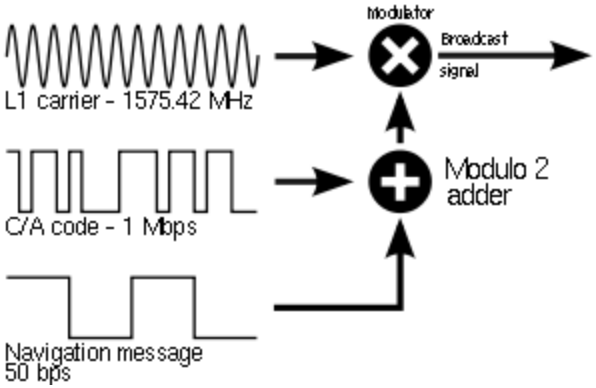
Galileo

- Joint project of the European Community and European Space Agency
- Experimental satellites launched in 2005 and 2008
- 4 In-Orbit Validation satellites launched in 2011 and 2012
- Initial open service planned by end 2016
- Completion of full system (30 satellites) planned for 2020

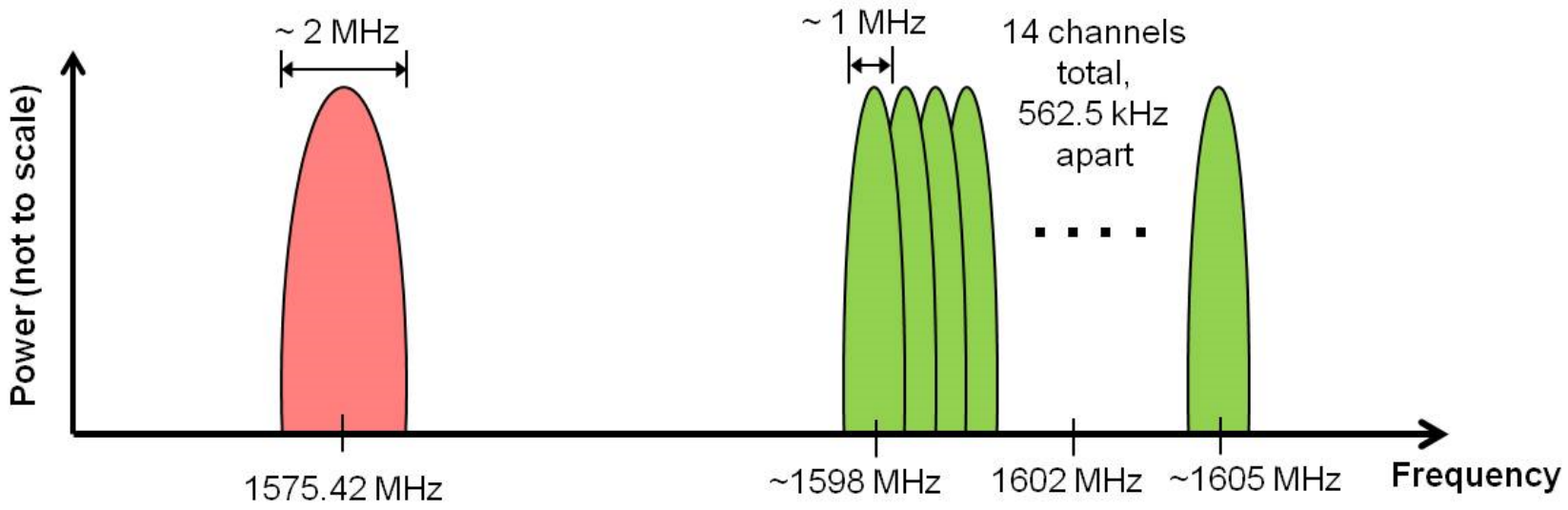
BeiDou (Compass)

- Developed by China
- 16 satellites launched, 14 in service following last launch in October 2012
- Began service for Asia-Pacific region in December 2012
- Completion of full system planned for 2020
- Interface Control Document (ICD) for open service signal published in December 2012

导航系统的工作频率



Standard	Freq* (MHz)	Mode	Country
GPS	1575.42	CDMA	USA
GLONASS	1602+Ch*0.5625	FDMA	Russian
Galileo	1575.42	CDMA	EU
Beidou	1561.098	CDMA	China



GPS L1 C/A Signal:
All satellites transmit at same frequency using different PRN codes

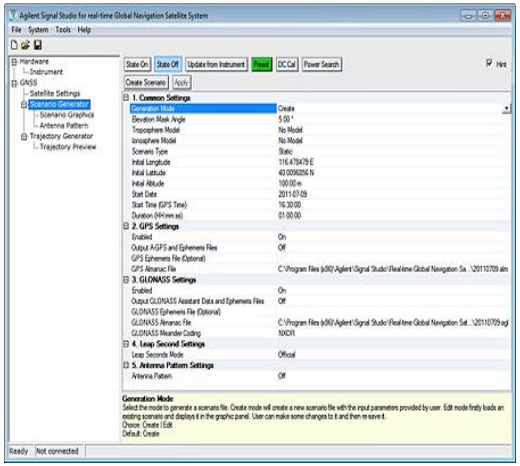
GLONASS L1 C/A Signal (FDMA):
Satellites transmit at different frequencies around 1602 MHz using same PRN code

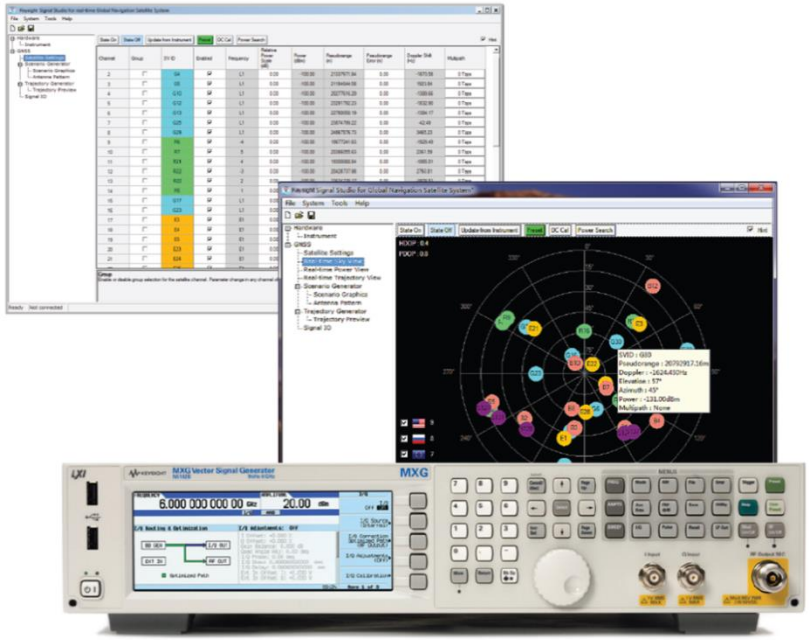
导航系统测试解决方案 - N7609B

可以客制化干扰信号，
如多径，伪距误差。

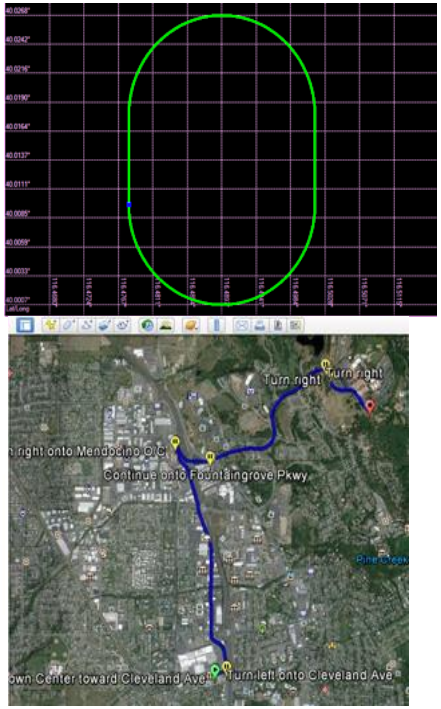
可模拟单颗卫星，测试接收灵敏度。
也可实时模拟多达**40**颗卫星的混合信号，
用以测试搜星速度。

支持轨迹运动信号的产生，
用以进行场测模拟。

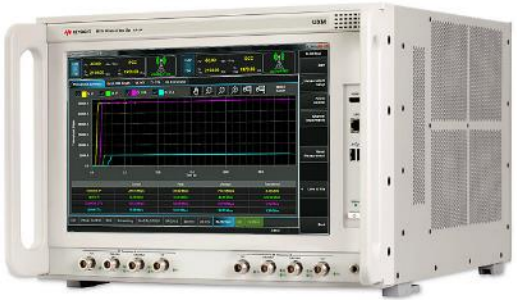




EXG (N5172B) / MXG (N5182B)

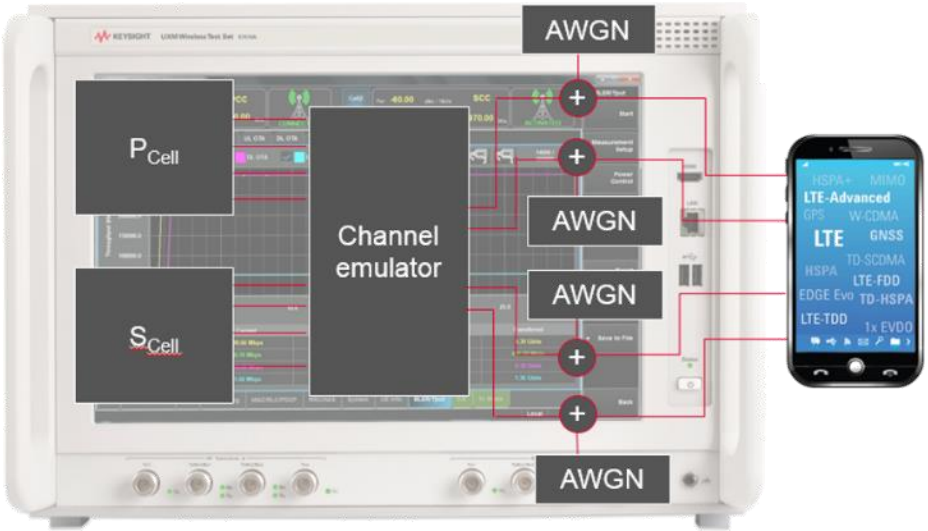


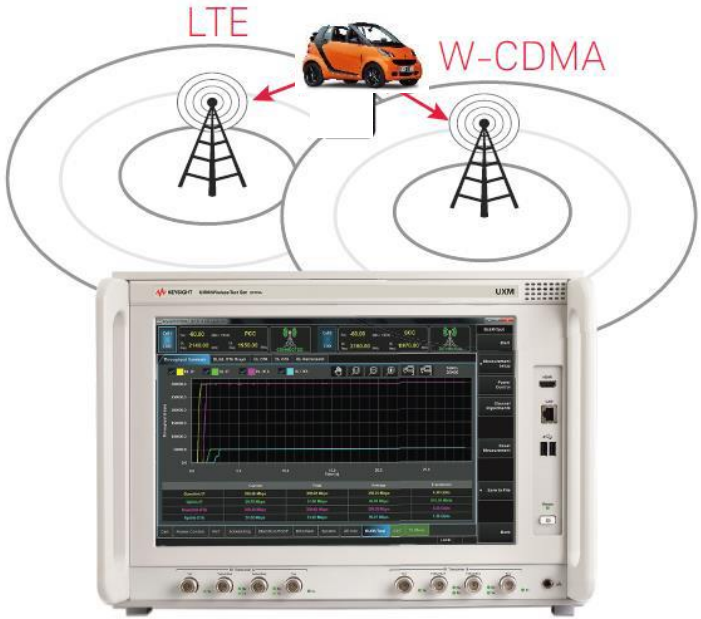
蜂窝网络信令测试解决方案 - UXM



E7515A UXM Wireless Test Set

- Full emulation of 2G/3G/LTE/LTE-A channel and network
- Verify máximum data rates
- Parallel testing
- i-RAT Handovers
- Protocol Logging
- VoLTE





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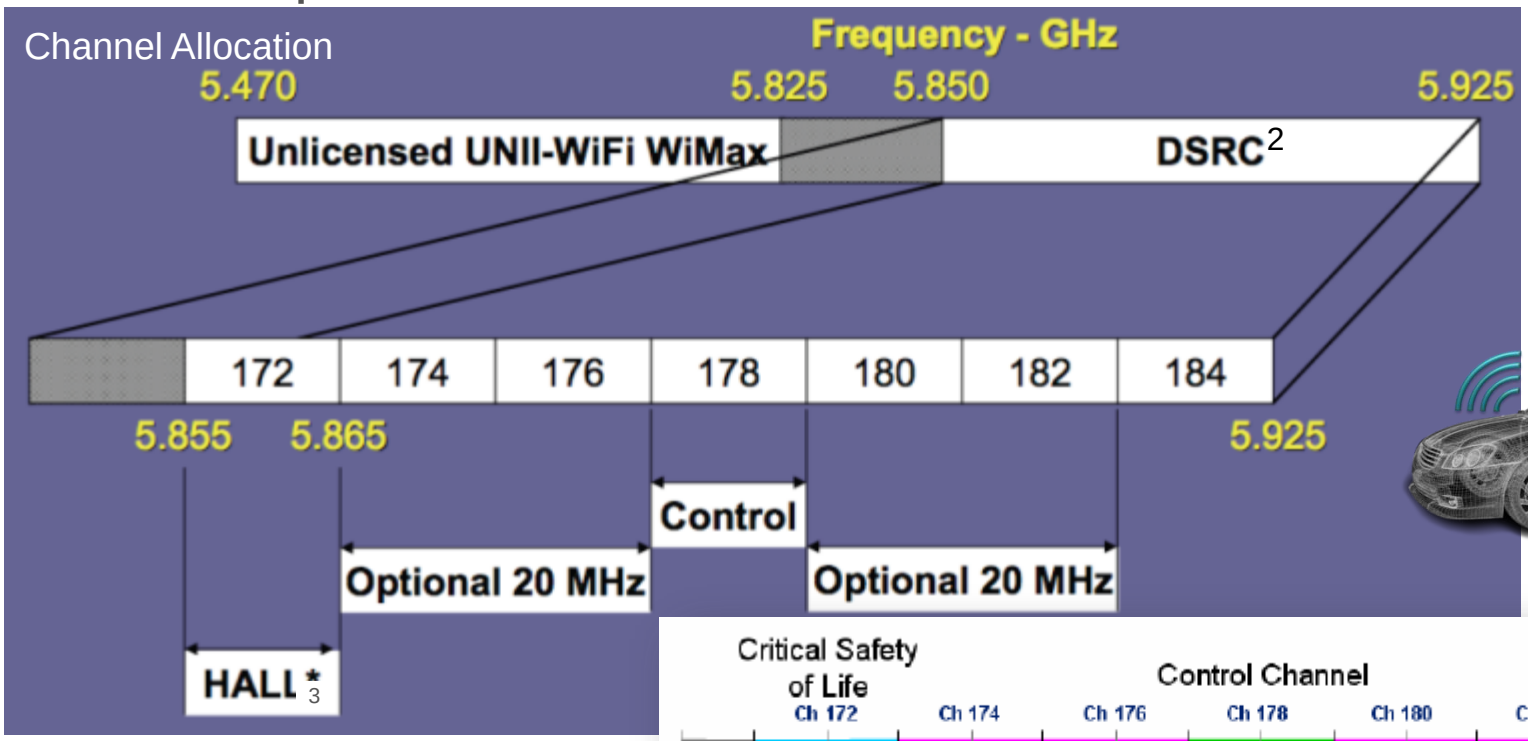
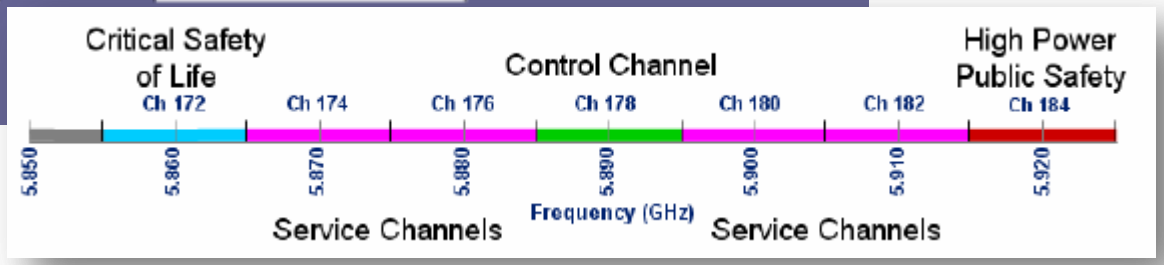
802.11p 工作频段

802.11p[1]





[1] Wireless Access for Vehicular Environment
[2] Dedication Short Range Communication
[3] High Availability and Low Latency

802.11p技术比较

802.11p vs. 802.11a

- **Frequency: 5.9 GHz (5.850-5.925 GHz)**
- **1 control and 6 service channels with 10 MHz spacing**
- **802.11p vs. 802.11a : Targets the reliable connection rather than higher data rates**

Physical parameters comparison between 802.11a and 802.11p standards

Parameters	802.11a (20 MHz)	802.11p
Channel bandwidth	20 MHz	5, 10 , 20 MHz
Bit Rate (Mbps)	6, 9, 12, 18, 24, 36, 48, 54	1.5, 2.25, 3, 4.5, 6, 9, 12, 13.5 18, 24, 27, 36, 48, 54
Modulation Type	BPSK, QPSK, 16QAM, 64QAM	BPSK, QPSK, 16QAM, 64QAM
Code Rate	1/2, 2/3, 3/4	1/2, 2/3, 3/4
# of Subcarriers	52	52
Symbol duration	4 µs	4.0, 8.0, 16.0 us
Guard Time	0.8 µs	0.8, 1.6, 3.2 µs
Preamble duration	16 µs	16, 32, 64 µs
Subcarrier Spacing	312.5 kHz	78.125, 156.25, 312.5 kHz
SEM	Fixed	Standard, Class A-D

802.11p 测量的挑战

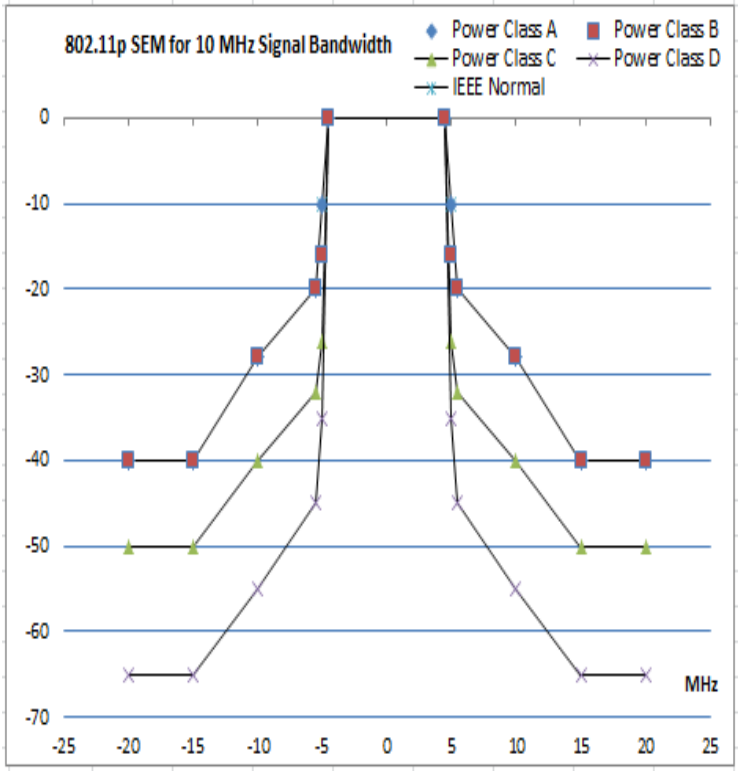
802.11p Class A-D power classification

Power class	Max. output power (dBm)
Class A	0
Class B	10
Class C	20
Class D	28.8

802.11p 10 MHz SEM definition

STA transmit Power class	Permitted power spectral density, dBr				
	±4.5MHz offset (± f_1)	±5.0MHz offset (± f_2)	±5.5MHz offset (± f_3)	±10MHz offset (± f_4)	±15MHz offset (± f_5)
Class A	0	-10	-20	-28	-40
Class B	0	-16	-20	-28	-40
Class C	0	-26	-32	-40	-50
Class D	0	-35	-45	-55	-65

802.11p SEM for 10M signal BW For power Class A-D



Much stricter SEM requirement for CLASS C and D device

Source: IEEE Std 802.11 ™- 2012

移动环境信道仿真

Example of WiFi Test Solutions – Channel Fading

802.11p_27M 64QAM
Real Time Channel Fading

Fading mode ON (Profile 5)

802.11p Receiver Test

- Signal Studio to generate 802.11p waveforms
- Support 5 MHz/10MHz/20MHz bandwidth
- **802.11p fading based on IEEE 802.11-14/0259r0 : V2V Radio Channel Models (MXG)**

MXG/EXG

\+

N7605B Signal Studio for Real-time Fading

Signal Studio

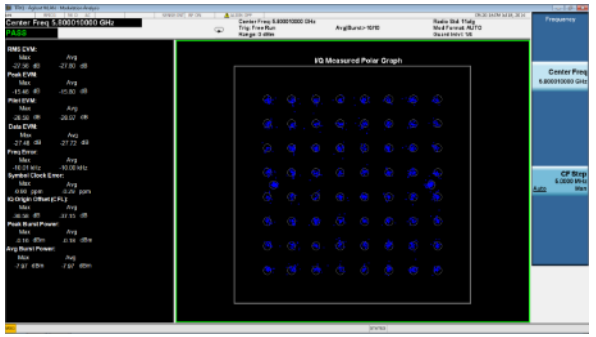
89600 VSA

802.11p 射频测试

R&D and Design Verification

– 802.11p Transmit Test Solution
  - MXA supports 802.11p
  - Product option MXA N9077A-2FP
  - Full measurement result set
    - Transmit Power
    - Modulation Accuracy
    - Spectrum emission mask
    - Out of Band emissions

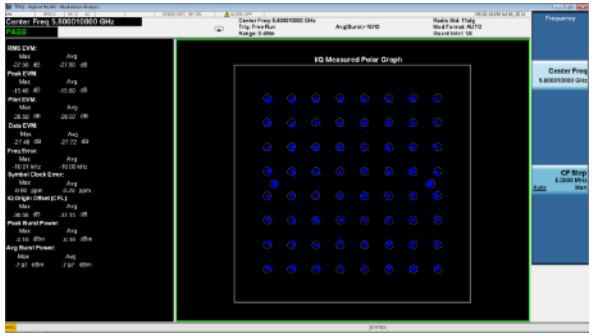
– 802.11p Receiver Test with MXG
  - Signal Studio to generate 802.11p waveforms
  - Support 5 MHz/10MHz/20MHz bandwidth



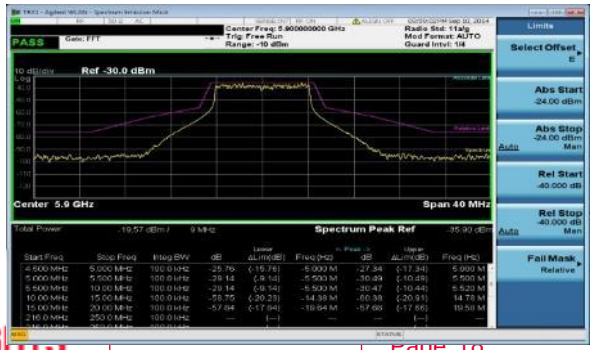
802.11p 射频测试

Design Verification and Production

– 802.11p Transmit Test Solution
  - EXM supports 802.11p
  - Product option EXM V9077B-2FP
  - Full measurement result set
    - Transmit Power
    - Modulation Accuracy
    - Spectrum emission mask

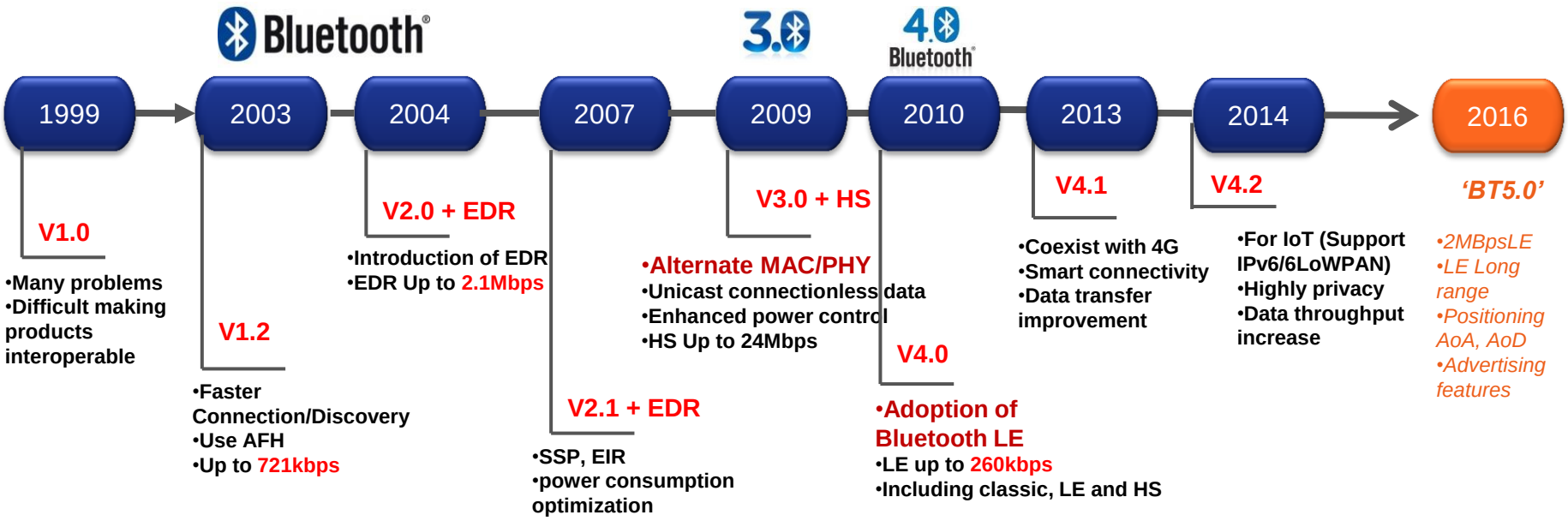


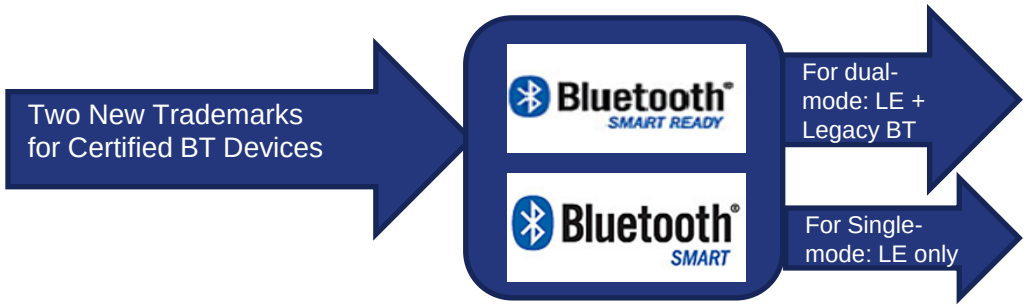
– 802.11p Receiver Test
  - Signal Studio to generate 802.11p waveforms
  - Support 5 MHz/10MHz/20MHz bandwidth



Signal Studio

蓝牙标准的演进





AFH: Adaptive Frequency Hopping
EDR: Enhanced Data Rate
SSP: Secure Simple Pairing
EIR: Extended Inquiry Response
LE: Low Energy
IPSP: Internet Protocol Support Profile

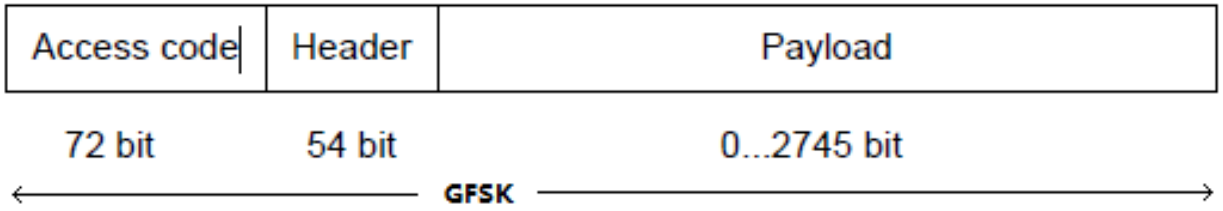
Bluetooth® Low Energy Vs. Classic

Technical Specification	Bluetooth Low Energy	Classic Bluetooth (BR/EDR/HS)
Radio frequency	2400 – 2483.5 MHz	2400 – 2483.5 MHz
Modulation Technique	Frequency Hopping	Frequency Hopping
Modulation Scheme/Index	GFSK / 0.5	GFSK / (0.28- 0.35)
Advertising channels	3	32
Data Channels	37	79
Channel spacing	2 MHz	1 MHz
Range	500m(class1) / 50m(class2)	100m
Over the air data rate	260 Kbps	721K/2.1M/24 Mbps
Nodes/Active Slaves	Unlimited (10-20 is practical #)	7
Max output power	20dBm(class1) / 4dBm(class2)	10dBm
Min output power	0dBm(class1) / -6dBm(class2)	-20dBm
Latency (from a non-connected state)	< 3 ms	100 ms
Network Topology	Star-bus (no mesh)	Piconet (with Scatternet)
Power consumption	0.01 to 0.5W(use case dependent)	1 W as the reference

蓝牙的帧结构（不同速率模式下）

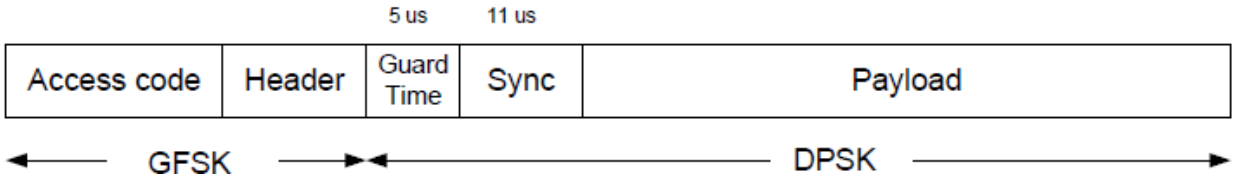
- **Basic Rate**

Every (data) packet consists of an access code, a header, and its payload:



- **Enhanced Data Rate**

An EDR packet contains the same access code and header (each GFSK) as a basic rate packet. In addition, a guard time area and a sync word area are inserted between the header and the payload. These two areas as well as the payload are DPSK-modulated.



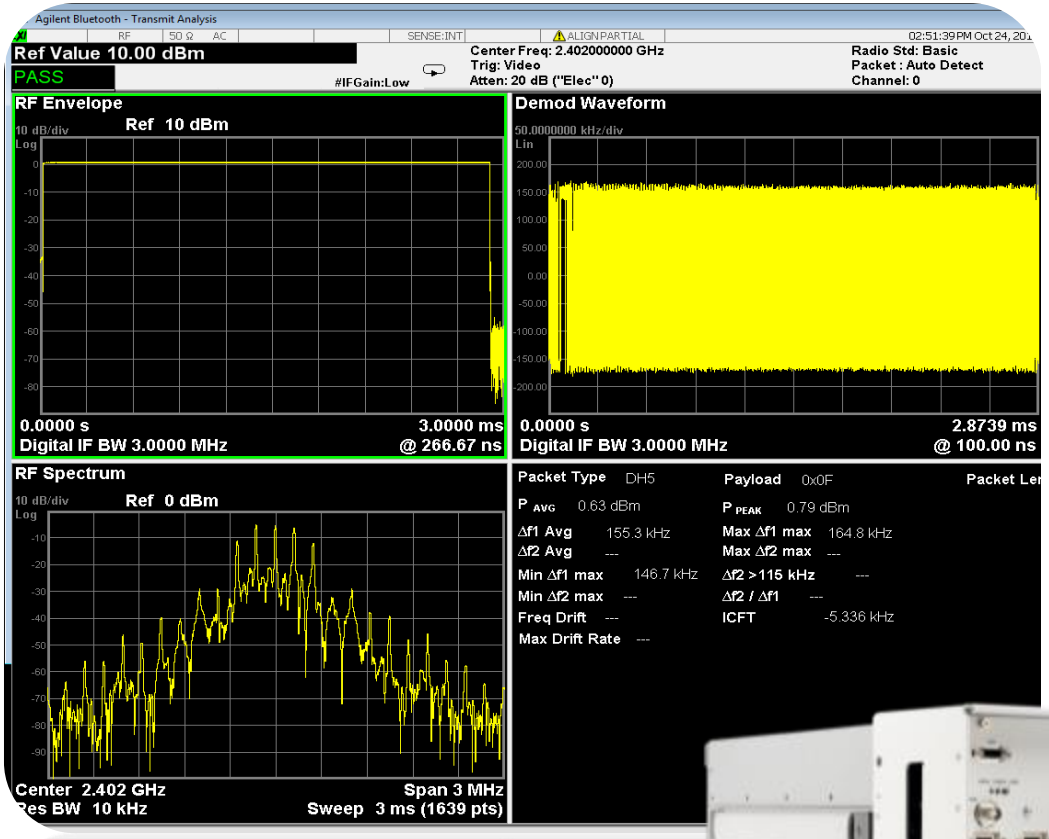
- **Low Energy**

Preamble	Access Address	PDU Header	PDU Payload	CRC
1 byte	4 bytes	2 bytes	variable (0 – 37 bytes)	3 bytes

GFSK

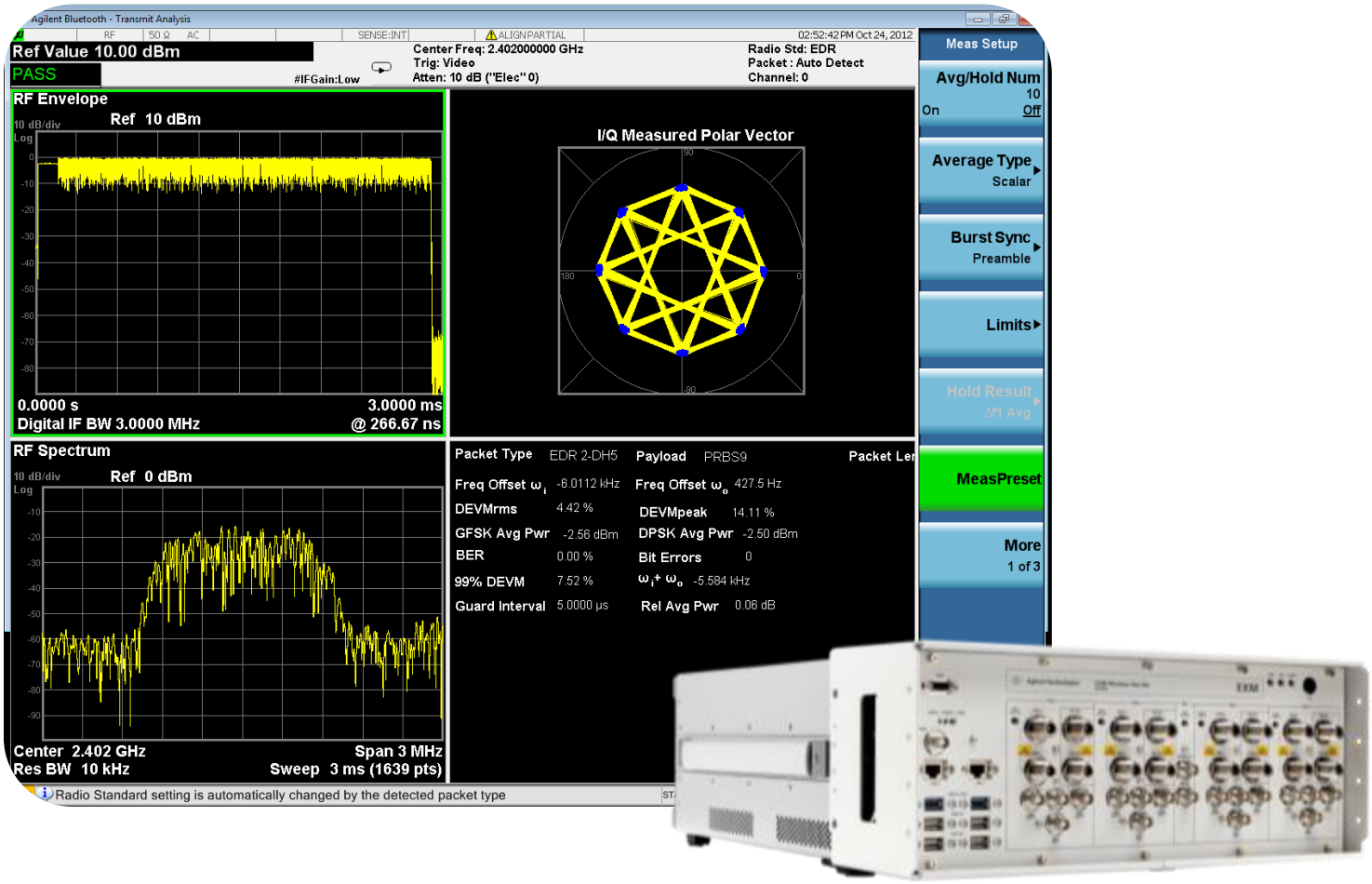
Bluetooth test BR

Header (GFSK) , Payload (GFSK)



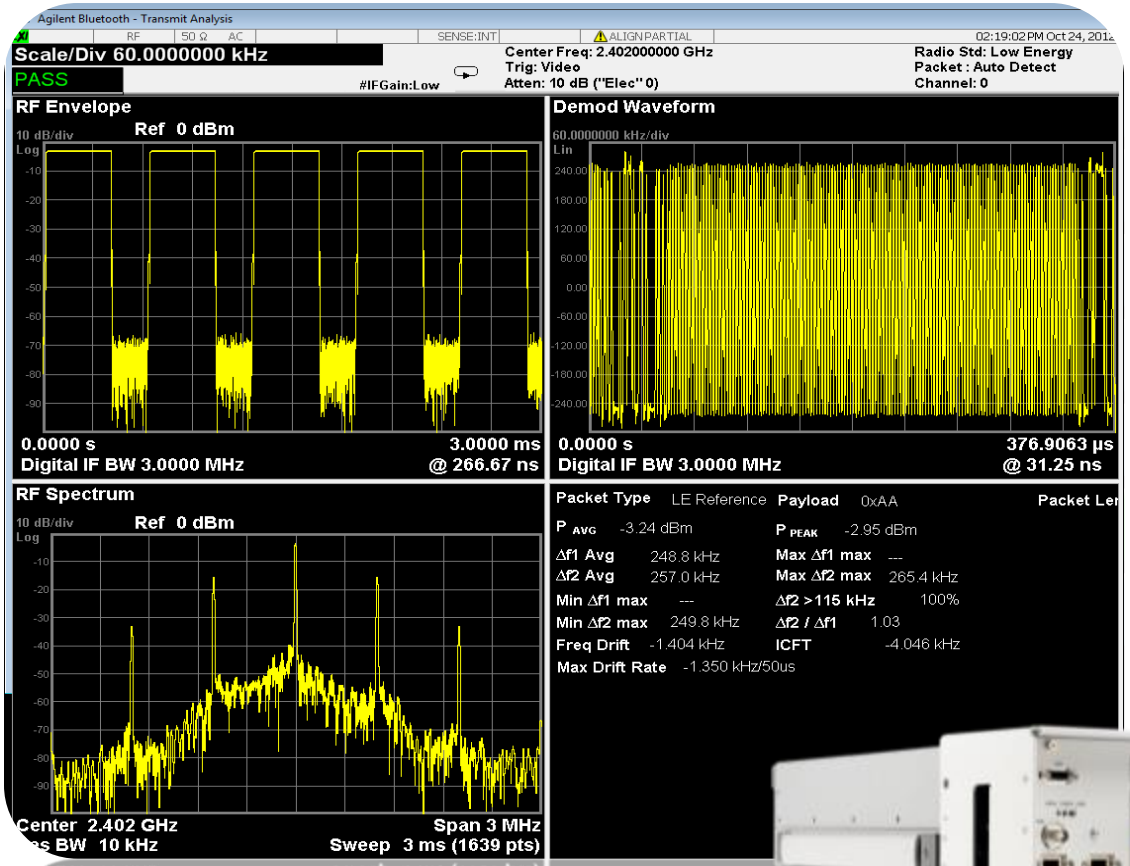
Bluetooth test EDR

Header (GFSK) , Payload (DPSK)

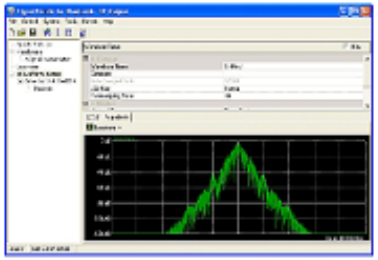


Bluetooth test BLE

Header (GFSK) , Payload (GFSK)



Bluetooth Rx test



N7606B Signal Studio for Bluetooth®

Sold By: Keysight - Call for availability

View Technical Overview

Visit Discussion Forums

Visit Technical Support

Bluetooth v 1.1

- Packet parameter setup
  - Link type: SCO, ACL
  - Packet type: NULL, POLL, FHS, DM1, DM1, DH1, HV1, HV2, HV3, DV, AUX1, DM3, DH3, DM5, DH5
  - Modulation: GFSK (BT=0.5)

Bluetooth v 2.1 + EDR

- Packet parameter setup
  - Link type: SCO (basic data rate), eSCO (basic or enhanced data rate), ACL (basic or enhanced data rate)
  - Packet type: 2-DH1, 3-DH1, 2-DH3, 3-DH3, 2-DH5, 3-DH5, EV3, 2-EV3, 3-EV3, EV4, EV5, 2-EV5, 3-EV5
  - Modulation: GFSK (BT=0.5) + DQPSK (2 Mbps), GFSK (BT=0.5) + D8PSK (3 Mbps)

Bluetooth low energy

- Packet parameter setup
  - Packet types
  - -- Reference channel: Reference
  - -- Advertising channel: Adv_Ind, Adv_Direct_Ind, Adv_Nonconn_Ind, Adv_Scan_Ind, Scan_Req, Scan_Rsp, Connect_Req,
  - -- Data channel: LL_Data, LL_Connection_Update_Req, LL_Channel_Map_Req, LL_Terminate_Ind, LL_Enc_Req, LL_Enc_Rsp, LL_Start_Enc_Req, LL_Start_Enc_Rsp, LL_Unknown_Rsp, LL_Feature_Req, LL_Feature_Rsp, LL_Pause_Enc_Req, LL_Pause_Enc_Rsp, LL_Version_Ind, LL_Reject_Ind, Reference
  - -- Packet modulation: GFSK (BT=0.5)

NFC 技术特点

建立通信连接，只需轻轻一点。

- ✓ 基于工作在 13.56MHz 的 RFID 技术.
- ✓ 工作距离通常不超过10 cm.
- ✓ 数据速率最高不超过 848 kbit/s.
- ✓ 3种工作模式: P2P, Card Emulation and Reader/Writer
- ✓ NFC 将与 *Bluetooth*® 和 Wi-Fi 技术互补，并且可以支持EMV™ 非接触式支付.
- ✓ 可以被用于汽车安全授权领域

Pictures Source Internet

NFC 操作模式

- ✓ **Reader Writer （读写器）**

  Retail
  Tourism
  Healthcare

- ✓ **Card Emulation（卡模拟）**

  Payment
  Transport
  Identification

- ✓ **Peer to Peer（点对点）**

  Data Transfer
  Bluetooth
  Pairing

R/W

身份识别
健康管理

电话（主动装置）13.56MHz
外设（被动装置）负载调制

CE

移动支付
门禁管理

电话（被动装置）负载调制
外设（主动装置）13.56MHz

P2P

资料交换
蓝牙配对

电话（主动装置）13.56MHz
外设（主动装置）13.56MHz

NFC 产品认证

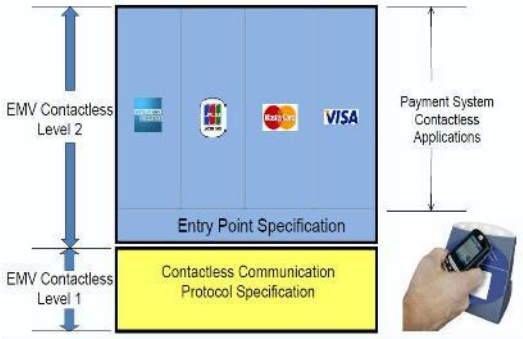
主要的认证组织

NFC Forum

- Covers proximity Technologies A, B and F.
- Planning to add vicinity technology soon (15693)
- Device supports R/W, P2P and CE (optional)
- Test require DTA
- Accredited certification labs

EMV contactless (EMVCo)

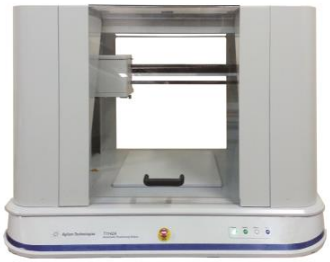
- Specs and certification program for payment devices
- Contact testing (ISO/IEC 7816)
- Contactless testing (ISO/IEC 14443 A and B)
- L2 according to each payment scheme



NFC测试系统的硬件组成

Keysight T3100S 系列包括:

- T3111S NFC一致性测试系统
- T3121S NFC研发测试系统
- T1141A NFC测试仪
- T1142A自动定位机器人



T1141A NFC综测仪

T1141A NFC综合测试仪是T3111S和T3121S系统的核心。

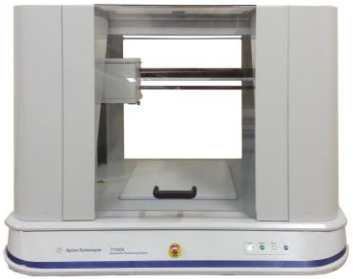
T1141A 支持模拟射频和数字协议等测试，包括以下NFC器件测试功能:

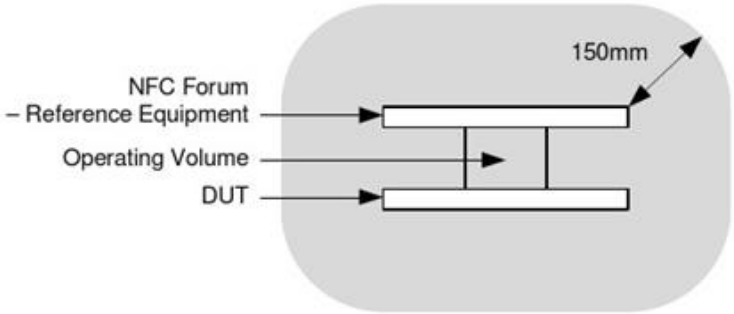
- 卡和终端脚本仿真
- 任意波形生成
- 全面且深入的波形、逻辑、协议和电压分析

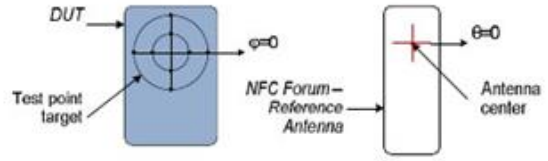
T1142A NFC自动定位仪

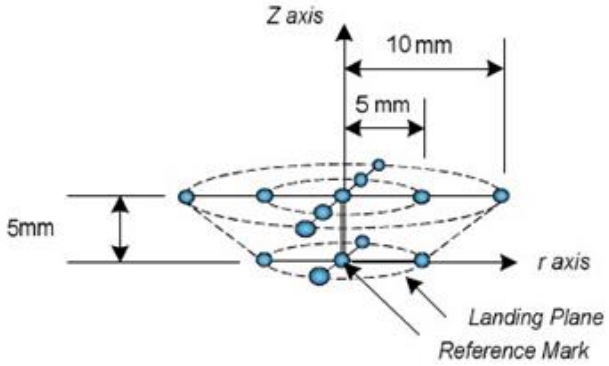
提供精确且可复验的天线定位，

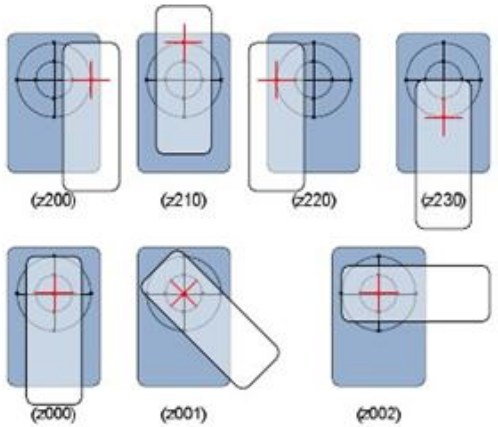
满足测试的位置精度和测试效率挑战。











NFC生产测试方案

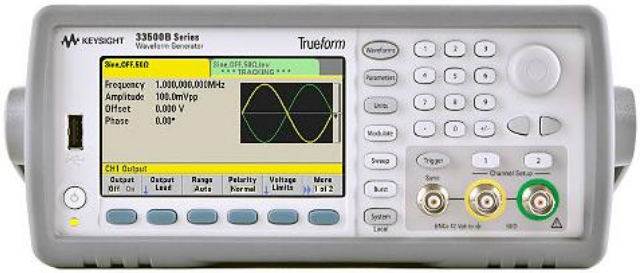
示波器+任意波形发生器

示波器：DSO-X3014T

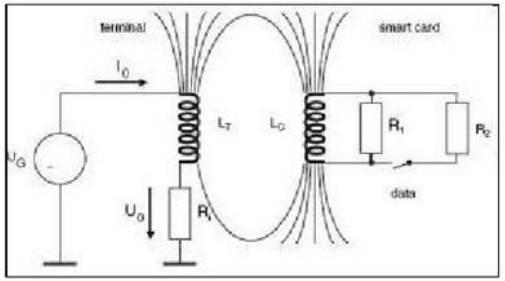
- **100M带宽，4通道示波器，NFC测量界面**

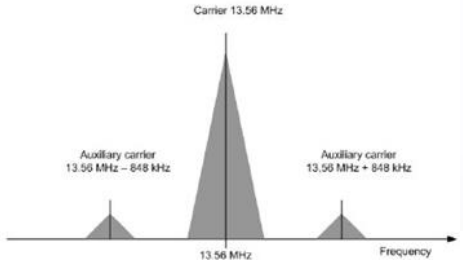
波形发生器：33522B（带MEM选件）

- **30M带宽，双通道任意波形发生器**



NFC天线：T3111S-SH1





Agenda

- Wireless Technologies Application in Automotive
  - E-call
- Wireless Technologies Verification in Automotive
  - 802.11p Test Requirement and Keysight Solutions
  - Bluetooth Test Requirement and Keysight Solutions
  - NFC Test Requirement and Keysight Solutions
- Virtual Drive Testing in Automotive
- Wireless Technologies in Automotive Summary

汽车真实使用环境

如何将真实环境带入实验室

Safe Cost Time Coverage Reproduction

传统外场测试已经无法满足车联网的性能测试需要

模拟路测 - 主要硬件平台

2G/3G/4G网络模拟器　　无线信道仿真仪

Anite 9000

Propsim

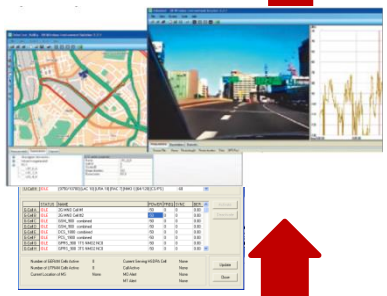
模拟路测 - 传导测试方案

车载通信模块 测试方案

从真实外场网络，记录网络侧信令流程，以及无线信道环境。

实验室重建网络配置以及信令业务脚本，同时重构无线传播环境

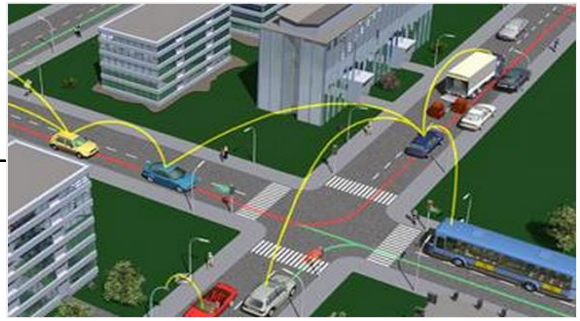
连接车联网部件，在实验室运行虚拟路测测试用例



模拟路测 - OTA测试方案

整车性能 测试方案

V2V: Vehicle to Vehicle
V2I: Vehicle to Infrastructure
V2R: Vehicle to Roadside

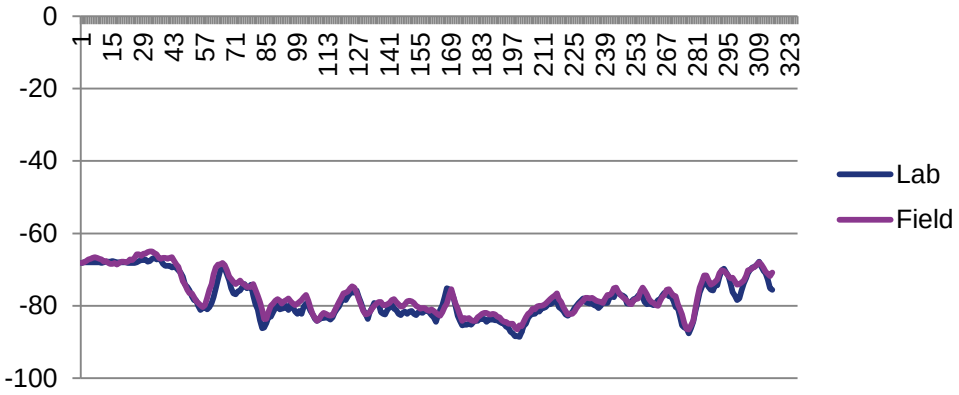


信道仿真仪在实验室重构典型车联网无线环境

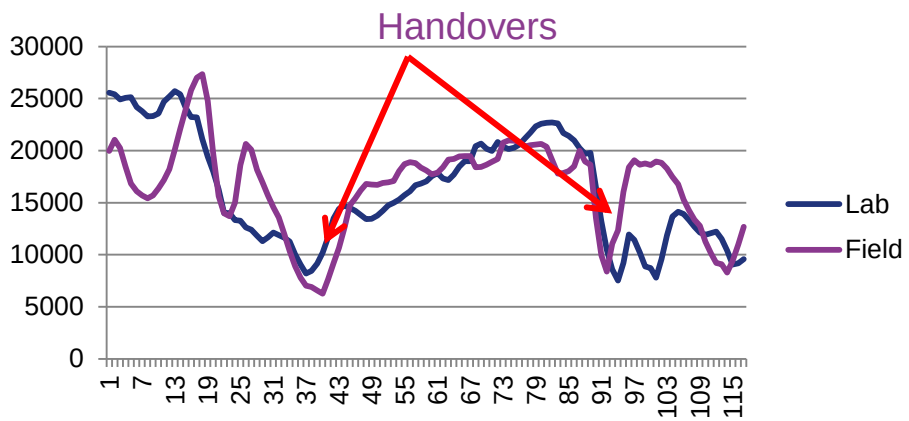
微波暗室完成空间信息搭建，更重要的是完成OTA方案中与被测物的无线连接测试

外场与实验室模拟测试结果对比

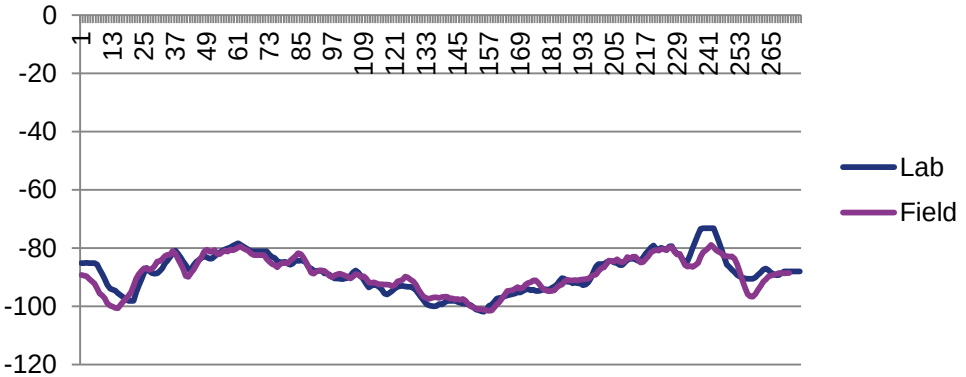
RSRP serving



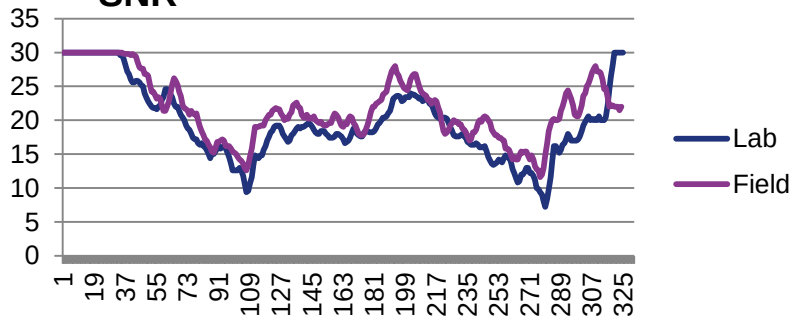
FTP Through put



RSRP neighbor



SNR



RSRP：Reference Signal Receiving Power 参考信号接收功率
SNR：Signal-to-noise ratio 信噪比
FTP Through put：FTP服务器数据吞吐量

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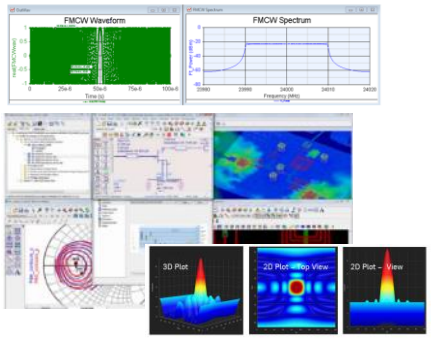
Wireless Technologies in Automotive Summary

Standards		Freq(s)	Max chan. BW	Mod/ Tech.	Comments
802.11p		5.85-5.925 GHz	20MHz	OFDM	aka WAVE, DSRC, ITS-vehicular use
Blue tooth (802.15.1)	BT1.0	2.4GHz	1MHz (hop)	GFSK	WPAN
	EDR BT 2.0		2MHz	DQPSK	EDR up to 2.1 Mbps
	BT LE 4.0/4.2/5.0		500KHz	GFSK	Single mode (BT Smart) Duel-mode (Smart Ready)
NFC		13.56MHz	1MHz	FSK, ASK	E-Ticket, access control, seat position
RFID		130kHz 13.56 MHz 900 MHz 2.4/5.8 GHz	1MHz	FSK, ASK	Transportation and logistics, Tracking item, EZ-Pass
GNSS		L1: 1575.42GHz L2: 1227.6GHz L5: 1176.45GHz	~30MHz	CDMA or FDMA w/ BPSK, QPSK, BOC, AltBOC	GPS (USA), Beidou(China), Galileo (EU), GLONASS (Russia), QZSS (JP), SBAS

Keysight 车联网系统化解决方案

"Over Your Design and Test Lifecycle"



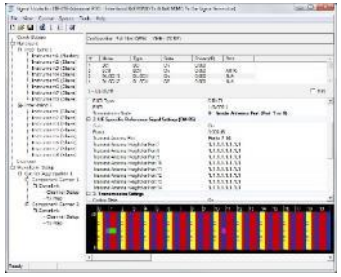
ADS / SystemVue Simulation SW

E7515A UXM Wireless Test Set

T4010S Conformance Test System

E6640A EXM Wireless Test Set

Architecture / Design → Development → Validation → Manufacturing



Signal Studio and
Signal Creation Software

X-Series Signal Analyzers

X-Series Signal Generators

X-Series Oscilloscopes

Questions?

Thank you!

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Keysight Technologies, Inc.

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