KEYSIGHT WORLD2018

IoT Wireless Design and Test Challenges

Solution Engineer / Keysight Technologies

Ki-Hee Han

Agenda

- IoT/M2M Introduction
- IoT/M2M Key Enabling Wireless Technologies
- Test challenges and Solution
- Summary

The Internet of Things

THIRD PHASE OF THE INTERNET REVOLUTION

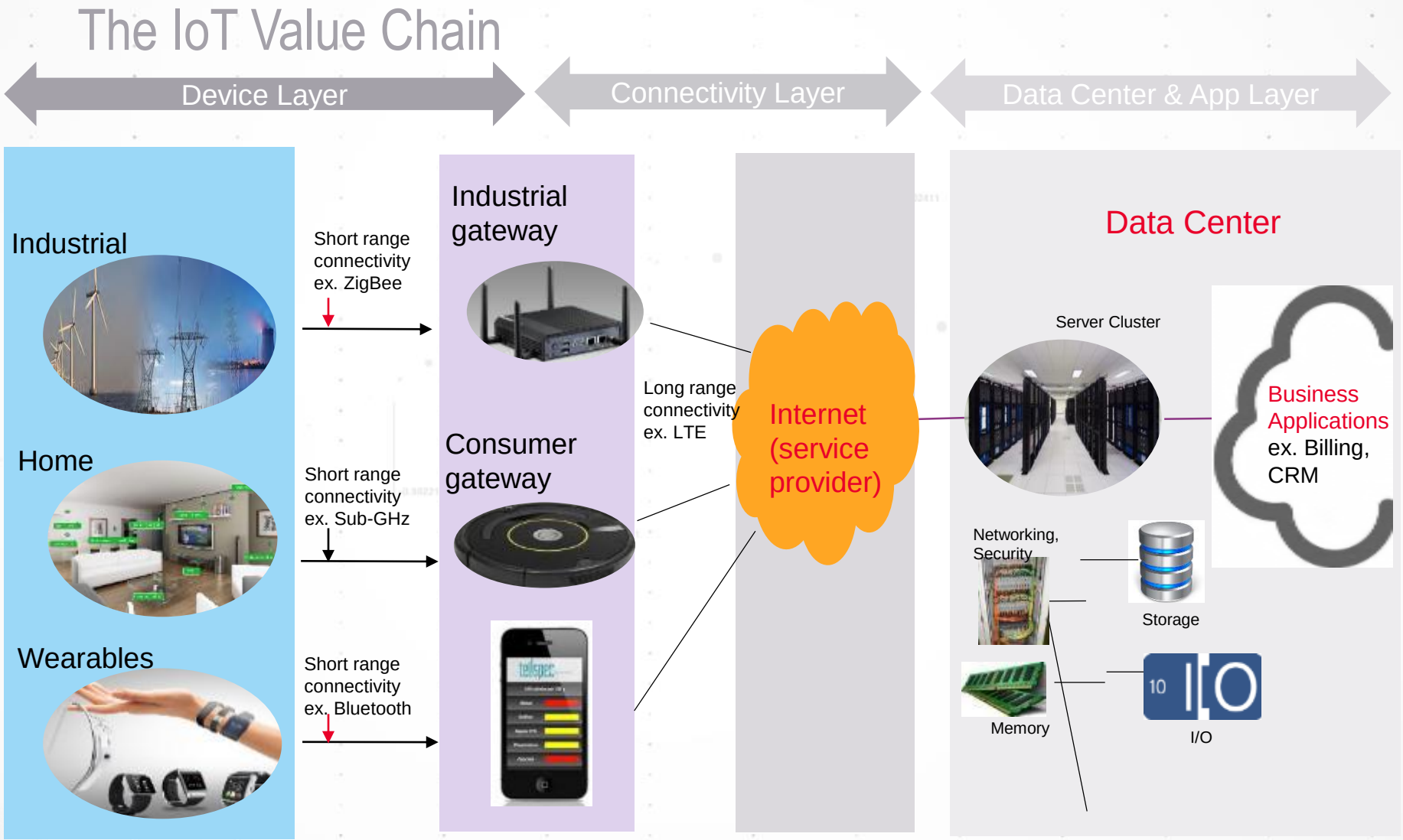
Fixed Internet
+1 Billion

Mobile Internet
+2 Billion

Internet of Things
+50 Billion

1990 **2000** **2010-2020**

How Do IoT Devices Work?



Primary IoT Market Segment

Internet of Things (IoT) / Machine To Machine Market

Wearable Healthcare Devices

- Smart watch
- Wearable glasses
- Smart bands
- E-textiles
- Hearing-aid
- Health monitor

Smart Home

- Controller
- Appliances
- Sensor & Security
- Climate control
- Lighting
- HVAC
- Audio/Video & Cables

Connected Car

- V2V / V2X /V2I communications
- eCall
- Infotainment
- GNSS
- Autonomous Driving Car
- RKE / TPMS
- EMI/EMC

Smart Grid Smart Energy

- Smart Meter
- Smart appliances
- DC distribution

Smart City and Industry Automation

- Sensor network
- Smart machine
- Surveillance Camera
- Asset tracking
- Wi-Fi
- Backhaul

Primary IoT/M2M Market – Enabled Technologies

Internet of Things (IoT) / Machine To Machine Market

Wearable Healthcare Devices

Bluetooth SMART

Wi Fi

NFC

EMV

Smart Home

Wi Fi 802.11ah

ZigBee Alliance

Z-WAVE ALLIANCE

enocean alliance

Connected Car

Wi Fi 802.11p

Smart Grid Smart Energy

ZigBee Alliance

Wi SUN

M-Bus wireless

Smart City and Industry Automation

NB-IOT

LTE Cat-M

LoRa

SIGFOX One network A billion dreams

IoT Radios

Blue: > billion units/year now
Red: emerging

STRONG CONFORMANCE REGIMES

- **3GPP LTE**, **LTE-Cat M, LTE-V**
- **3GPP GSM, WCDMA, EC-GSM**
- 3GPP2 Cdma2000
- WiMAX
- **3GPP NB-IoT**

- **NFC**
- **EMV**

- **Bluetooth**
- ANT+
- MiWi

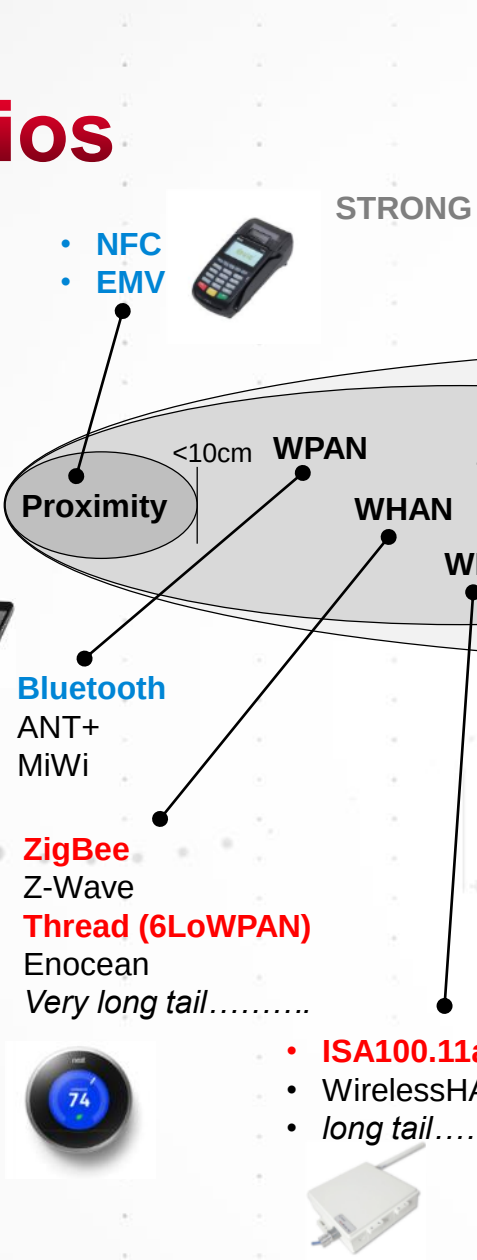
- **ZigBee**
- Z-Wave
- **Thread (6LoWPAN)**
- Enocean
- *Very long tail…….*

- **ISA100.11a (6LoWPAN)**
- WirelessHART
- *long tail…….*

- **802.11a/b/g/n/ac**
- **802.11ah (1km)**
- **802.11p (V2X)**
- 802.11af (white space)

- Wi-SUN (6LoWPAN)
- ZigBee NAN (6LoWPAN)
- Wireless M-bus
- *Long tail…….*

- **SIGFOX**
- **LoRa**
- **Telensa**
- OnRamp
- Positive Train Control
- *Long tail……*



INTEROP BASED CONFORMANCE

WPAN: Wireless Personal Area Network
WHAN: Wireless Home Area
WFAN: Wireless Field (or Factory) Area
WLAN: Wireless Local Area
WNAN: Wireless Neighbourhood Area
WWAN: Wireless Wide Area
LPWA: Low Power Wide Area

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Wearable Devices

MOVE INTO THE MOMENT

Apps

Enable Technologies:

Bluetooth® SMART

NFC Near Feild Communication

EMV

*EMV is a registered trademark in the U.S. and other countries and an unregistered trademark elsewhere. The EMV trademark is owned by EMVCo

Wearables

BLUETOOTH, WI-FI (802.11), NFC

Technologies	Bluetooth	Wi-Fi (802.11 a/b/g/n/j/p/ah)	NFC
Frequency	2.4 GHz	<1 GHz, 2.4 GHz, 5 GHz	13.56 MHz
Modulation	GFSK, π/4-DPSK and 8DPSK	OFDM (Orthogonal frequency-division multiplexing)	ASK / FSK/ OOK
Markets	Consumer devices	Business devices/systems Auto Industry (WAVE) Consumer devices/systems	Consumer transactions Access Identification
Region	Worldwide	Worldwide	Worldwide

Bluetooth ® Standard Evolution

1999 — V1.0
- Many problems
- Difficult making products interoperable

2003 — V1.2
- Faster Connection/Discovery
- Use AFH
- Up to 721kbps

2004 — V2.0 + EDR
- Introduction of EDR
- EDR Up to 2.1Mbps

2007 — V2.1 + EDR
- SSP, EIR
- power consumption optimization

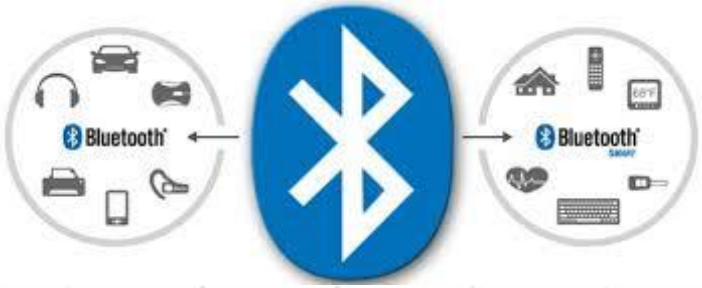
2009 — V3.0 + HS
- Alternate MAC/PHY
- Unicast connectionless data
- Enhanced power control
- HS Up to 24Mbps

2010 — V4.0
- Adoption of Bluetooth LE
- LE up to 260kbps
- Including classic, LE and HS

2013 — V4.1
- Coexist with 4G
- Smart connectivity
- Data transfer improvement

2014 — V4.2
- For IoT (Support IPv6/6LoWPAN)
- Highly privacy
- Data throughput increase

2016 — V5.0
- For IoT Connection with longer range
- 8X broadcasting
- Advanced beacon and location in home



Bluetooth 5 Enhancement

Up to 2x bandwidth of Bluetooth 4.2 with low energy

Up to 4x range of Bluetooth 4.2 with low energy

Up to 8x broadcasting message capacity over Bluetooth 4.2

Smart Home

ALL WIRELESS CONNECTED

Enable Technologies:

Wi Fi™

ZigBee™ Alliance
Wireless Control That Simply Works

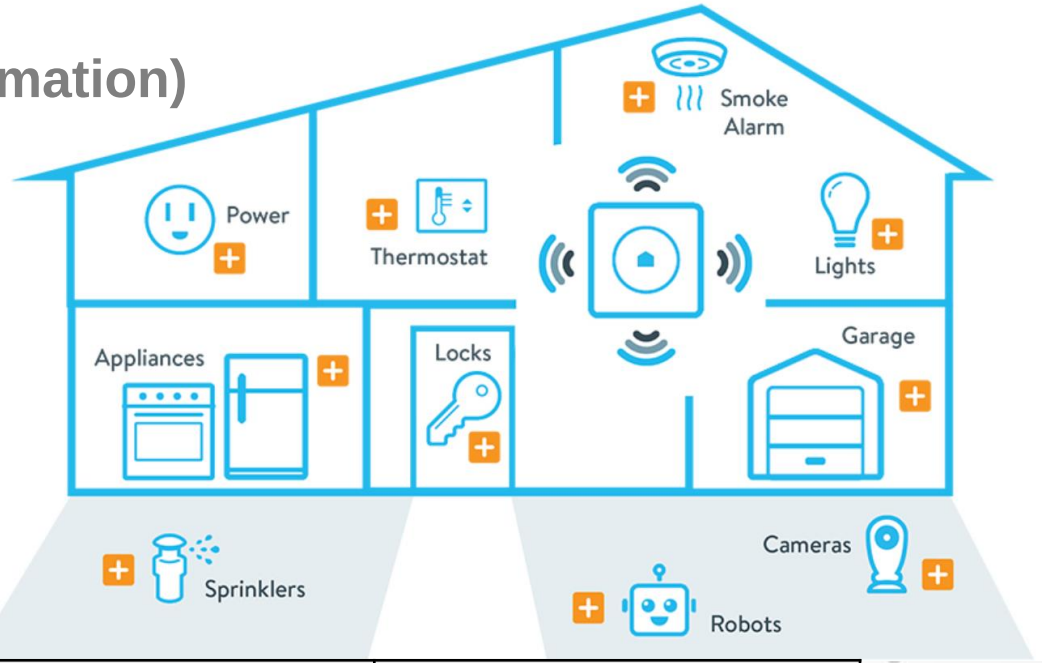
Z-WAVE ALLIANCE

enocean alliance
No Wires. No Batteries. No Limits.

THREAD GROUP

Smart Home

(Also known as Home Automation or Building Automation)



Technologies	ZigBee	Z-wave	EnOcean
Frequency	900 MHz and 2.4GHz	Sub-1GHz	315 MHz/900 MHz
Modulation	O-QPSK and BPSK	FSK/GFSK	ASK
Markets	Home Control Building Automation Industrial automation	Home Control Building Automation Light Industrial	Home Control Building Automation Light Industrial
Region	Worldwide	Americas	Europe, Asia

Energy Harvesting !!

What's new in Wi-Fi for IoT: 802.11ah

HIGHER DATA RATE THAN ZIGBEE, AND FURTHER DISTANCE COVERAGE

What's 802.11ah

- Multi-year battery life
- Transmission range up to ~½ mile
- 802.11ah is considered a competitor to the Z-Wave and ZigBee with bandwidth up to 20 MHz.
- Uses *OFDM Modulation
- Data rates > 100 Kbit/s
- Uses frequencies < 1 GHz

Target Market

- Home Automation / Internet of Things
- Wearable devices
- Extended range usages such as 'home to pole-top' utility networking and expanded hotspot AP coverage

*OFDM: Orthogonal Frequency Division Multiplexing

Smart City

CONNECTED, SUSTAINABLE AND RESILIENT

LPWA Technologies:

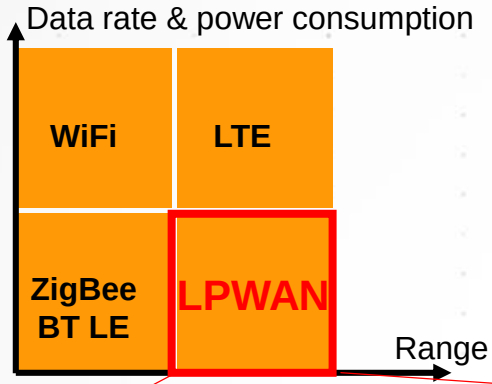
NB-IoT

LTE Cat-M

LoRa™

SIGFOX
One network A billion dreams

Example LPWAN Applications



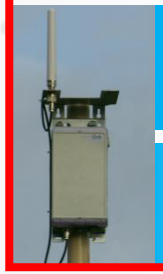
Unlicensed or lightly licensed band LPWAN e.g. LoRa, SIGFOX, Telensa

- Low cost base stations with cellular of fixed line backhaul
- Application focussed coverage pools (e.g. critical infrastructure and agriculture)
- Rolling out national deployments 2015/16

Licenced LPWAN e.g. 3GPP NB-IoT

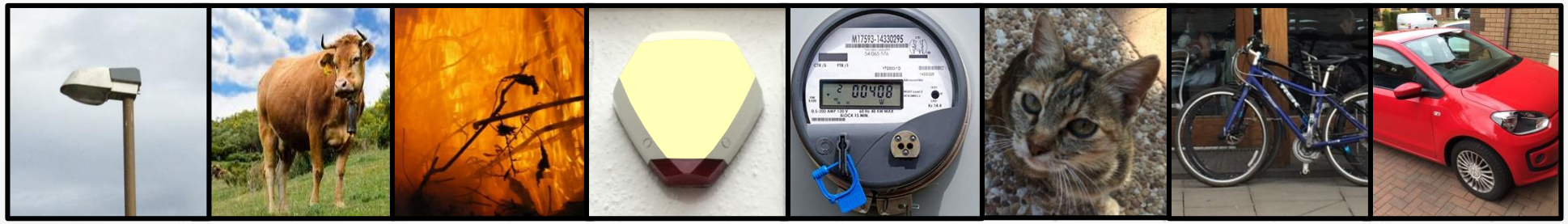
- Software updates to existing infrastructure e.g. re-use GSM spectrum
- 2017 introductions with deep in-building coverage

National and international licenced spectrum cellular software updates
e.g. 3GPP NB-IoT



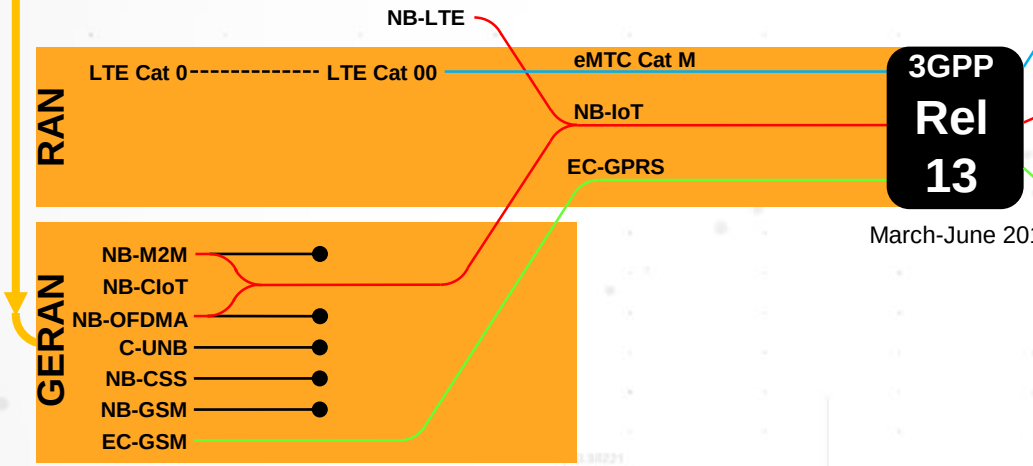
New national deployments in lightly or un-licensed spectrum
e.g. SIGFOX & LoRa

Application focussed deployments in lightly or un-licensed spectrum
e.g. Telensa, LoRa



3GPP Release 13 Cellular IoT Timelines

GERAN Objectives
- 164dB link budget (GPRS +20dB)
- 40 devices per home (~50k/cell)
- >160bps at range limit
- 10 second latency
- 10 year life with 5Wh ~AA battery



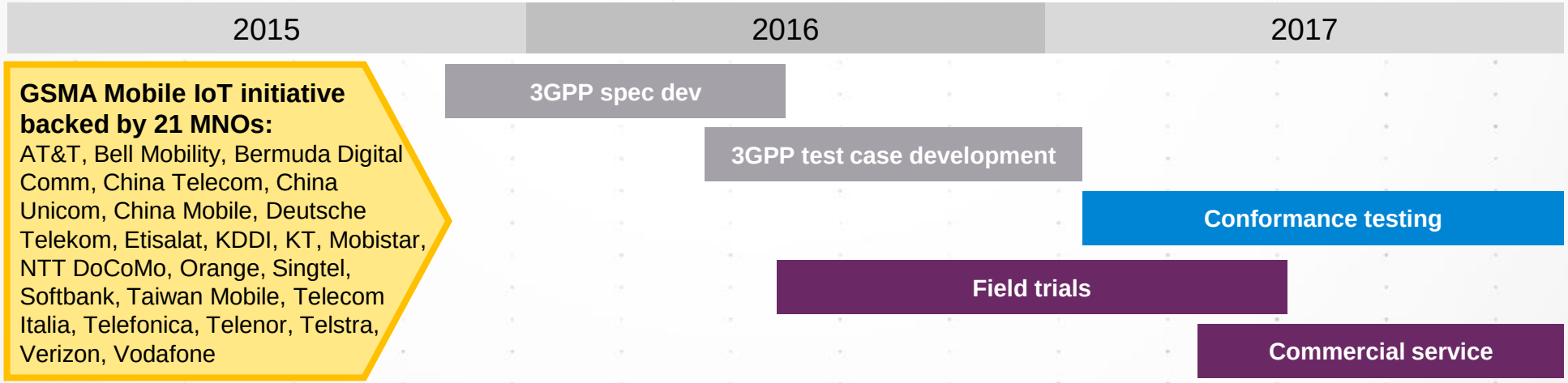
3GPP Rel 13

March-June 2016

eMTC Cat M:
- Machine Type Communication
- 1.4MHz Bandwidth LTE derivative
- Software update to LTE infrastructure
- 1Mbps, full mobility, 156dB link, 10 year batt

NB-IoT:
- Narrowband IoT
- 200 (180kHz) Clean sheet format
- Software update to LTE or GSM infrastructure
- <~250kbps, nomadic, 164dB, 10 year batt

EC-GPRS
- Extended coverage GPRS
- 200kHz GSM/EDGE
- Repetitions to get to 164dB link budget
- EC-PDTCH and EC-PACCH, ~52 min DRX
- Software update to GSM infrastructure



GSMA Mobile IoT initiative backed by 21 MNOs:
AT&T, Bell Mobility, Bermuda Digital Comm, China Telecom, China Unicom, China Mobile, Deutsche Telekom, Etisalat, KDDI, KT, Mobistar, NTT DoCoMo, Orange, Singtel, Softbank, Taiwan Mobile, Telecom Italia, Telefonica, Telenor, Telstra, Verizon, Vodafone

3GPP Rel-14 : NB-IoT Enhancements

CAT-NB2 (REL-14)

❑ Agreement on NB-IoT positioning

- ○ OTDOA is supported
  - • Baseline signal are : NB-IoT Rel-13 signals, LTE CRS/PRS in 1 PRB
- ○ UTDOA positioning is supported under the following conditions
  - • It used an existing NB-IoT transmission
  - • It can be used by Rel-13 UEs
- ○ Any signal used for positioning needs to have its accuracy, complexity, UE power consumption performance confirmed

	Cat-NB1 (Rel-13)	Cat-NB2 (Rel-14)
Max DL TBS	680 bits	2536 bits
Max DL data rate	26 kbps	127 kbps
Max UL TBS	1000 bits	2536 bits
Max UL data rate	62 kbps	159 kbps
Num. HARQ processes	1	1 or 2

❑ Main feature enhancements

- ○ Support for Multicast (SC-PTM)
- ○ Power consumption and latency reduction (DL and UL for 2 HARQ process and large maximum TBS)
- ○ Non-Anchor PRB enhancements (transmission of NPRACH/Paging on a non-anchor NB-IoT PRB)
- ○ Mobility and service continuity enhancements (without the increasing of UE power consumption)
- ○ New Power Class e.g.14dBm

3GPP Rel-14 : eMTC Enhancements

EMTC (REL-14)

- **Main Feature enhancement**
  - Support for positioning (E-CID and OTDOA)
  - Support for Multicast (SC-PTM)
  - Mobility for Inter-Frequency measurements
  - Higher data rates
    - Specify HARQ-ACK bundling in CE mode A in HD-FDD
    - Larger maximum TBS
    - Larger max. PDSCH/PUSCH channel bandwidth in connected mode at least in CE mode A in order to enhance support e.g. voice and audio streaming or other applications and scenarios
    - Up to 10DL HARQ process in CE mode A in FD-FDD
  - Support for VoLTE (technics to reduce DL repetitions, new repetition factors, and adjusted scheduling delays)

IoT Enabling Technologies- LoRa (Long Range)

- **Background**

  LoRaWAN network protocol owned by **LoRa alliance**, with 200+ members.

  SEMTECH owned key patterns and is the only chipset suppliers*

- **Target use cases:**

  Optimized for long range, low cost, long battery life use cases (10 miles range and > 10 years battery life)

- **PHY/MAC – trade-off of power, range, rate**
  - Sub-1 GHz license-exempt bands : 433MHz,853-870MHz(Europe), 779-787MHz(China), 902-928MHz (North America)
  - **LoRa** Modulation: Chirp FM + spread spectrum
  - Programmable SF: 7 to 12, with up to 13 dB processing gain
  - Programmable BW: 125kHz, 250kHz, 500kHz
  - Simple Star Network Topology
  - > 32 km coverage from single gateway*

**SEMTECH has pattern agreement with Microchips and Silicon Lab*
**Real data from gateway in San Jose*

Smart Grid and Smart Meters

Enable Technologies:

ZigBee™ Alliance
Wireless Control That Simply Works

Wi SUN

M-Bus wireless

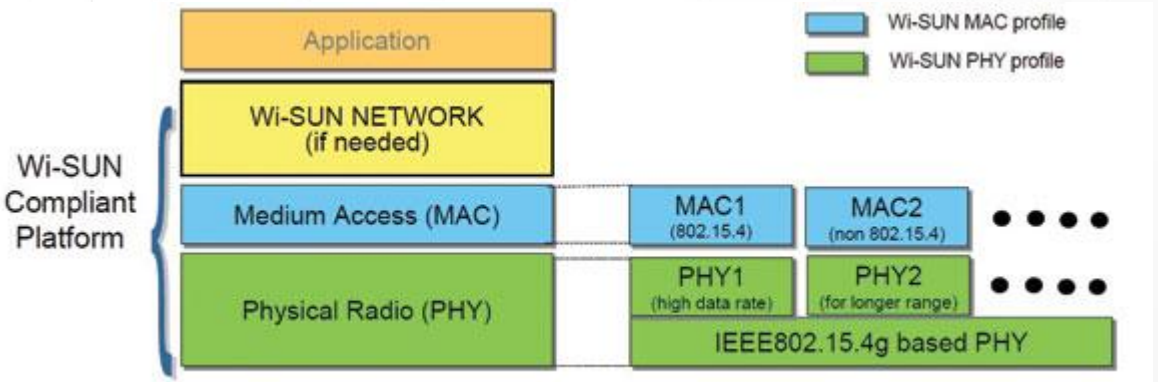
Customized ASK/FSK wireless or Power Line communication

Wi-Sun (802.15.4)

SAME PHY AS ZIGBEE

- IPv6 based Wireless Smart Utility Network (Wi-SUN) based on IEEE 802.15.4g
  - IEEE 802.15.4g, also known as the Smart Utility Networks (SUN), was approved by IEEE in March, 2012
- Initially Japan focused, now expanding globally (US, South East Asia, India, Europe)
- Target smart utility use cases:
  - Gas metering; demand/response; distribution automation
- PHY layer based on IEEE 802.15.4g but the specification will be categorized based on use cases
  - Frequency: 920MHz (Japan),868 MHz (EU), 915 MHz (USA), 2.4 GHz ISM bands (worldwide)
- MAC may be based on or not based on 802.15.4. Application dependent.

3 PHY formats supported:
- MR-FSK: 2FSK and 4FSK
- MR-OFDM: available but not popular
- MR-O-QPSK: DSSS and multiplexed DSSS



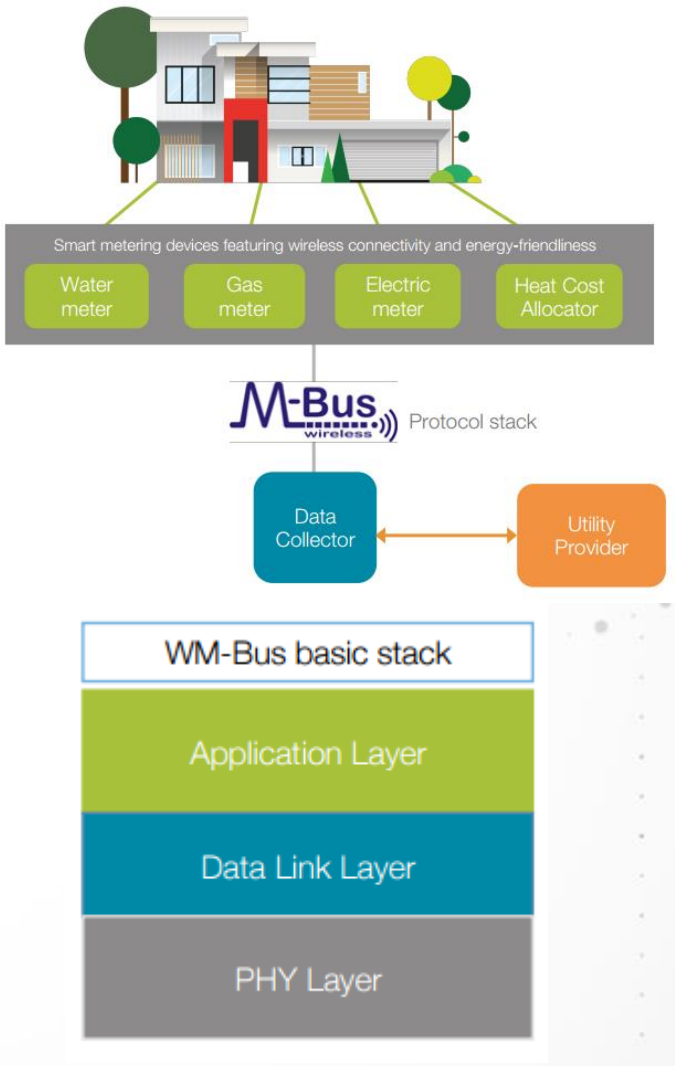
IoT Enabling Technologies: Wireless M-BUS

- Wireless M-BUS is widely used for metering applications across Europe.

- PHY Layer defined in EN13757-4
  - 3 frequency band for different working mode

Mode	Frequency(MHz)	Notes
S (Stationary)	868	Meters send data few times a day
T (Frequent Transmit)	868	Meters send data several times a day
C (Compact)	868	Higher data rate version of mode T
N (Narrowband)	169	Long range, narrow band system
R (Frequent Receive)	868	Collector reads multiple meters on different frequency channels
F (Frequent Tx and Rx)	433	Frequent bi-directional communication

  - Modulation type: 2-FSK, and 4-GFSK for higher data rate



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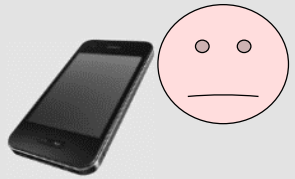
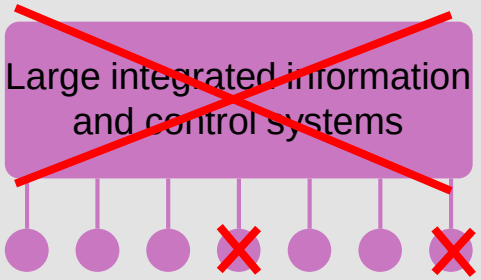
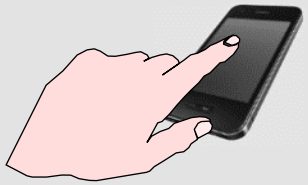
The Value for Testing (1): Ensure the Wireless Connection

"Things" are not well trained to move for signals as human beings

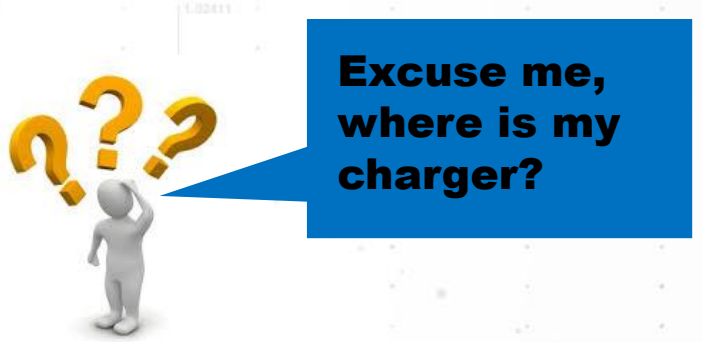
The No. of "Things" connected to one cell may be > 100 times of no. of people

The Value of Testing(2): Reduce Cost of Failure

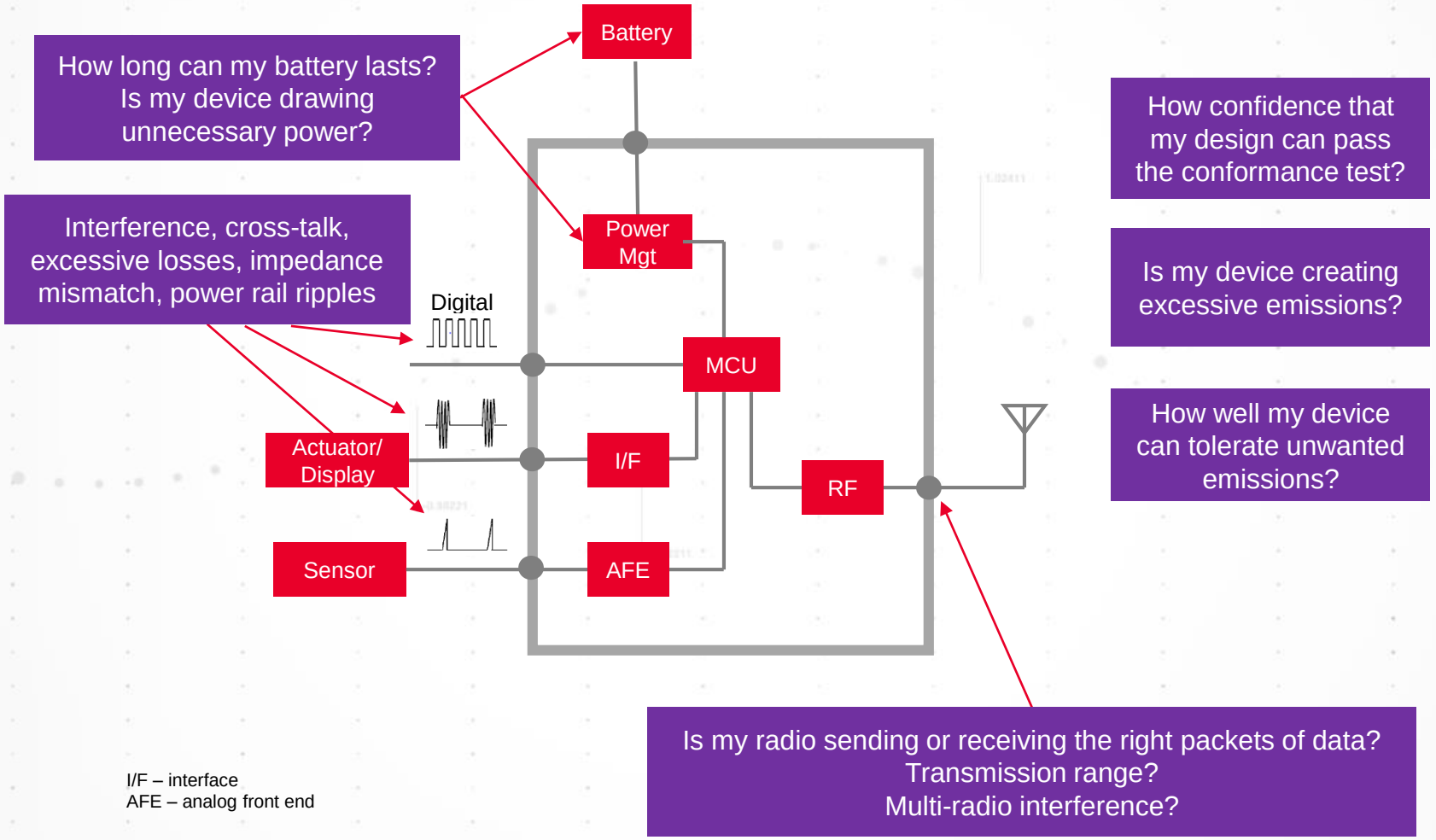
	Smartphone	Critical IoT
Failure impact		
Repair	 User powers off/on User recharges Unlimited software updates	 Onsite repair to reset and/or replace prematurely drained battery Battery constrains software updates

- How often do you need to power cycle your smartphone?
- Have you ever experienced an app or network problem that drained the battery?
- What was the cost to repair… power off/on or recharge the battery until software fixed?
- Large systems may only be as good as the weakest (IoT) element
- Repair can involve expensive onsite visit

The Value for IoT Test (3): Optimize the Battery Operation Life



Typical IoT Module Block Diagram and Test Challenges



I/F – interface
AFE – analog front end

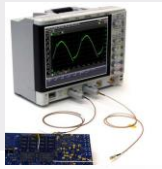
IoT Device Design & Test Solutions

RECAP OF WHAT WE COVERED LAST YEAR

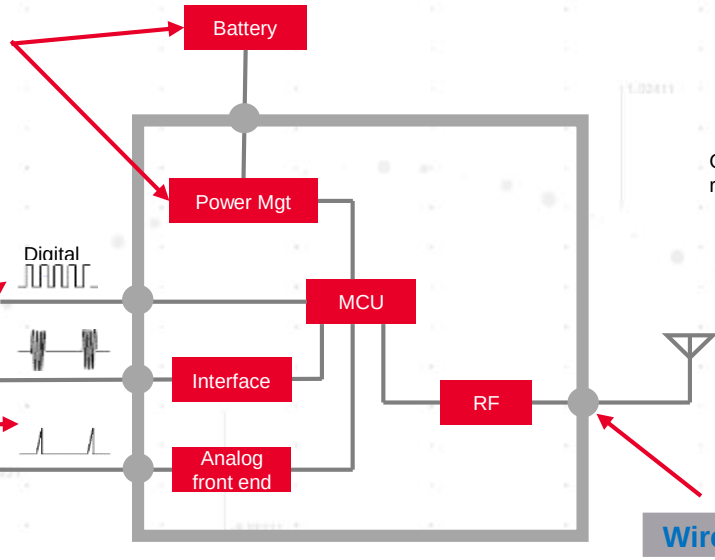
Power Consumption tests

Visualize current drain from nA to A in one pass and one picture unlocking insights to deliver exceptional battery life

Signal & power integrity



Best visibility of your signal and data integrity issues



Insight 2017 IoT course recording

IoT device test challenges sales tools

Simulation & design software

Complete tools for ecosystems from component, IC, Board to System level.

Regulatory & Conformance tests

One box for EMI and spectrum regulatory pre-compliance tests

Conformance test systems for operator acceptance test

Over-the-air functional test (custom solution)

Failproof your IoT device against the rigors of real world

Wireless & interference analysis

Broadest format coverage, wide range of solutions for R&D, manufacturing to field deployment

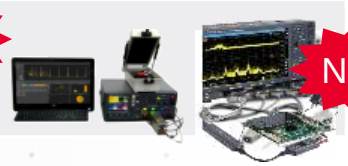
IoT Device Design & Test Solutions

KEYSIGHT SOLUTIONS COVER ALL THE CHALLENGES

Power Consumption tests

New

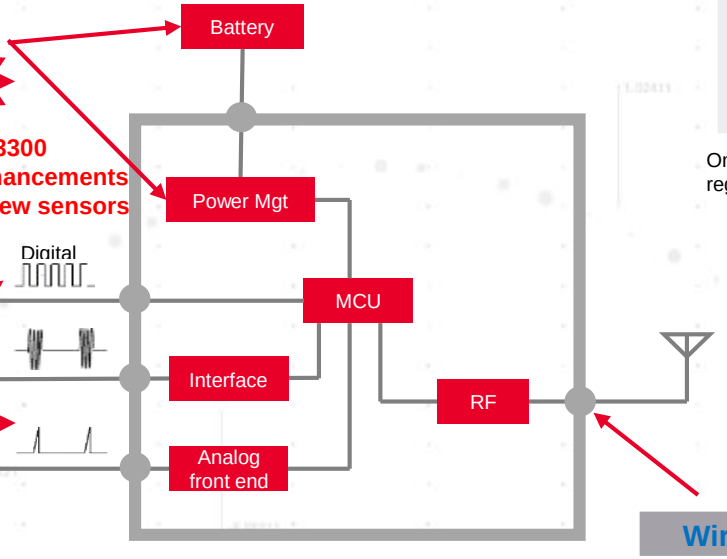
X8712A IoT device battery life optimization solution



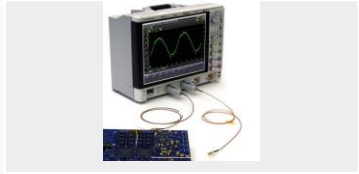
Detect design weaknesses early with event based power consumption analysis. Accurately predict the battery life of IoT devices.

New

CX3300 enhancements & new sensors



Signal & power integrity



Best visibility of your signal and data integrity issues

Regulatory & Conformance tests

One box for EMI and spectrum regulatory pre-compliance tests

Conformance test systems for operator acceptance test

Over-the-air functional test for manufacturing

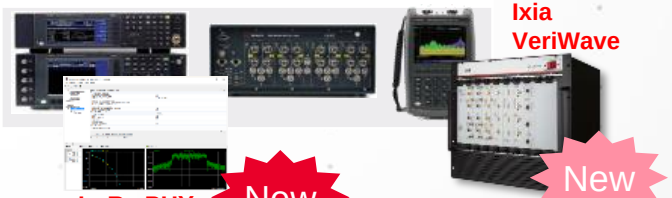
New

X8711A IoT functional tester

Failproof your IoT device against the rigors of real world

Wireless & coexistence tests

Ixia VeriWave



New

LoRa PHY layer test solution

New

Cover in MED_I18_1)

Simulation & design software

Complete tools for ecosystems from component, IC, Board to System level.

Test Challenge 1: Multi-Format Wireless Tests

- How do we ensure devices play well together?
- How do we ensure devices will work in a wide range of environments?
- How do we do this quickly and inexpensively given the volumes of products and market cost demands?

Key RF Technologies of IoT

Wearables
BLE, WIFI, NFC, EMV

Keysight solutions for wearables

Smart home
802.11ah, ZigBee, Z-wave, EnOcean

Keysight solutions for smart home

Smart City / Ind Auto
NB-IoT, LTE-M, LoRa, SigFox

Keysight solutions for smart city / industrial automation

Smart Energy / Smart Grid
ZigBee, Wi-SUN, Customized ASK/FSK

Keysight solutions for smart energy

E6640A EXM Wireless Test Set

- Ultimate Scalability and Port Density
- Broadest Multi-Format Coverage
- Highest Throughput and Yield

FAST

- SAMM, SSI, High Speed Sequencer

ACCURATE

- Best in class amplitude accuracy
- Best in class EVM

Cellular

- LTE-Advanced FDD/TDD, LTE FDD/TDD, 5G NR
- HSPA+, W-CDMA
- 1xEV-DO, cdma2000
- GSM/EDGE/EDGE Evo
- TD-SCDMA/TD-HSPA
- DECT, PHS

Wireless Connectivity

- WLAN 802.11a/b/g/n/j/p/ac/ah/af/ax
- Bluetooth 1.0 to 5.0, Bluetooth Low Energy (BLE)
- ZigBee, Z-Wave
- Multi-Satellite GNSS: GPS, Galileo, GLONASS, Beidou, SBAS, QZSS
- Mobile WiMAX
- Digital video, FM

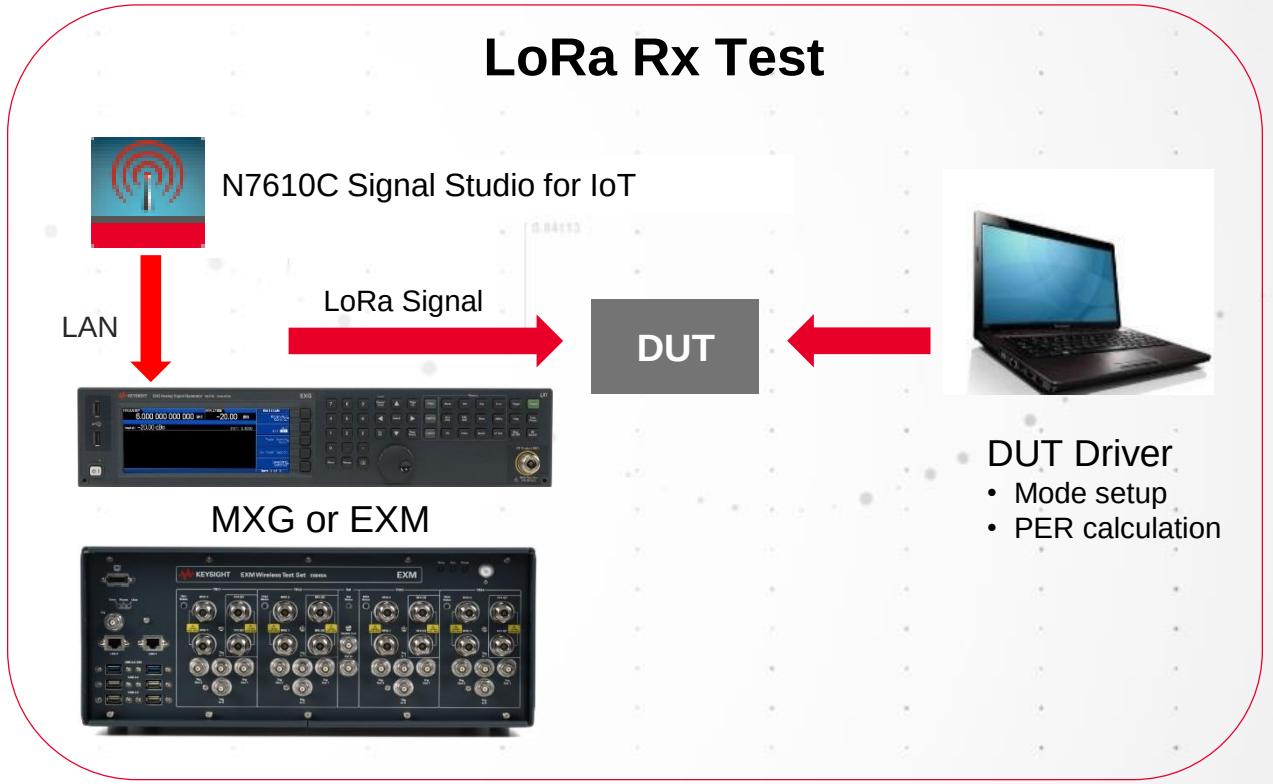
MIMO (2x2, 3x3, 4x4) & carrier aggregation

- Switched MIMO for manufacturing test
- True MIMO (multi-TRX) for design validation
- LTE-A CA Inter- and intra-band

Keysight LoRa Test Solutions

RECEIVER TEST (N7610C SIGNAL STUDIO FOR IOT)

- Platform Required
  - Software: N7610C Signal Studio for IoT
    - Zigbee (IEEE 802.15.4), WI-SUN(IEEE 802.15.4g), LoRa CSS, Z-WAVE(ITU-T G.9959)
    - LoRa waveform generation with different configurations
    - Pre-distortions: AWGN, Frequency error, Sampling clock error
  - Hardware: Vector Generator(N5182B MXG), E6640A EXM Transceiver
  - Interference test by two signal generators or combining signals at baseband waveforms



Test Challenge 2: IoT Device Manufacturers

Many customers are going into the IoT, but may lack wireless competencies.

Connected Medical Devices



Consumer Devices


Industrial / Smart City


Challenges

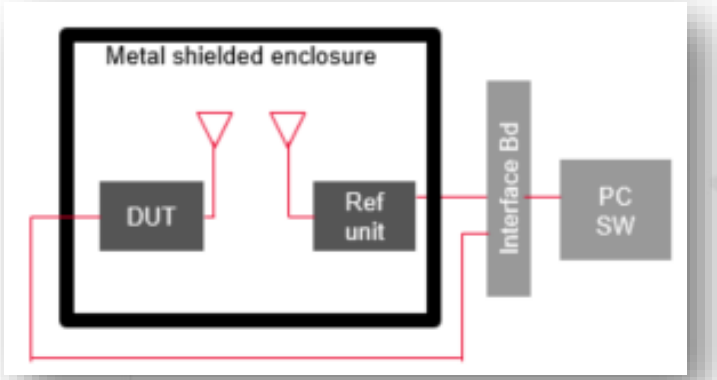
- Lack of RF knowledge
- Maintain low cost
- Ensure quality
- Fast time-to-market

Typical Test Solutions (Current State)

GOLDEN RADIO OR SIMPLE PHONE PAIRING

Simple pairing method
(e.g. smartphone)

Or



Golden radio
(chipset / reference radio)

Simple, Low Cost!

Typical Test Solutions (Current State)

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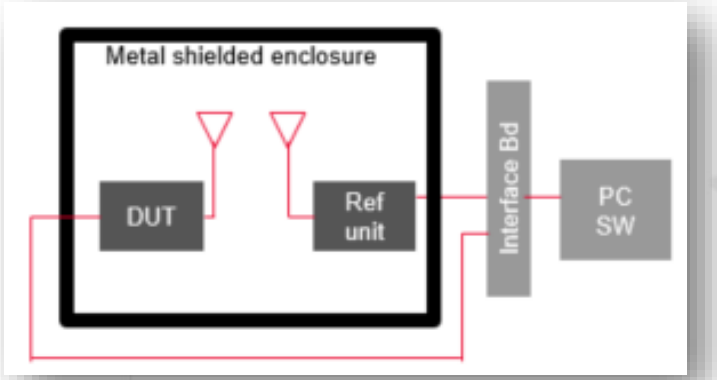

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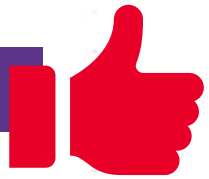


But…

Short range!

Slow data!

Intermittent connection!

Why???

Limitation of Golden Radio Test Method

WHAT YOU MAY NOT REALIZE…

Poor Accuracy	Lack of Capability	Lack of Test Coverage
• No direct power measurements (accuracy is unknown) • Only provide RSSI, P = RSSI + offset • RSSI is an indicative value with reference to unknown initial value (vendor dependent)	• No power control capability • You are not testing at the actual use condition (e.g poor signaling condition) • Marginal DUT may slip through the test	• No signaling PER test • PER is important receiver performance check • You will not know the performance of your receiver
Short operating range?	***Intermittent network connectivity?***	***Slow data rate?***

Your customer may be shipping faulty devices!

Why do We Need OTA Signaling Test?

Small DUT, no connector or interface for wire connections

- Internet of Things
- Wearables, smart home devices
- Automotive connectivity

Chipset specific control / driver is not required

- don’t have expertise for DUT chipset control

Measure with final commercial firmware

- Measure actual performance of DUT
- Test mode can’t be available in the firmware of shipped product
- Final production test / go-no-go test

The Keysight X8711A IoT Device Functional Test Solution

COMPLETE TX AND RX TESTS IN LESS THAN 30S

Cost-effective OTA signaling test

- Test device in actual operating mode and in its final form
- Reduce production test time
- Eliminate test firmware flashing
- Lower capital investment

Simplified quantitative measurements

- Objectively test transmitter with Tx power measurement
- Receiver quality testing with PER and Sensitivity test

Complete solution with hardware and software

- Shorten test development time
- Simplify after sales support and calibration
- Expandable to cover more radios, and static voltage and current measurements

Keysight Solution

IoT device functional test solution

(Base on 34972A modular LXI platform)

Typical Setup – X8711A (Demo Booth)

SIGNALING TEST

TAP-based SW
(KS83301A or KS83302A or both)

E36102B
(optional)

Shield box
(not from Keysight)

34972A Data
Acquisition Unit

NEW

34999A RF Module

Keysight X8711A IoT Device Functional Test Solution

KEY SPECIFICATIONS

Key Specifications:

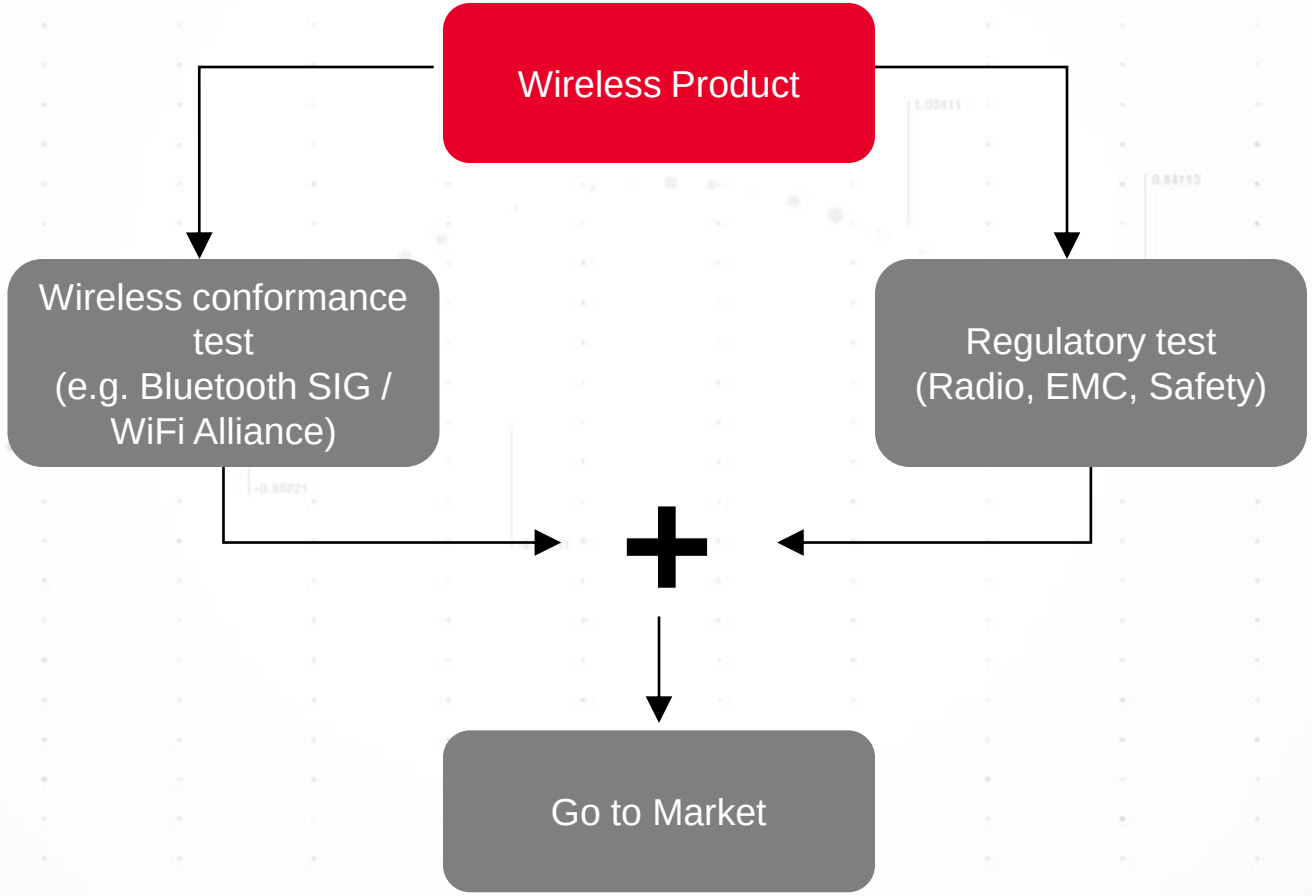
Output Power (Rx sensitivity measurements):
BLE Output: -40 to -90 dBm, 0.5dB step; accuracy ±2dB
WiFi Output: -33 to -73 dBm, 0.5dB step; accuracy ±2dB

RF Power measurement (Tx power measurements) :
Range: 0 to -30 dBm at RFIO port
Accuracy: ±2dB

Test Parameters	34972A+RF Module (BLE/WLAN)	E36102A (optional)
DC Test • Power On/Off • DC Power measurement		 ✓ ✓
RF/Radio Test		
• Radio Format	BLE 4.2, WLAN 802.11b/g/n	
• Tx RF Power	✓	
• Rx PER Test	✓	
• Rx Sensitivity Test	✓	

Test Challenge 3: Compliance Testing

Wireless electronics devices must go through wireless conformance and regulatory testing before gaining market entry



To verify product conform to wireless standard to promote interoperability and rights to use logo and word mark.

To improve the reliability of the product and safety of the users

Compliance Test Solutions

Is my device creating excessive emissions?	How well my device can tolerate unwanted emissions?	How confidence that my design can pass the conformance test?

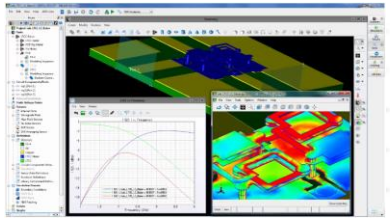
EMI / EMC Compliance Test Solutions

Pre-compliance measurements

- With N/W6141A EMI measurement apps (PXA/MXA/EXA/CXA)
- Avoid costly project delays due to EMC compliance test failures

EMC compliance testing

- With N9038A MXE EMI receiver
- Compliance with CISPR 16-1-1 and MIL-STD-461
- Keysight Solution Partners integrate complete solution with MXE, chambers, antennas, software, probes, etc



EMI/EMC simulations

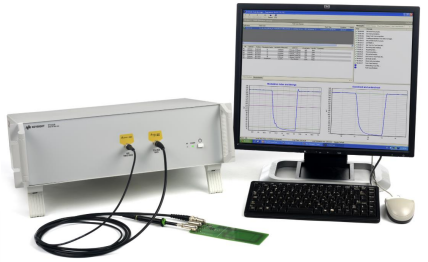
- With Keysight EMPro software
- Allow engineers to simulate radiated emissions of electronic circuits and components & compliance to EMC standards

www.keysight.com/find/emc

Conformance Test Solutions

T3111S NFC Conformance Test System

- One box solution for RF analog and digital protocol testing of NFC, EMV and ISO devices
- Validated platform for NFC Forum Certification program



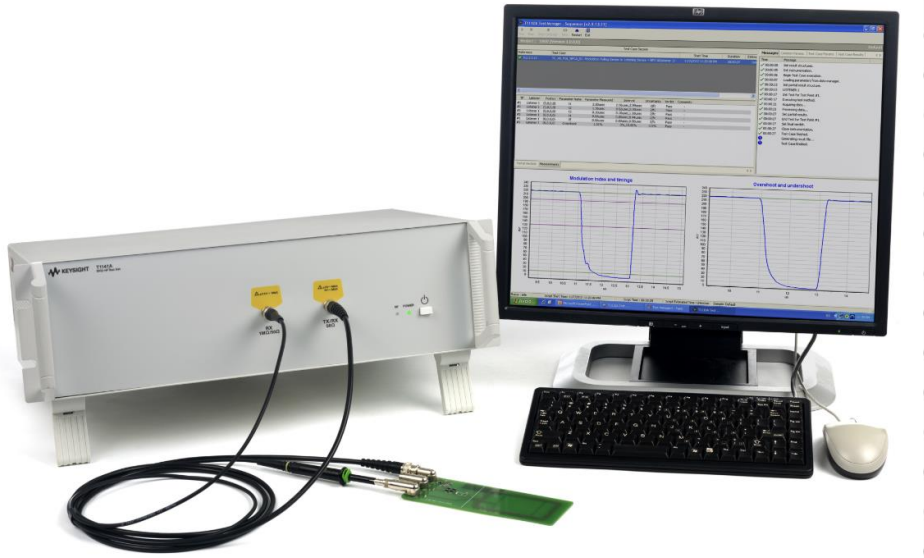
T1111S Bluetooth RF conformance test system

T4010/4020S LTE & NB-IoT conformance test systems

T3111S NFC Conformance Test System

- One box solution for RF analog and digital protocol testing of NFC, EMV and ISO devices
- Validated platform for NFC Forum Certification program

T1142A Automated Positioning Robot



T3111S RFID HF test set

T4010S Conformance Test System

NB-IOT / CAT-M CONFORMANCE

Configuration suitable for NB-IoT/Cat-M and LTE up to 2CC,
3CC/4CC requires a second UXM

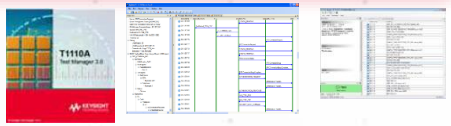
RF and RRM support validated for GCF and PTCRB – TP 195

Conformance and pre-conformance

Full test system automation

UE automation capabilities

Easy to use test project management environment for streamlined testing execution and results analysis



Dual feed antenna UE' s support

Scalable solution from benchtop to full rack

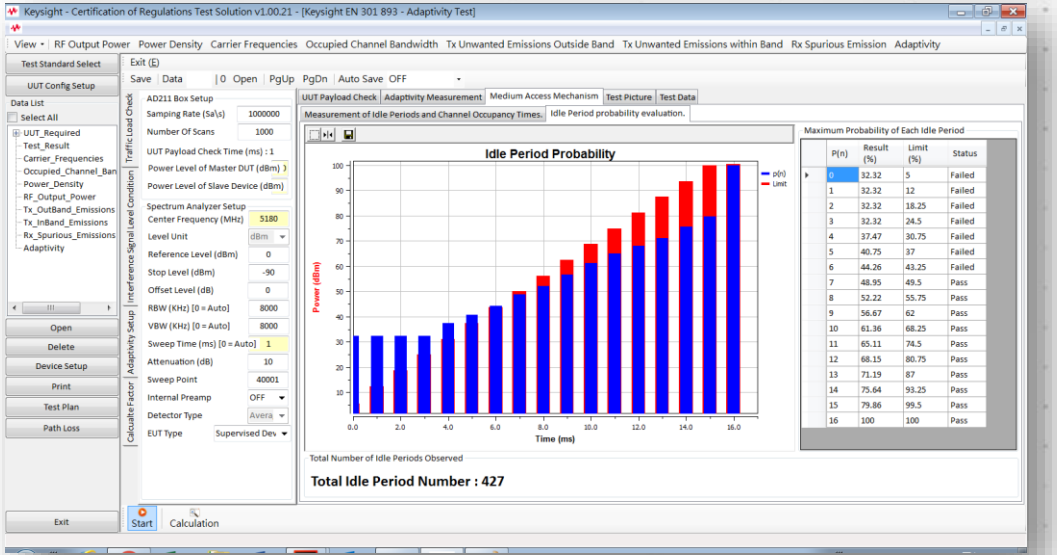
From LTE Rel-8 to 4CC supported today and ready for 5CC

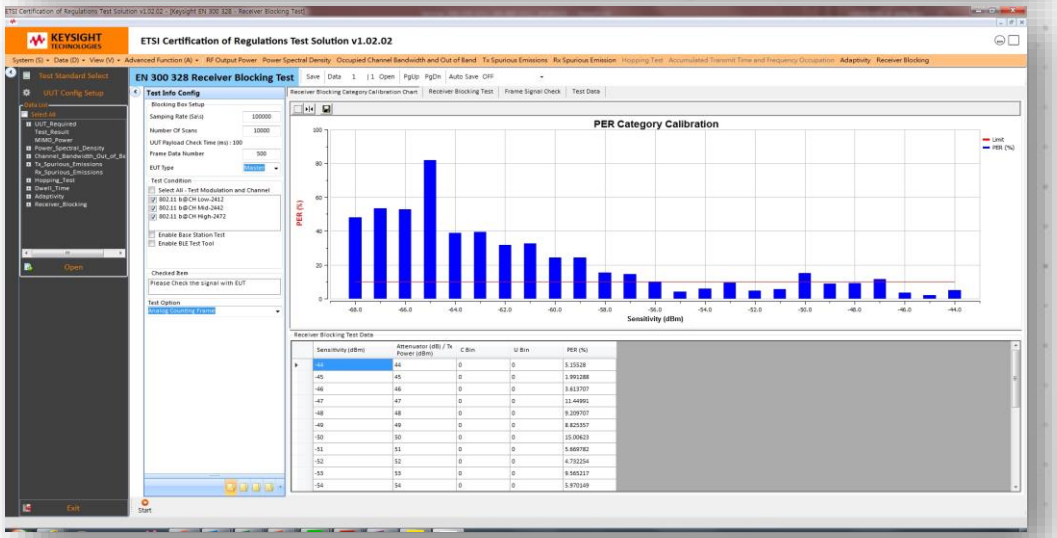
Design and Verification capabilities

Operators test plans support

Regulatory testing as per EN 301 908-13

Regulatory Test System for Wireless Connectivity Device





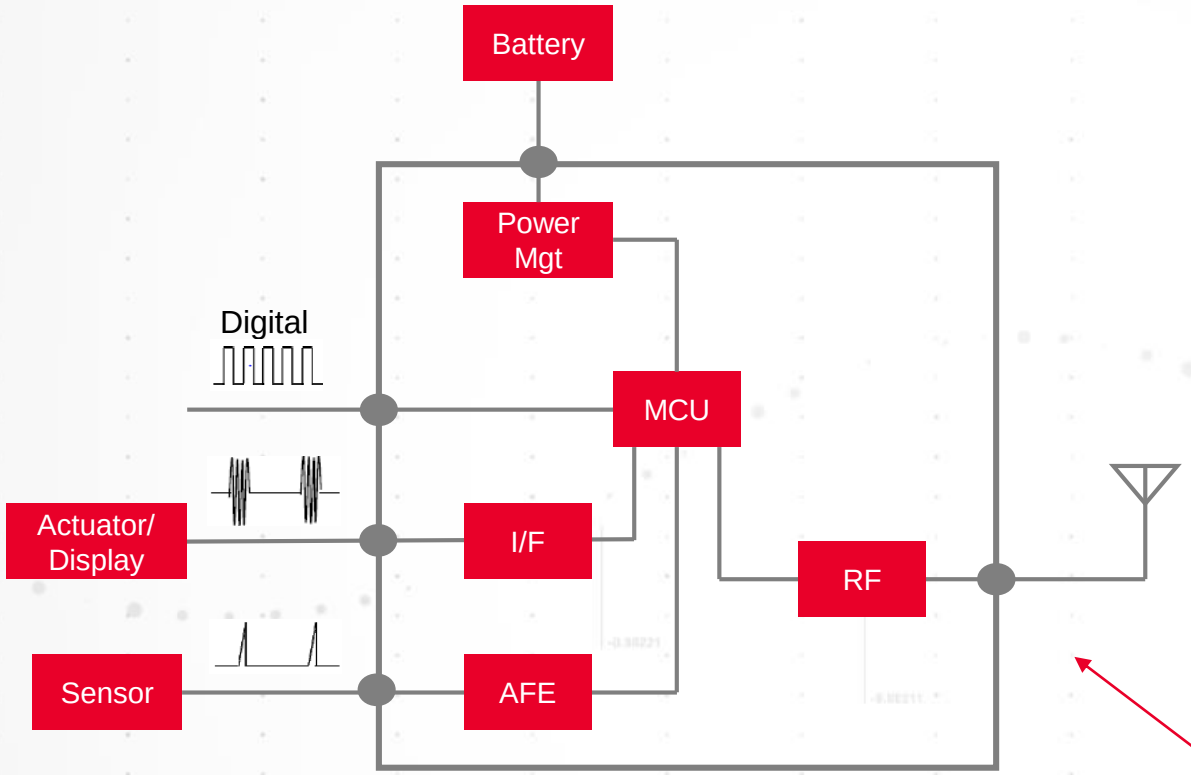
We're supporting..

- *EN 300-328 v2.1.1 (2.4GHz)*
- *EN 301-893 v.2.1.1 (5GHz)*
- *FCC 15.247 (2.4GHz)*
- *FCC 15.407 (5GHz)*
- *KC KS-X-3123, MIC* and so on.

Agenda

- IoT/M2M Introduction
- IoT/M2M Key Enabling Wireless Technologies
- Test challenges and Solution
- **Summary**

Summary: Keysight IoT Test Solutions



Simulation & Measurement Software

- ADS Simulation Software
- Momentum 3D EM simulation software
- X-Series measurement apps
- Signal Studio
- 89600 VSA software

Conformance Test

- T3111S NFC/EMV conformance test system
- T1111S Bluetooth RF conformance test system
- T4010/4020S LTE/LTE-A/NB-IoT conformance test system

EMI / EMC Test

- EMI / EMC simulations with EMPro
- EMI pre-compliance test with X-Series SA
- EMC compliance test with MXE EMI receiver

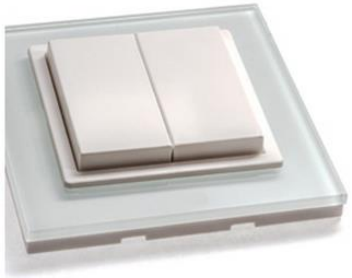
RF & Wireless Test Solutions

R&D / DV	Production
• X-Series signal generator & signal analyzer	***High volume manufacturing test:*** • EXM / VXT • X8711A IoT Device functional solution ***Low cost:*** • U2001A USB power sensor + Freq counter • Basic signal generator and 33622A FG (IQ input) + spectrum analyzer

I/F – interface
AFE – analog front end

Customer Story #1

SMART HOME DEVICES TEST



Customer Need: A general purpose tool for R&D.

Customer product are based on Chip vendor's modules, so they do not need advanced test tool

Keysight solution

- Use N9320B for general spectrum analysis
- Use N9320B-DMA for ASK demodulation

Customer Story #2

SMART PARKING

Customer need: A test solution to test both transmitter and receiver.

They use a proprietary protocol based on FSK modulation (315 MHz).

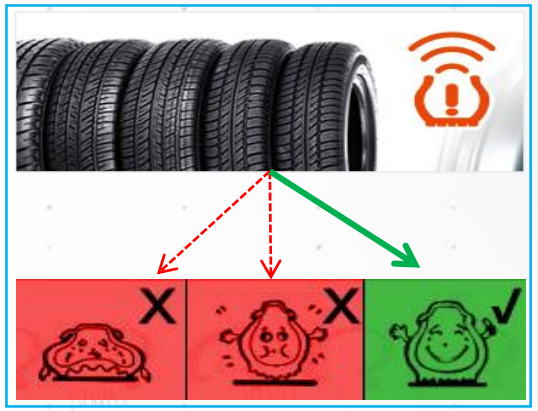
Keysight solution

- Use N9310A and 33522B to generate FSK signal to test receiver
- Use N9320B-DMA to demodulate the FSK signal from transmitter

Customer Story #3

Smart car – Tire pressure monitoring system

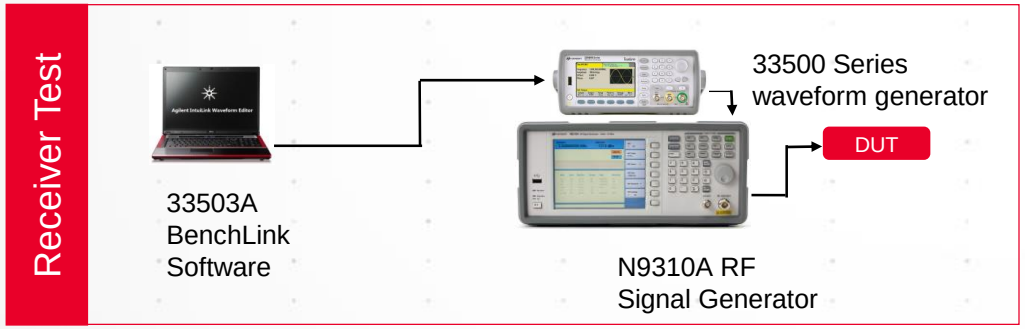
The tire pressure monitoring system (TPMS) is one of the active safety technologies in the automotive today. The new generation of TPMS directly measures the pressure and temperature in the tires and reports the data to the MCU for analysis and display. The MCU will alert the driver immediately when the tire pressure go out of the normal range.

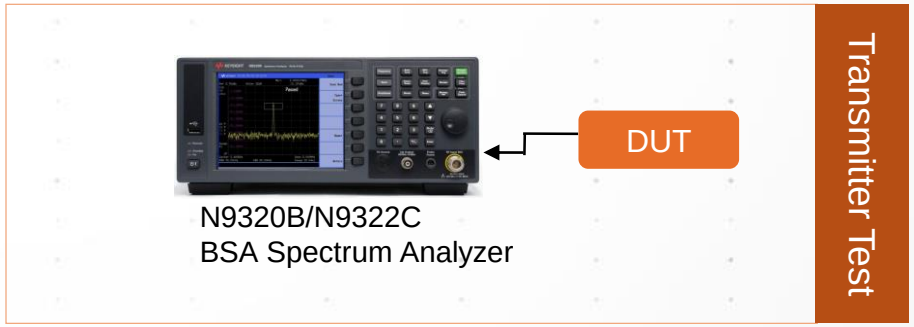


TPMS – For your driving safety and fuel efficiency

Customer need: A high-efficient test platform that measures transmitter power, frequency, and particularly the FSK deviation

Keysight solution (Economic version)





For More Information

www.keysight.com/find/iot

Useful Application Notes or Videos	Download
IoT – With great power comes great challenges	Appnote
IoT – Enabling technologies and solutions for design and test	Appnote
Power Consumption or Battery Drain Analysis	
Battery life challenges for IoT wireless sensors and the implication for test	Appnote
Evaluating battery run-down with the N6781A or N6785A 2-Quadrant Source/Measure Unit and the 14585A Control and Analysis Software	Appnote
Enhancing the battery life of your mobile or wireless device	Appnote
Capturing the Dynamic Current from a Battery Power Device and Using it as a Load on the Batteries	Video
Debugging technique for Ultra Low Power Microprocessor, Analyzing dynamic current	Video
Tips for Making Low Current Measurements with an Oscilloscope and Current Probe	Appnote
Considerations in Making Small Signal Measurements	Appnote
Evaluating Oscilloscopes for Low-Power Measurements	Appnote
Measuring low current consumption with a digital multimeter	Appnote, Video
RF / Wireless Test	
A flexible test solution for IoT devices with ASK / FSK modulation using Keysight basic RF instruments	Appnote
Flexible test solution for 2.4GHz Zigbee transmitters and receivers	Appnote
A cost effective way to test Bluetooth modules on smart devices	Appnote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