

Demystifying EMC 2020

OTA TESTING METHOD FOR RED, COEXISTENCE AND EM INTERFERENCE IN AUTOMOTIVE



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ROHDE & SCHWARZ

Make ideas real



NEXT 50 MINUTES

- 1 Introduction, motivation & challenges
- 2 Measurement parameters
- 3 OTA test setup, methodology & results
- 4 Additional parallel testing possibilities
- 5 Conclusion

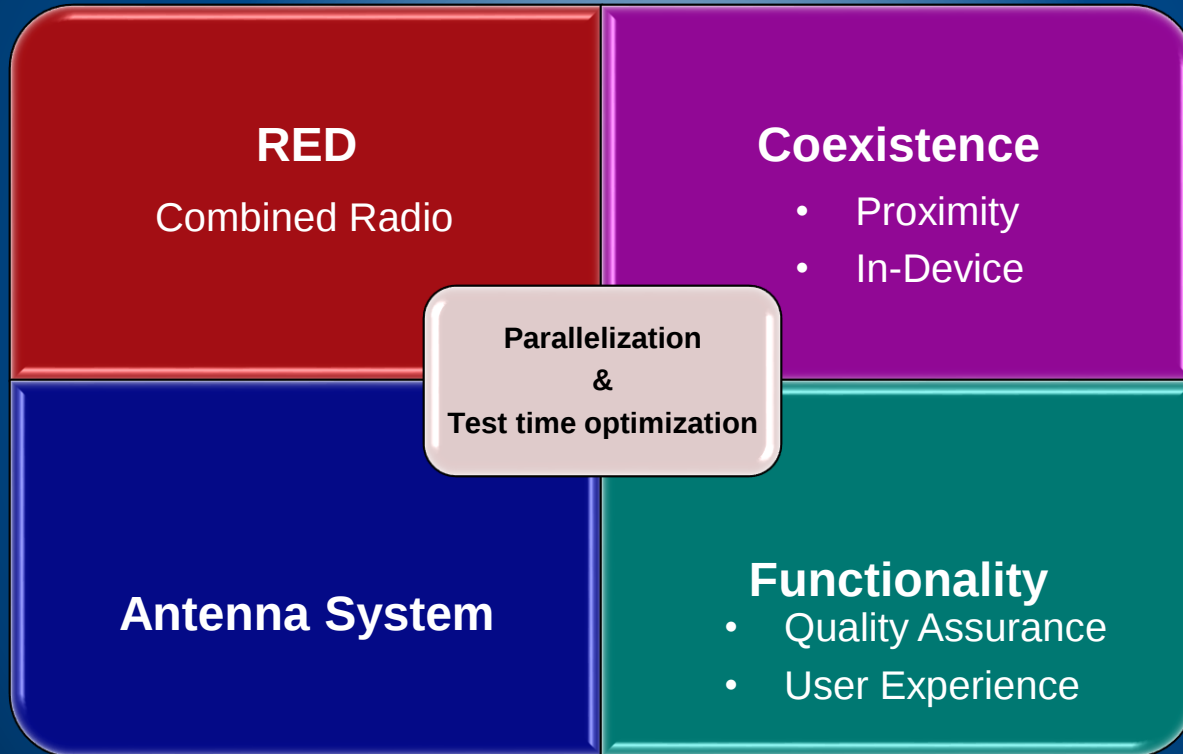
INTRODUCTION, MOTIVATION & CHALLENGES

- New Technologies entering the car:
 - Safety
 - Information
 - Entertainment
 - Connectivity
 - Autonomous Driving



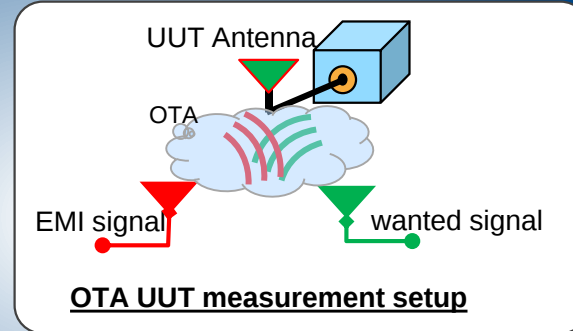
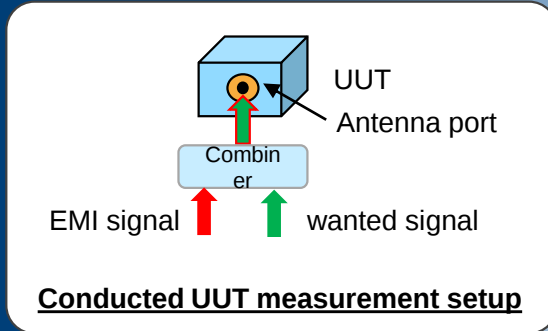
Introduction, Motivation & Challenges

Key requirements of a test concept



Introduction, Motivation & Challenges

- **Vehicle level measurement challenges:**
 - Conducted or over-the-air (OTA)



- Size of the vehicle
- Number of radio systems and electronic systems in the vehicles
- Source of Interference and use case reproduction

Introduction, Motivation & Challenges

Antenna Position

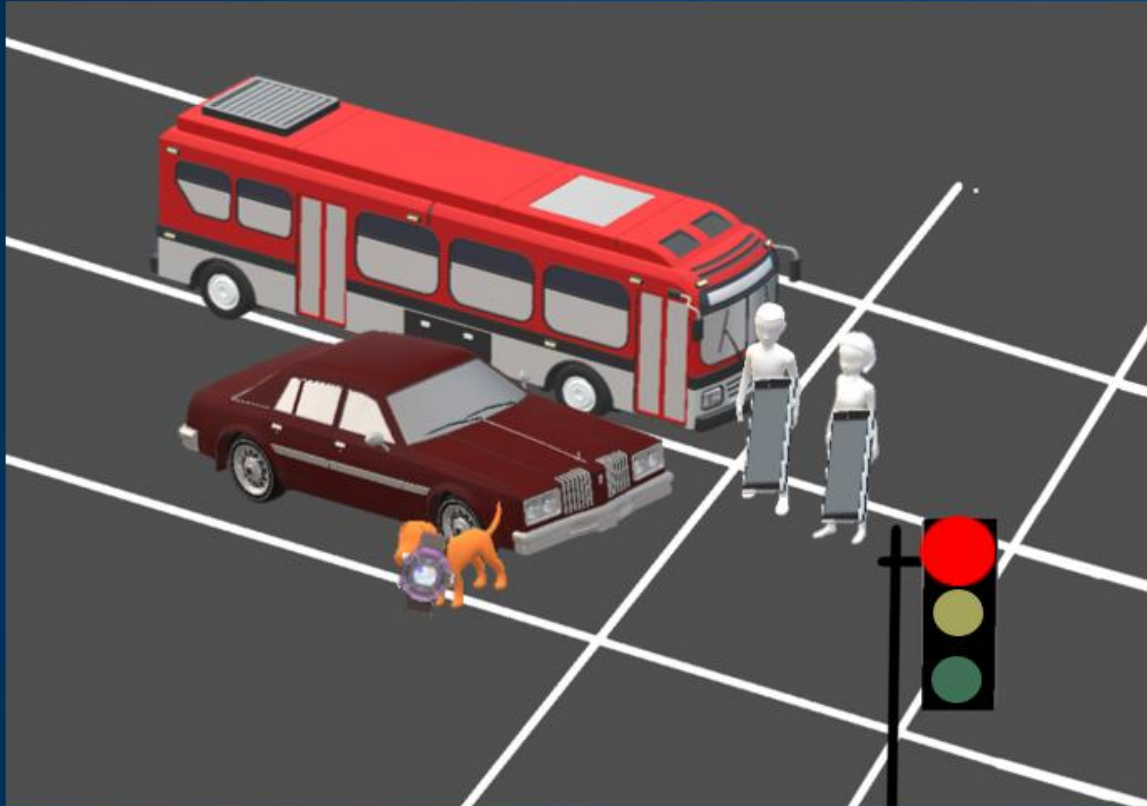


External embedded antenna
Wi-Fi, GPS, RKE, TPMS,
Cellular communication

Internal Embedded Antenna
Wi-Fi, Bluetooth

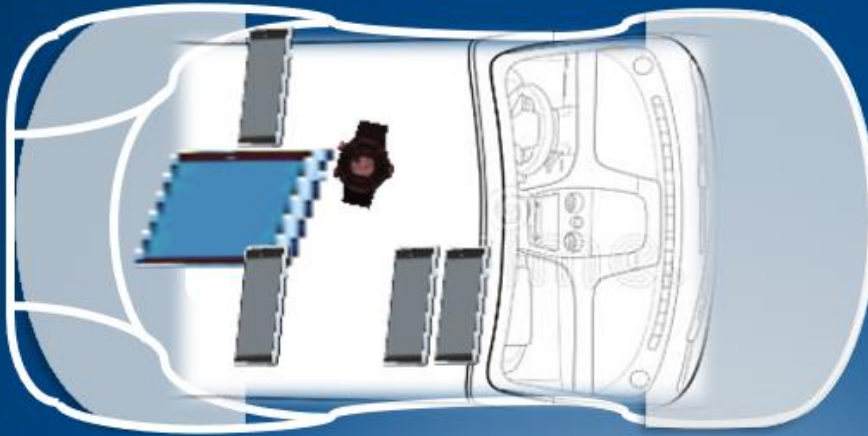
Source: Car radio antennas: Where have they gone?
<https://www.torque.com.sg/features/car-radio-antennas-where-gone/>

Introduction, Motivation & Challenges



- **From Bus**
 - Wi-Fi
 - Bluetooth
- **From Pedestrian**
 - Wi-Fi
 - Bluetooth
- **From Dog**
 - Pet Tracker (LPWAN)

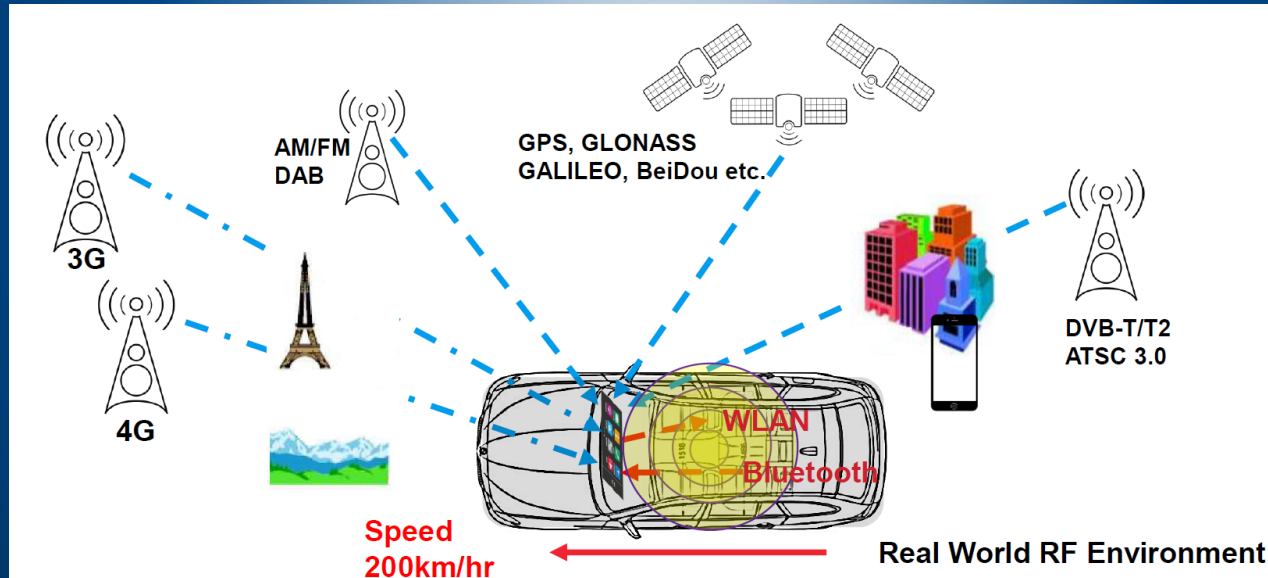
Introduction, Motivation & Challenges



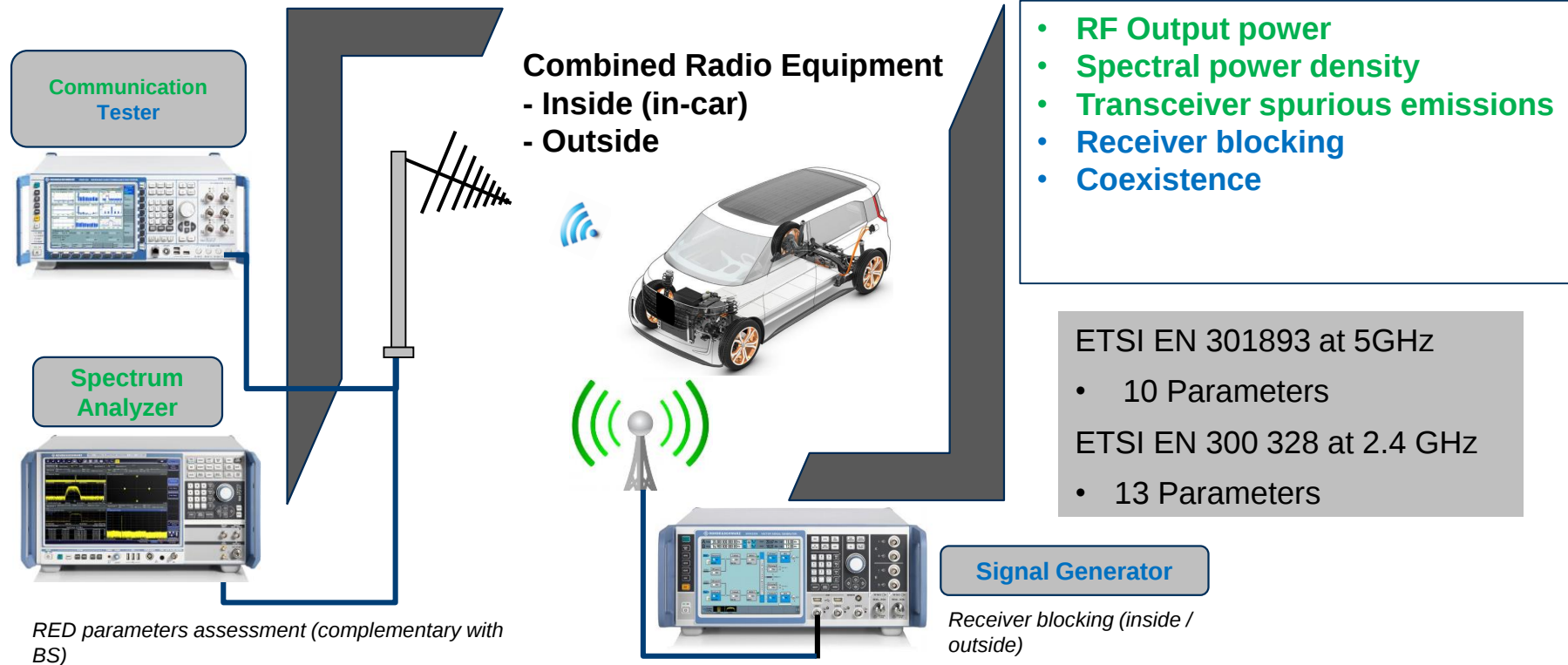
- **Portable Tablets ,
Phones and
Smartwatches**
 - **Bluetooth**
 - **Wi-Fi**

Introduction, Motivation & Challenges

- Test & Measurement challenge
 - Field to lab (Anechoic Chamber)
 - Over-the-air (OTA) setup
 - Interference Signal Type



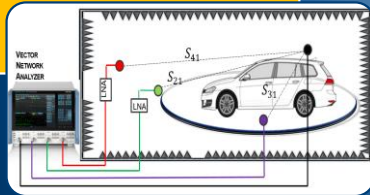
Measurement Parameters



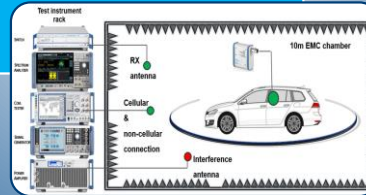
Measurement Method

1. RF output power
2. Spectral density
3. Spurious Emission

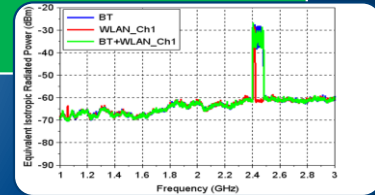
Chamber
Calibration



Measurement
Procedure

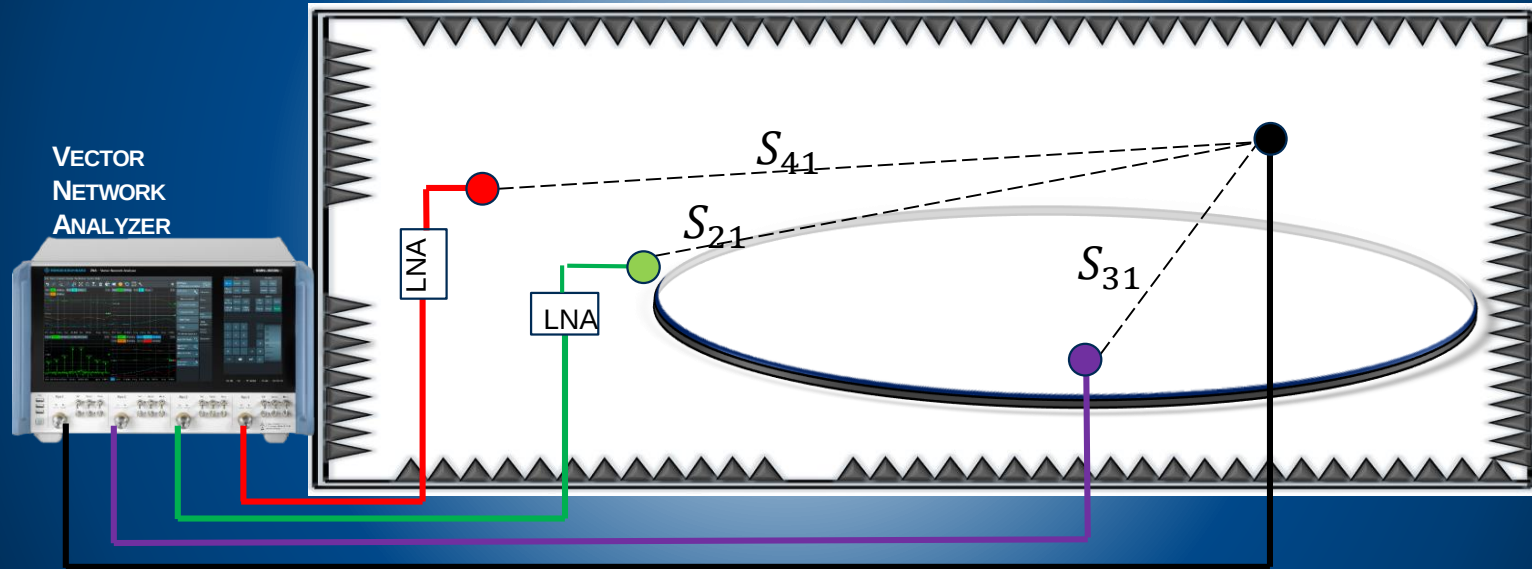


Result
documentation

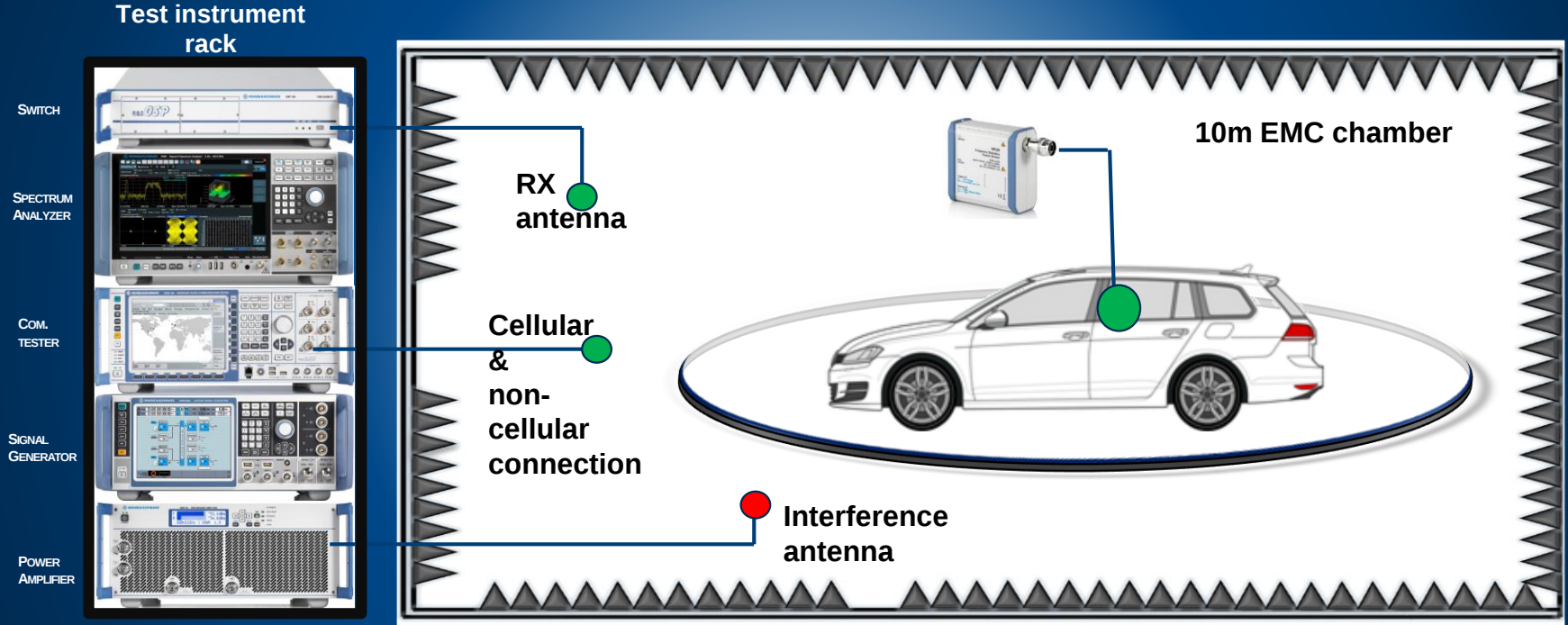


OTA test setup for vehicle level testing

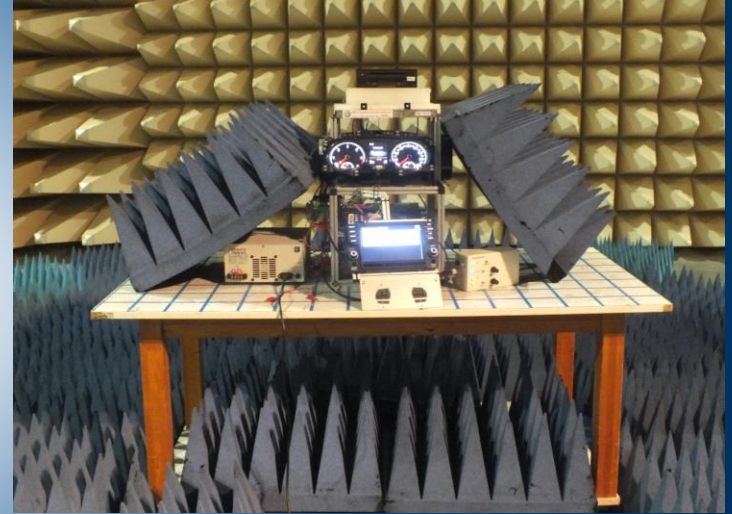
- Over-the-Air **chamber calibration** setup



OTA test setup for vehicle level testing



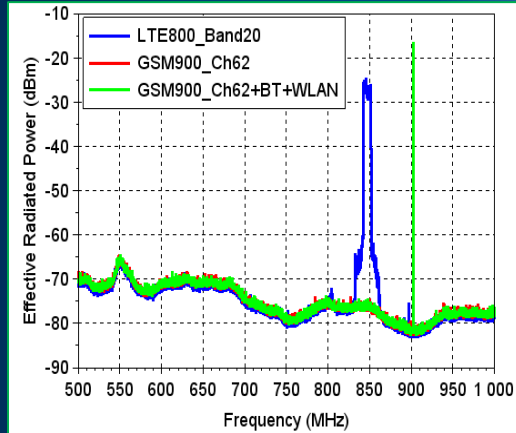
Component level testing



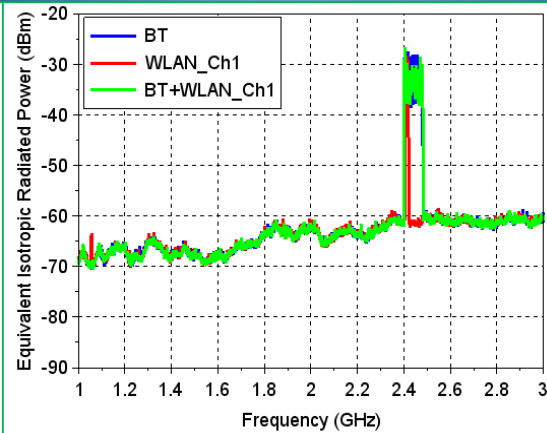
Vehicle level testing



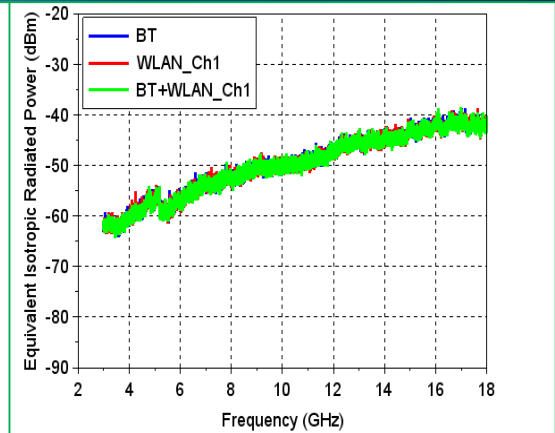
Measurement Results



(a)



(b)



(c)

Effective radiated power (a) and equivalent isotropic radiated power (b) (c) of radio equipment for the three measured sub bands.

Measurement Method

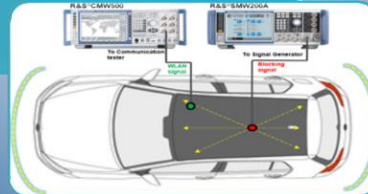
4. Receiver Blocking

5. Co-existence

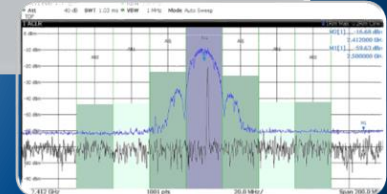
Test scenario
Definition

	LTE800	LTE2600	WLAN	Bluetooth
LTE800	n.a.			
LTE2600		n.a.		
WLAN			n.a.	
Bluetooth				n.a.

Connection &
Measurement



Result
documentation



Risk Assessment and Test Scenario Definition

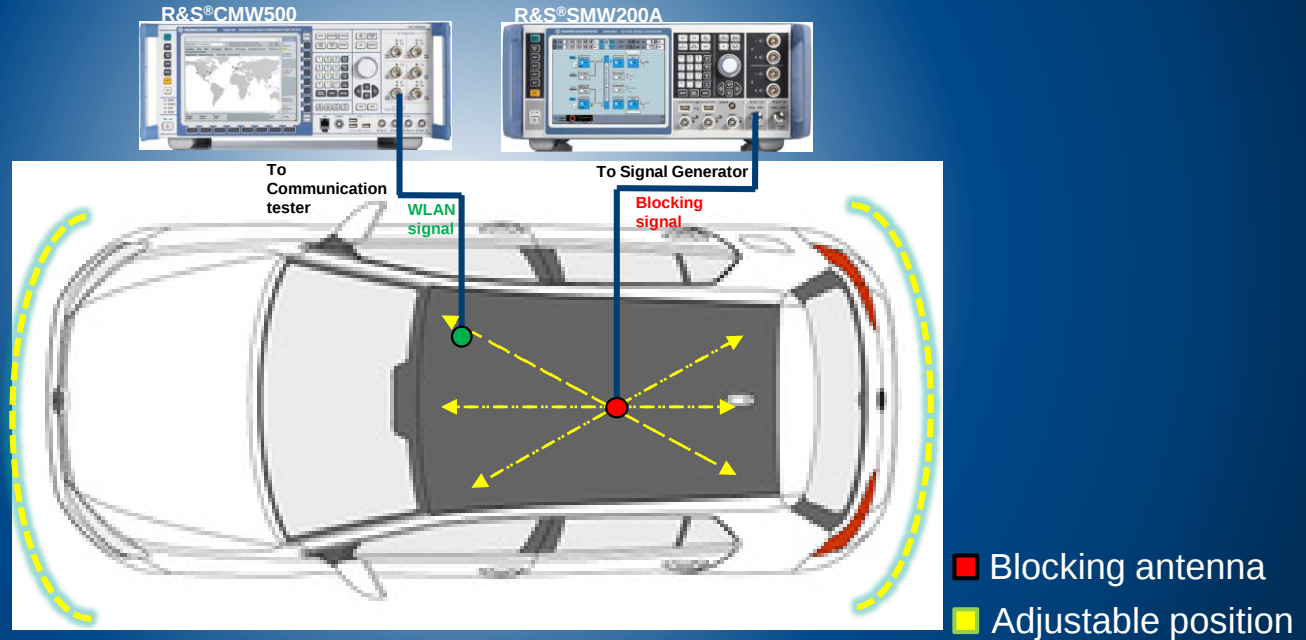
	LTE800	LTE2600	WLAN	Bluetooth
LTE800	n.a.			
LTE2600		n.a.		
WLAN			n.a.	
Bluetooth				n.a.

Risk assessment matrix example

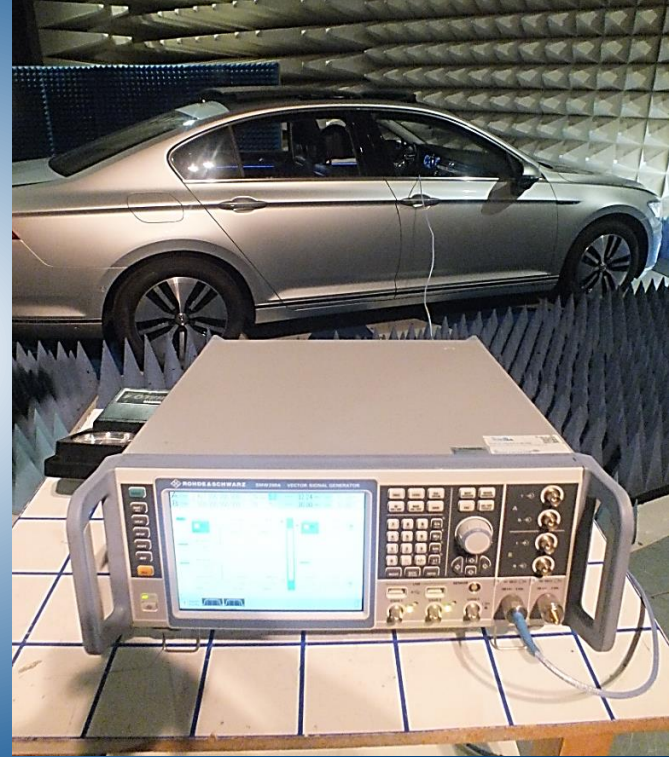


OTA test setup for vehicle level testing

- Over-the-Air **co-existence** measurement setup

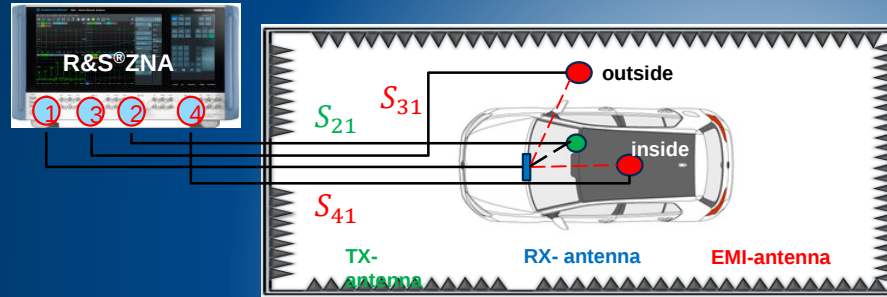


OTA test setup for vehicle level testing



OTA Test measurement in the vehicle

Calibration:

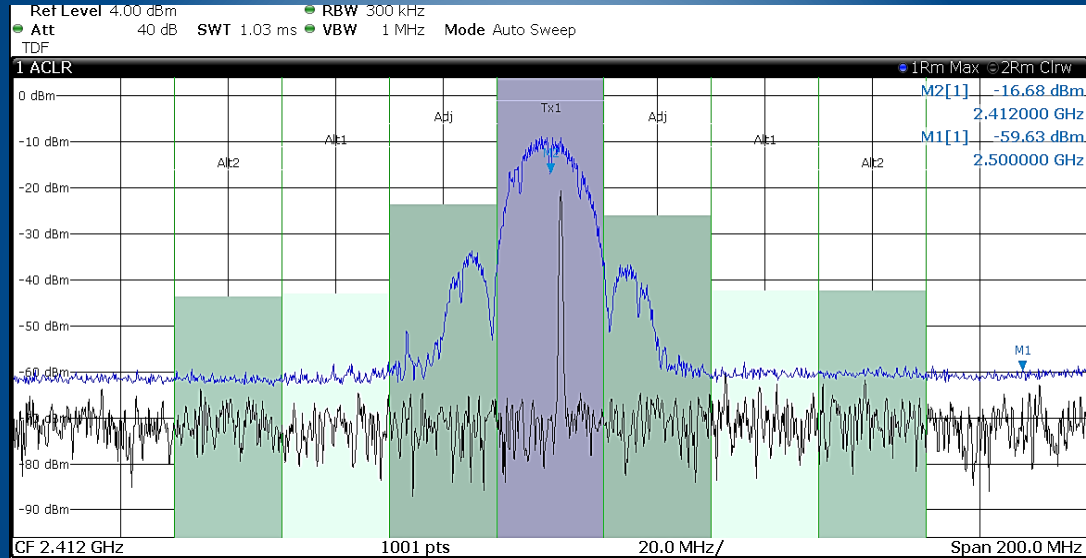


over-the-air	WiFi
S_{31}	- 52 dB
S_{41}	- 28.5 dB

Blocking and coexistence measurement:

- WiFi hotspot antenna in glove box and client antenna passenger seat
- Measurement of the sensitivity power and desensitization
- EMI antenna is placed inside and outside the car
- Measurement of the blocking with CW signal as unwanted and coexistence with LTE signal as wanted

Measurement Results



OTA blocking setup: superposition of the wanted and interferer signal

OTA Test measurement in the vehicle

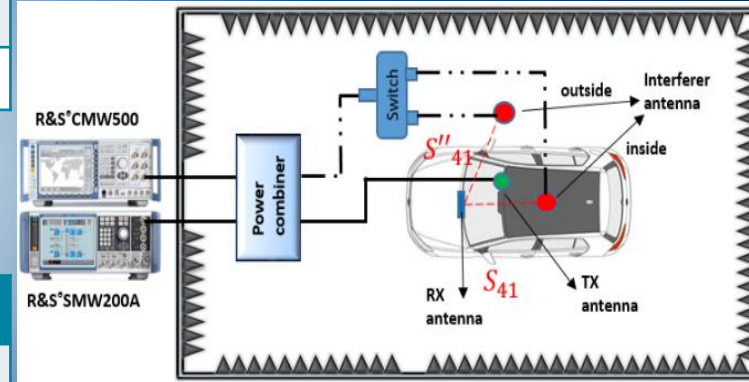
Results of PER:

- Blocking test:

	In-band	Out-of-Band
	2412 MHz	2440 MHz
CW (– 30.62 dBm)	12.8 %	0.8 %

- Coexistence test:

	Inside		Outside	
	LTE UL: 2505 MHz	LTE DL: 2606 MHz	LTE UL: 2505 MHz	LTE DL: 2606 MHz
LTE 7 (– 15 dBm)	1 %	0.6%	0.9 %	0.2 %



OTA Test measurement in the vehicle

Sensitivity Test

	WLAN ch1 BW=20MHz		LTE Band-7	
	64QAM TP=54Mbit/s	BPSK TP=6Mbit/s	64QAM BW=20MHz	16QAM BW=5MHz
Baseline PER 2%	- 70 dBm	-88 dBm	- 100 dBm	-109 dBm
Max PER 10%	- 74 dBm	-92 dBm	- 102 dBm	-111 dBm
Sensitivity + 6 dB	- 68 dBm	-86 dBm	- 96 dBm	-105 dBm

Additional Parallel Measurement Possibility

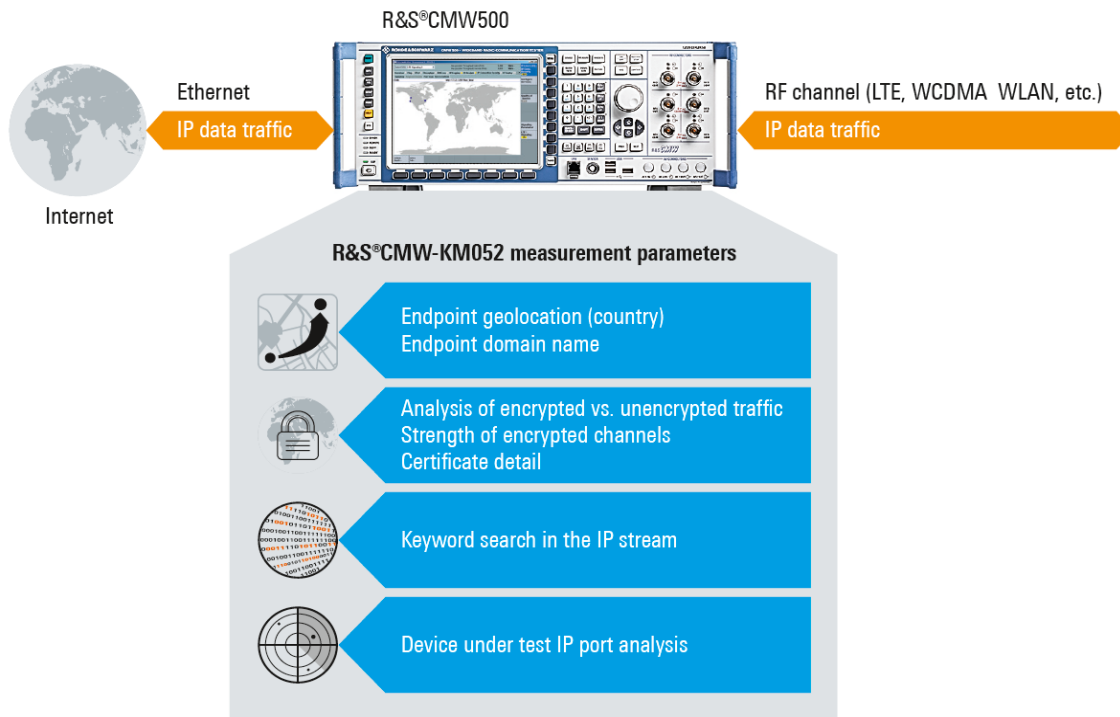
Additional Measurements

1. IP connection security analysis
2. User experience testing

ADDITIONAL PARALLEL TESTING POSSIBILITIES

IP CONNECTION SECURITY ANALYSIS

TEST SOLUTION



OVER VIEW SCREEN

Data Application Measurement 1 - X3.5.52.1

Select RAN:

Overview | Ping | IP Perf | Throughput | DNS req. | IP Logging | IP Analysis | IP Connection Security | IP Replay | Audio Delay

Overview | Keyword Results | Port Scan | Geo Locations

Application/Connection Info

Application

- generic (73405)
- Google Shared Services (457...)
- Google Mail (9847)
- YouTube (26144)
- Amazon Cloud (6646)
- Twitter (15562)
- Google Play (9512)
- WeChat (7543)

Connection Group

IP	Port	FQDN	Protocol	Geo	UL Data(B)	UL PKT	DL Data(B)	DL PKT
54.77.220.243:80	☐	mkt-odc.samsungapps.com	lteue_sig1	n/a	HTTP	IE		
54.77.65.136:80	☐	mkt-odc.samsungapps.com	lteue_sig1	n/a	HTTP	IE		
54.77.65.136:443	☒	mkt-odc.samsungapps.com	lteue_sig1	n/a	SSL	IE		
144.76.96.7:123	☐	2.android.pool.ntp.org	lteue_sig1	n/a	NTP	DE		
117.20.185.203:...	☐	settings.crashlytics.com	lteue_sig1	n/a	SSL	US		
216.58.212.170:...	☐	cloudconfig.googleapis.com	lteue_sig1	n/a	SSL	US		
216.58.212.170:0	☐	cloudconfig.googleapis.com	lteue_sig1	n/a	ICMP	US		
172.217.22.42:443	☐	cloudconfig.googleapis.com	lteue_sig1	n/a	SSL	US		
54.239.28.40:443	☐							

Connections per Group

IP	Detail	FQDN	Protocol	Geo	UL Data(B)	UL PKT	DL Data(B)	DL PKT
54.77.65.136:443	☐							
172.28.3.77:54190	☒	mkt-odc.samsungapps.com	SSL	IE	1880	16		

Switch to Handshake or Certificates details for more info

Select Applic... | Select Tab... | Filter... | SSL/TLS Handshake | SSL/TLS Certificates | Config...

IP Conn.Security
IP Conn. Security
RUN
Configure Services
Quality of Service
Signaling Parameter

1: Application

2: Connection group

3: Domain name

4: Geolocation of server - Country

5: Protocol / Indication encrypted or unencrypted channel

6: Data statistics

8: Details about SSL/TLS Handshake

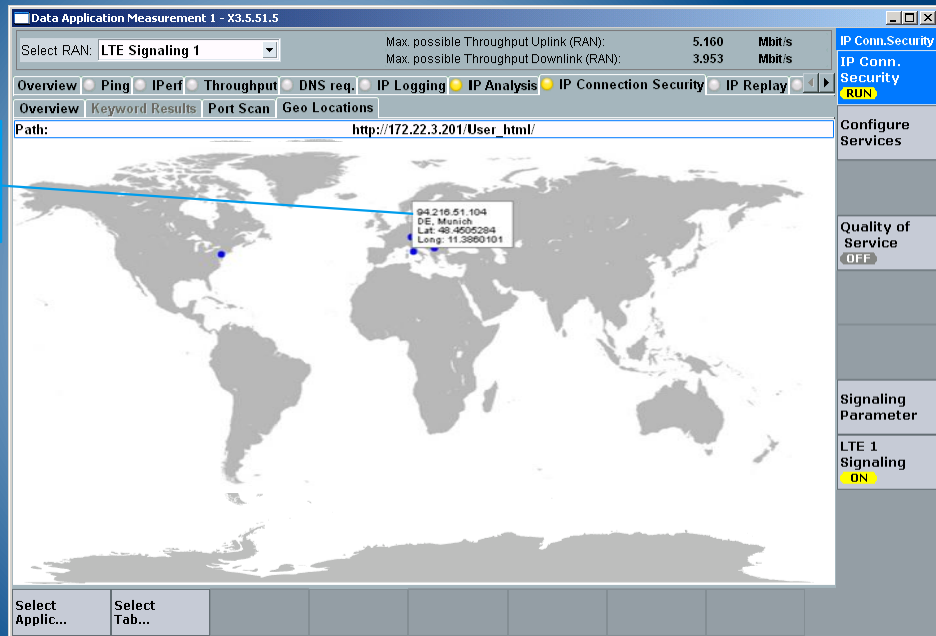
7: Connection Details

IP-BASED GEOLOCATION

MAPPING OF AN IP ADDRESS TO THE REAL-WORLD GEOGRAPHIC LOCATION

Connection Details:

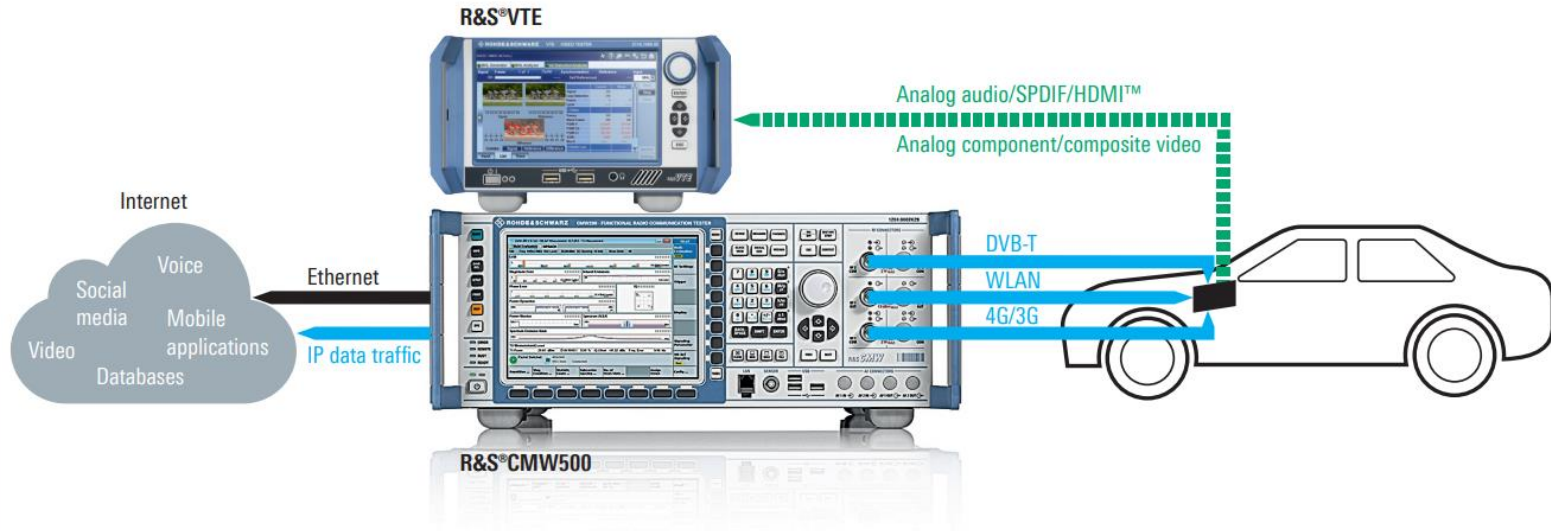
94.216.51.104
DE, Munich
Lat: 48.4505284
Long: 11.3860101



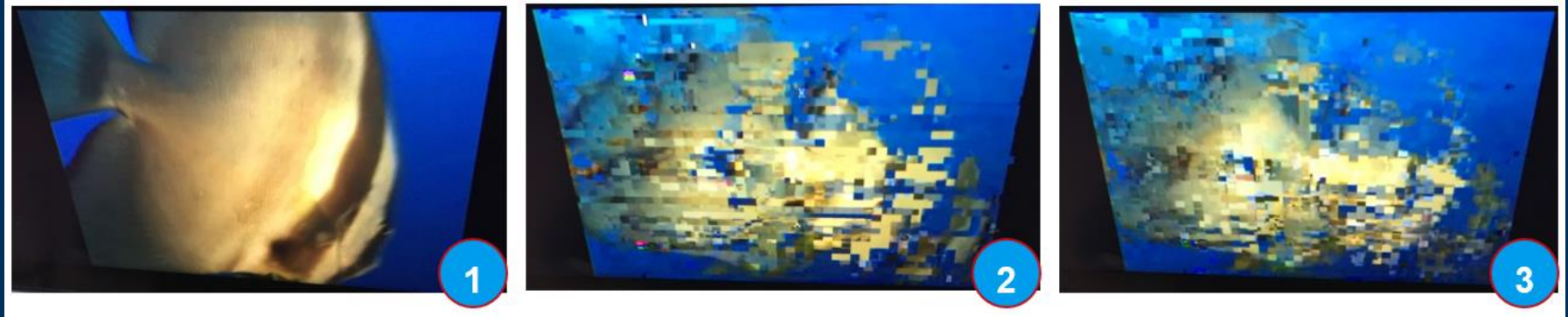
ADDITIONAL PARALLEL TESTING POSSIBILITIES

USER EXPERIENCE TESTING

Measurement setup for video quality testing on infotainment devices



USER EXPERIENCE TESTING



1. Original Video
2. 140 km / hr
3. At cell edge

Conclusion

Take Away points:

1. OTA setup introduced and methodology explained
2. Chamber calibration setup introduced and explained
3. Co-existence and Blocking test setup introduced and method explained
4. Measurement Results were discussed
5. Additional Measurement

Thank you for your attention

