R&S CMW500

C-V2X TEST SOLUTIONS INTRODUCTION

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ROHDE&SCHWARZ
Make ideas real

R&S C-V2X TEST SOLUTIONS

PRODUCTION

ROHDE&SCHWARZ

CMW100 K06

PRODUCTION TEST

- Frequency range up to 6GHz,
- 160MHz Bandwidth
- High accuracy
- Parallel test up to 8 RF ports
- CMW-KM570 C-V2X PC5 Meas.

CONFORMANCE

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CMW500 PT + SMBV100A/B

PROTOCOL TEST

- Data Transmission
- Data Reception
- Performance Testing (Fading)

GCF PROTOCOL CONFORMANCE

- GCF Work Item 281(V2V)
- GCF Work Item 282 (V2X)

APPLICATION

ROHDE&SCHWARZ

VECTOR

CMW500 PT + SMBV100B + CANoe .Car2x

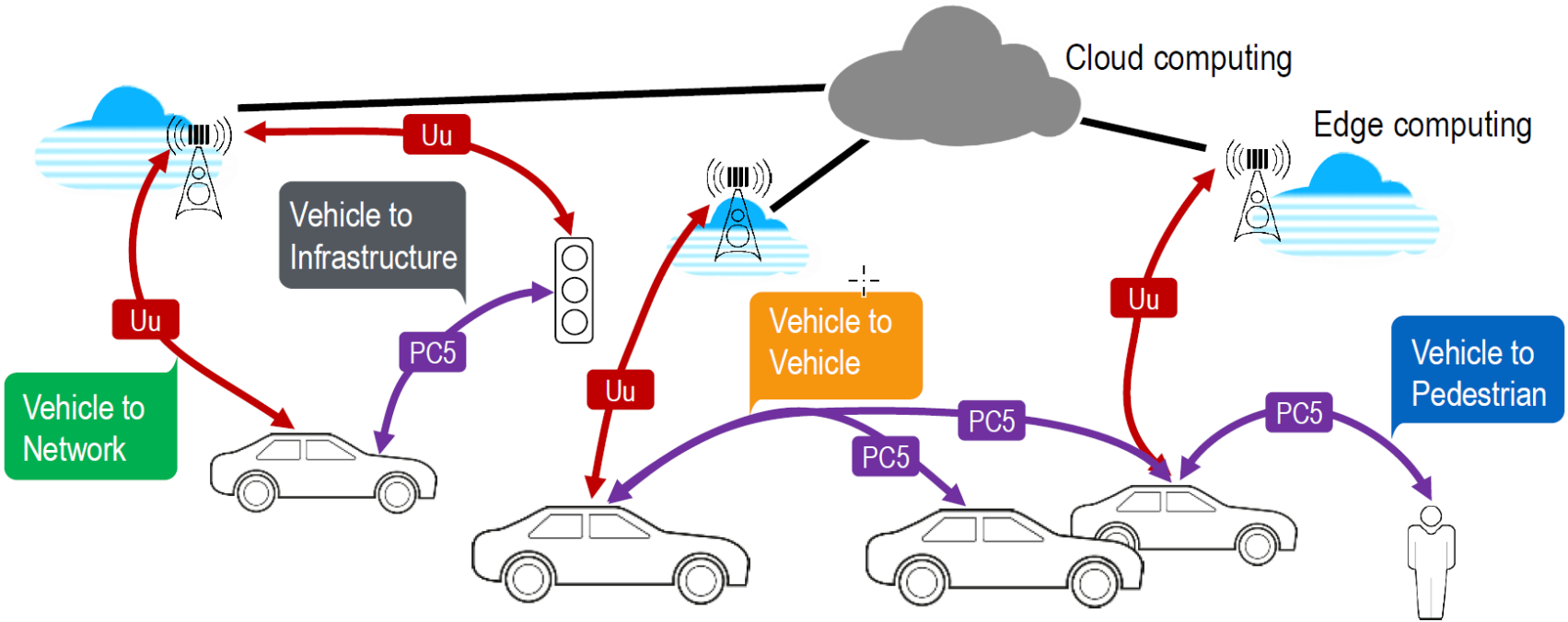
C-V2X SCENARIO BASED TESTING

- Development and Test of C-V2X Scenarios
- Graphical Scenario Editor
- Reproducible test scenarios
- Test of all layers
- Support of all common automotive bus connectivity

OUTLINES

- **Conformance testing**
- Application testing
- Production testing

V2X COMMUNICATION ARCHITECTURE: V2V, V2N, V2I, V2P



TEST SETUP

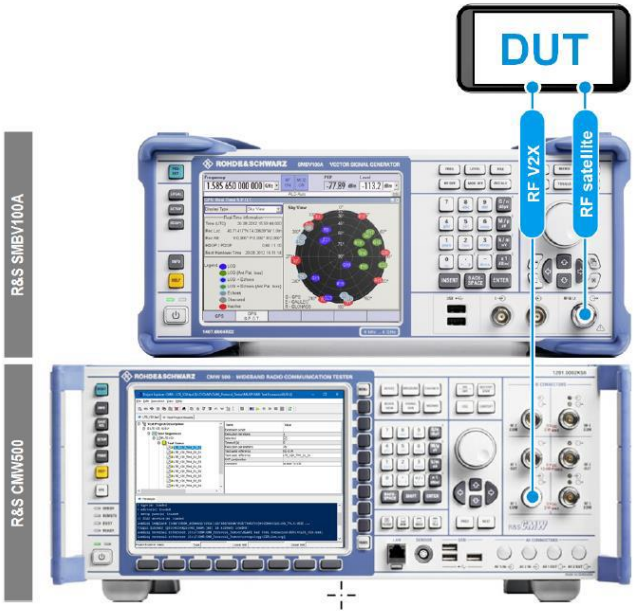
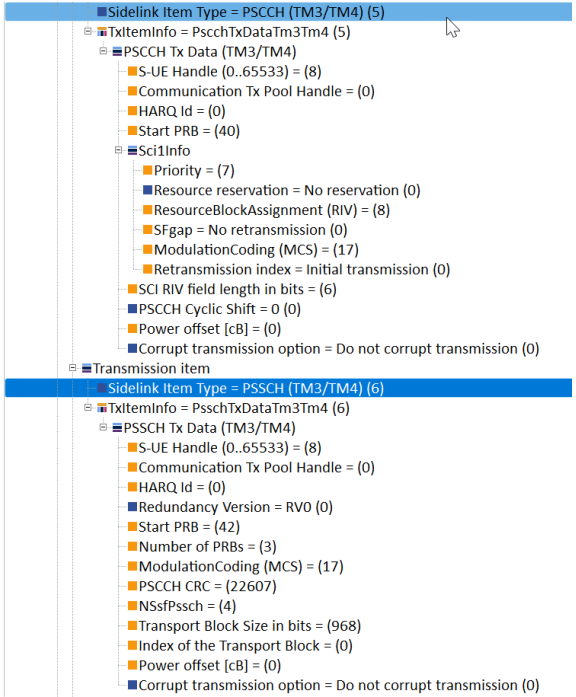


Figure 2-2: Front panel RF connections

RF satellite = RF connection for the positioning signal
RF V2X = LTE V2X RF connection

FLEXIBILITY AND CONTROL OVER CONFIGURATION

- CMW500 is simulating side link UE(s)
  - Flexible PC5 configuration
  - Scheduling pattern
  - Resource allocation
  - Modulation Coding Scheme
  - Periodicity
- SMBV is simulating GNSS signals:
  - Common time reference, UTC Time
- Fading and Noise
  - Apply fading profiles (EPA5, LTEEVA5, EVA70, ETU70, ETU300)
  - Apply AWGN noise
  - Inject fading profile & noise per UE simulation



PROTOCOL TEST (MLAPI) (KU514)

Available

Scenario	Test Purpose	R&S Product	R&S Status
CMW-KU514 LTE V2X TM4 Out of coverage Test Scenarios			
LTE-V2X Data Transmission			
LTE_V2X_TM4_01_01	Successful IP Multicast Data transmission over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Adjacent PSCCH-PSSCH	CMW-KU514	implemented
LTE_V2X_TM4_01_02	Successful IP Multicast Data transmission over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Non-Adjacent PSCCH-PSSCH	CMW-KU514	implemented
LTE_V2X_TM4_01_03	Successful IP Multicast Data transmission over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Zone Selection	CMW-KU514	planned
LTE_V2X_TM4_01_04	Successful IP Multicast Data transmission over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Carrier Sensing testing	CMW-KU514	implemented
LTE_V2X_TM4_01_05	Successful Non-IP Multicast Data transmission over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Adjacent PSCCH-PSSCH / Non-IP Type of Data	CMW-KU514	verified
LTE-V2X Data Reception			
LTE_V2X_TM4_02_01	Successful IP Multicast Data reception over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Adjacent PSCCH-PSSCH	CMW-KU514	implemented
LTE_V2X_TM4_02_02	Successful IP Multicast Data reception over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Non-Adjacent PSCCH-PSSCH	CMW-KU514	implemented
LTE_V2X_TM4_02_03	Successful IP Multicast Data reception over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Transmission on Multiple Rx Resource Pools	CMW-KU514	implemented
LTE_V2X_TM4_02_04	Successful Non-IP Multicast Data reception over PC5 using UE Selected resources (TM4) / Synchronization provided over GNSS / Adjacent PSCCH-PSSCH / Non-IP Type of Data	CMW-KU514	verified
Performance Tests with Fading			
LTE_V2X_TM4_03_01	Sidelink HARQ reception over PSSCH test (TM4), BLER vs SNR / Synchronization provided over GNSS / using the fading profile EPA5(1x1)	CMW-KU514	implemented
LTE_V2X_TM4_03_02	Sidelink HARQ reception over PSSCH test (TM4), BLER vs SNR / Synchronization provided over GNSS / using the fading profile LTEEVA5(1x1)	CMW-KU514	implemented
LTE_V2X_TM4_03_03	Sidelink HARQ reception over PSSCH test (TM4), BLER vs SNR / Synchronization provided over GNSS / using the fading profile LTEEVA70(1x1)	CMW-KU514	implemented
LTE_V2X_TM4_03_04	Sidelink HARQ reception over PSSCH test (TM4), BLER vs SNR / Synchronization provided over GNSS / using the fading profile LTEETU70(1x1)	CMW-KU514	implemented
LTE_V2X_TM4_03_05	Sidelink HARQ reception over PSSCH test (TM4), BLER vs SNR / Synchronization provided over GNSS / using the fading profile LTEETU300(1x1)	CMW-KU514	implemented
LTE_V2X_TM4_03_06	Sidelink HARQ reception over PSSCH test (TM4), BLER vs SNR / Synchronization provided over GNSS / using the V2X ETH2700 fading profile (with 2700Hz doppler speed)	CMW-KU514	implemented

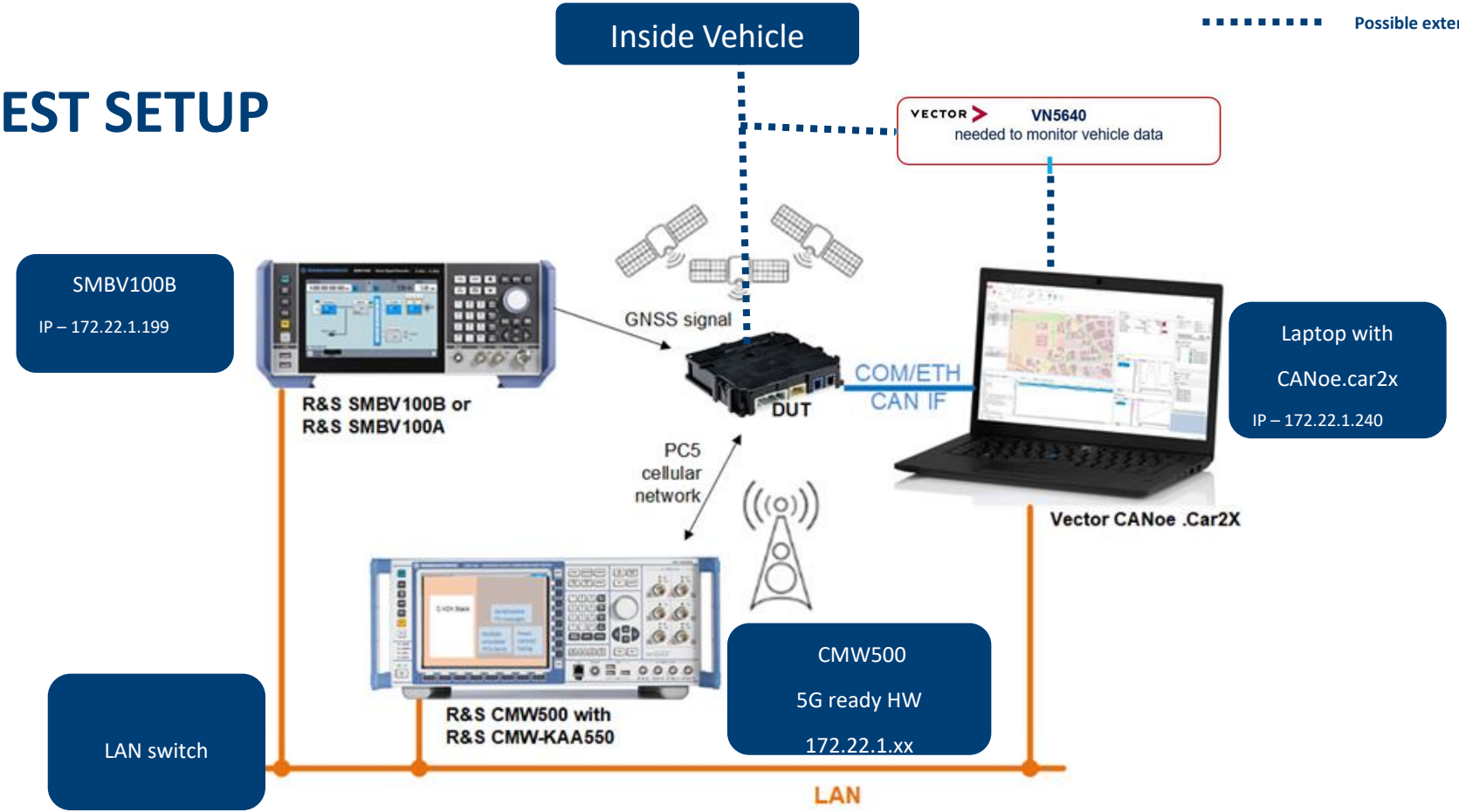
GCF PROTOCOL CONFORMANCE (KK550)

PCT	LTE	3GPP TS 36.523-1	24.1.15	LTE	E47(20)	V2X Sidelink Communication / Pre-configured authorisation / UE out of coverage on the frequency used for V2X sidelink communication / Operation with/without SyncRef UE/ Transmission SLSS	KK550	WI-282
PCT	LTE	3GPP TS 36.523-1	24.1.16	LTE	E47(20)	V2X Sidelink Communication/ Pre-configured authorisation / Utilisation of the pre-configured resources / CBR measurement	KK550	WI-282
PCT	LTE	3GPP TS 36.523-1	24.1.18	LTE	E47(20)	V2X Sidelink Communication / Pre-configured authorisation / UE out of coverage on the frequency used for V2X sidelink communication and without inter-frequency V2X configuration on anchor carriers/ Operation with/without SyncRef UE/ SLSS and MasterInformationBlock-SL-V2X message Transmission/ syncPriority in SL-V2X-Preconfiguration is set to eNB	KK550	WI-282
PCT	LTE	3GPP TS 36.523-1	24.1.19	LTE	E47(20)	V2X Sidelink Communication/ Pre-configured authorisation / Utilisation of the pre-configured resources / CBR measurement/Transmission based on CR limit	KK550	WI-282
PCT	LTE	3GPP TS 36.523-1	24.1.2	LTE	E47(20)	V2X Sidelink Communication / Pre-configured authorisation / Utilisation of the pre-configured resources / Transmission	KK550	WI-281
PCT	LTE	3GPP TS 36.523-1	24.1.4	LTE	E47(20)	V2X Sidelink Communication/ Pre-configured authorisation / Utilisation of the pre-configured resources / Reception	KK550	WI-281
PCT	LTE	3GPP TS 36.523-1	24.1.9	LTE	E47(20)	V2X Sidelink Communication/ Pre-configured authorisation / UE in RRC_IDLE or RRC_Connected on an E-UTRAN cell not operating on the carrier frequency provisioned for V2X / UE out of coverage on the frequency used for V2X sidelink communication / Utilisation of the pre-configured resources / Transmission based on zoning	KK550	WI-281

OUTLINES

- Conformance testing
- **Application testing**
- Production testing

TEST SETUP


Inside Vehicle
Possible extension
VECTOR
VN5640
needed to monitor vehicle data
SMBV100B
IP – 172.22.1.199
R&S SMBV100B or
R&S SMBV100A
GNSS signal
DUT
COM/ETH
CAN IF
Laptop with
CANoe.car2x
IP – 172.22.1.240
Vector CANoe .Car2X
PC5
cellular
network
R&S CMW500 with
R&S CMW-KAA550
CMW500
5G ready HW
172.22.1.xx
LAN switch
LAN

ON CMW500

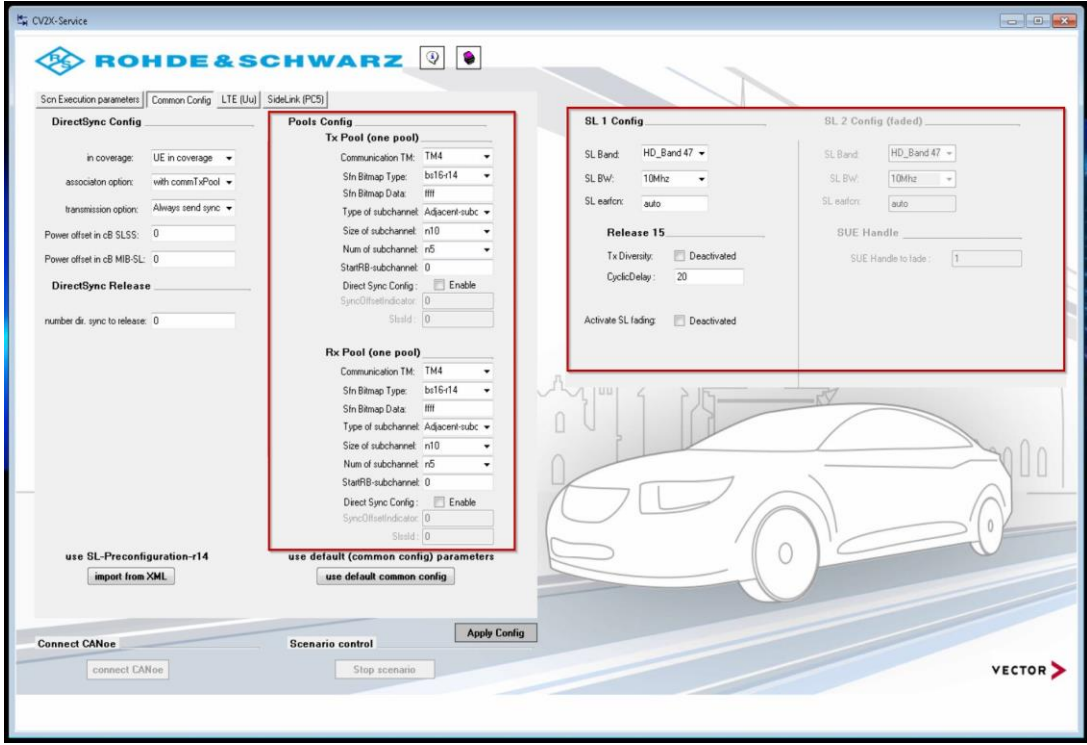
- Use C-V2X application layer testing manual for
  - Checking hardware requirements
  - Checking software requirements
  - Software installation
    - Use installation manager to search KAA550 and install all dependencies (Version 35.43 or the latest available)
      - **KAA550**
      - **V2X GUI (KAA550)**

ON CMW500

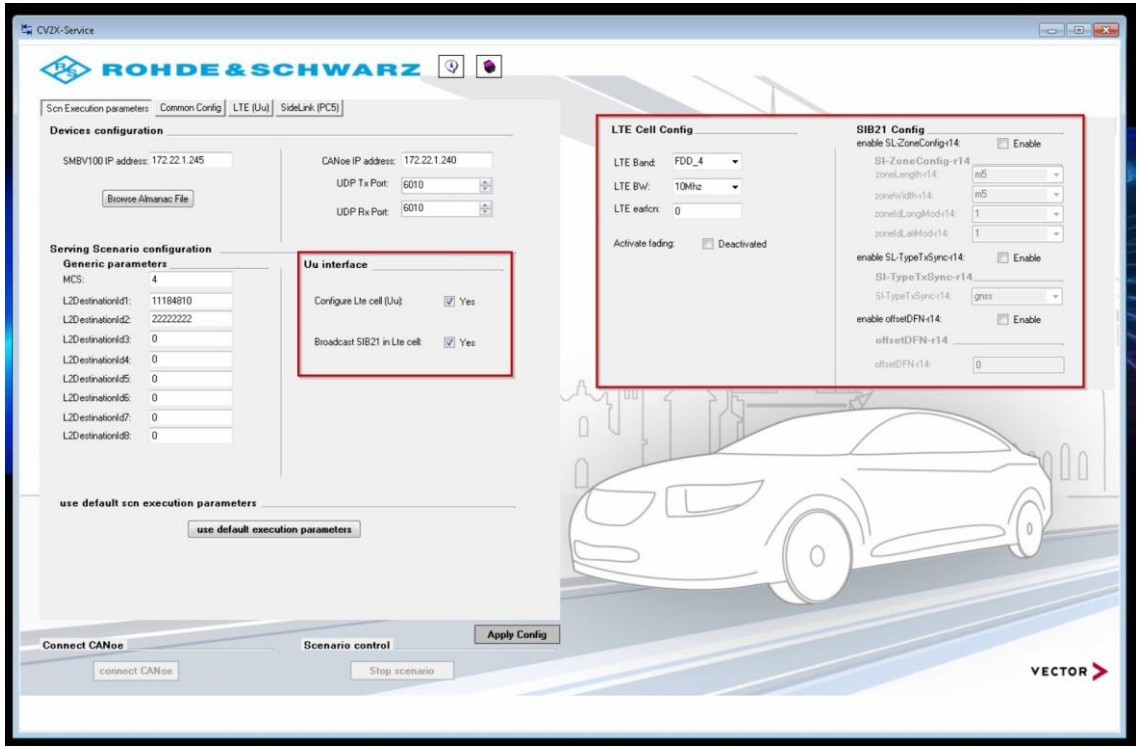
- **Start V2X GUI**

  Project explorer (i.e. blue window) will start in the background

- **Configure V2X GUI**
  - Set SMBV IP to 172.22.1.199
  - Set CANoe IP to 172.22.1.240
  - Leave UDP Tx/Rx Ports as it is
  - **Set pool config compatible to DUT**
    - Picture shows settings compatible to QC 9150 reference device that we have in RSNA.
    - This will be different for customer's device.
  - Hit Apply Configuration
  - Hit connect CANoe



SIMULTANEOUS TESTING OF PC5 & UU ALSO SUPPORTED



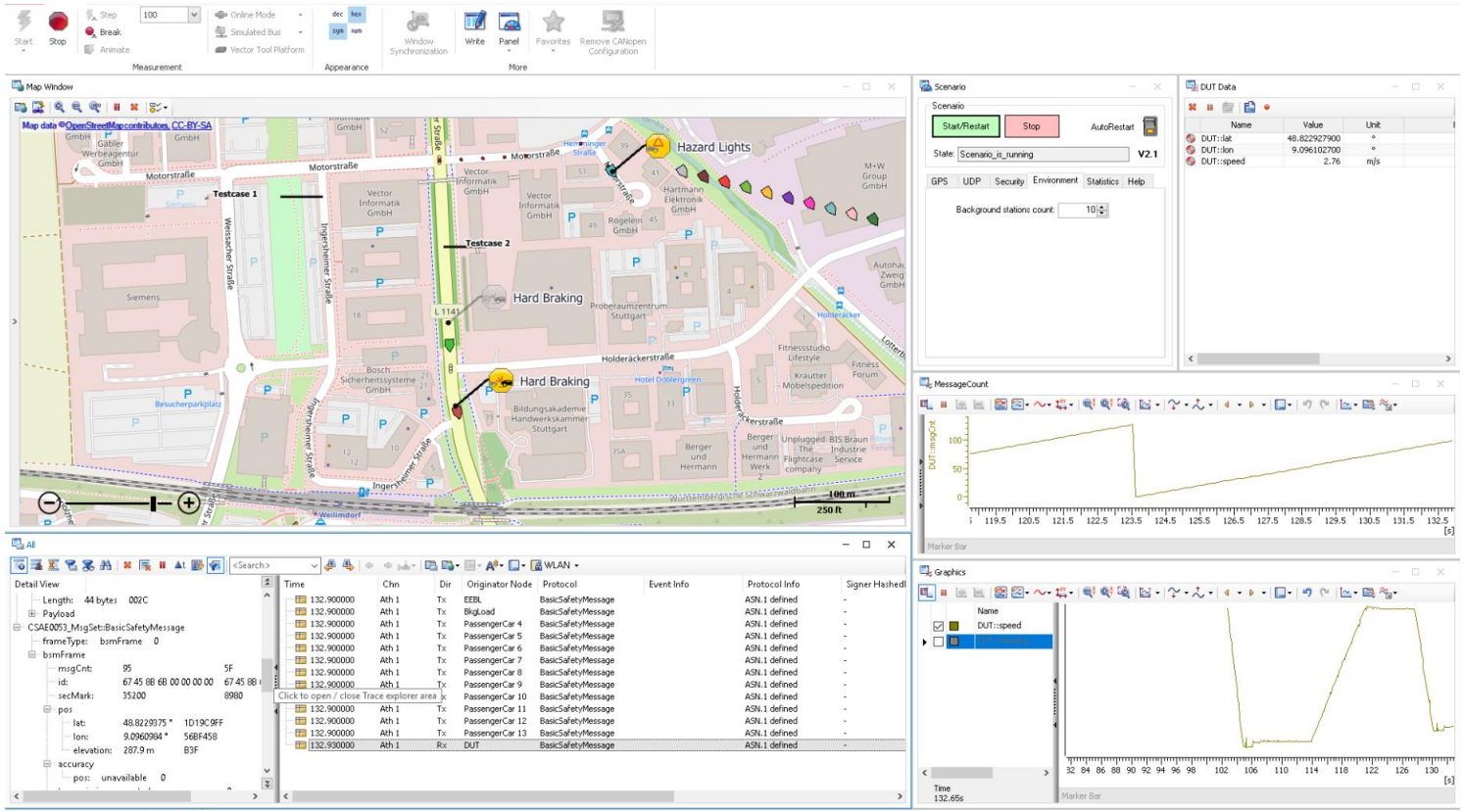
CMW LOGS TO CHECK NUMBER OF VEHICLES SIMULATED

E.g. 250 cars: Source layer ID starts at 45001 and ends at 42252

Lte	SRC	CSRC		CSRC_COMMTXBEARERCONFIG	Cnf					
UPLANE	UPC	MNUPC_V2		Flow State	Ind				250	
Lte	SRC	CSRC		CSRC_V2XCOMM_SIDELINK_SUE_RESOURCE_	Req	45249				
Lte	SMAC	CSMAC		CSMAC_V2X_COMMGRANT_CONFIG	Req	45249				
Lte	SMAC	CSMAC		CSMAC_V2X_COMMGRANT_CONFIG	Cnf					
Lte	SRC	CSRC		CSRC_V2XCOMM_SIDELINK_SUE_RESOURCE_	Cnf					
Sys	GUI	TestCase		Status	Ind					
Sys	GUI	TestCase		Status	Ind					
UPLANE	UPC	MNUPC_V2		Activate Proxy	Req		348; V2X; 172.22.1.240; 9000		None(0)	1250
UPLANE	UPC	MNUPC_V2		Activate Proxy	Cnf		172.22.1.201; 9000		251	
Sys	GUI	TestCase		Status	Ind					
Lte	SRC	CSRC		CSRC_COMMTXBEARERCONFIG	Req					
Lte	SRLC	CSRLC		CSRLC_CONFIG	Req	45250		1250		
Lte	SRLC	CSRLC		CSRLC_CONFIG	Cnf					
Lte	SRLC	CSRLC		CSRLC_LOG_CONFIG	Req			1250		
Lte	SRLC	CSRLC		CSRLC_LOG_CONFIG	Cnf			1250		
Lte	SPDCI	CSPDCP		CSPDCP_CONFIG	Req	45250		1250		
Lte	SRLC	SRLC_UCTI		SRLC_DISCARD_TIMER	Req			1250		
Lte	SPDCI	SPDCP_U_(		SPDCP_U_MAPPING	Ind	45250		1250		
UPLANE	UPC	CUDA_V2		Update Flows	Ind					1250
UPLANE	UPC	CUDA_V2		Update Flows	Rsp				251	1250
Lte	SPDCI	SPDCP_U_(		SPDCP_U_MAPPING	Rsp					
Lte	SPDCI	CSPDCP		CSPDCP_CONFIG	Cnf					
Lte	SPDCI	CSPDCP		CSPDCP_LOG_CONFIG	Req			1250		
Lte	SPDCI	CSPDCP		CSPDCP_LOG_CONFIG	Cnf			1250		
Lte	SMAC	CSMAC		CSMAC_STCH_CONFIG	Req	45250		1250		

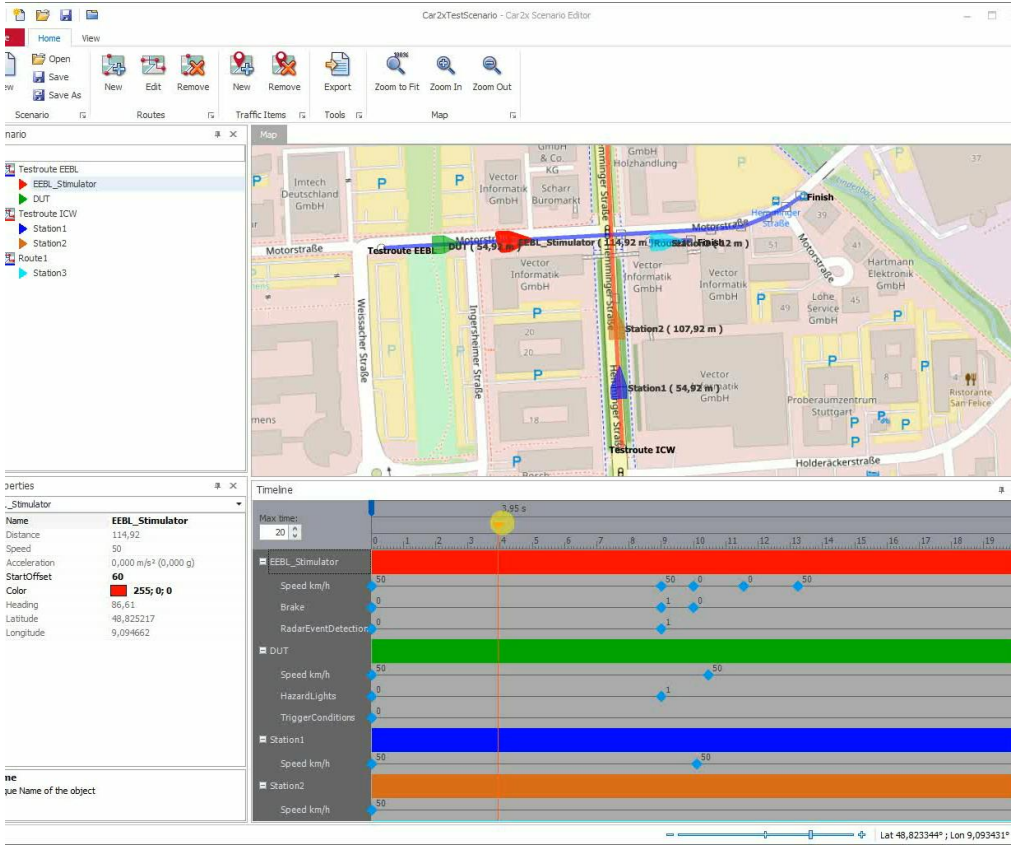
Lte	SPHY	SPHY_LOG		SPHY_DATA	Req		Mac Sidelink Pdu(3)	
Lte	SRLC	SRLC_LOG		SRLC_LOG_DATA	Req	45240	Transparent - PDCP	
Lte	SRLC	SRLC_LOG		SRLC_LOG_DATA	Req	45241	Transparent - PDCP	
Lte	SRLC	SRLC_LOG		SRLC_LOG_DATA	Req	45242	Transparent - PDCP	

CANOE LOOK AND FEEL



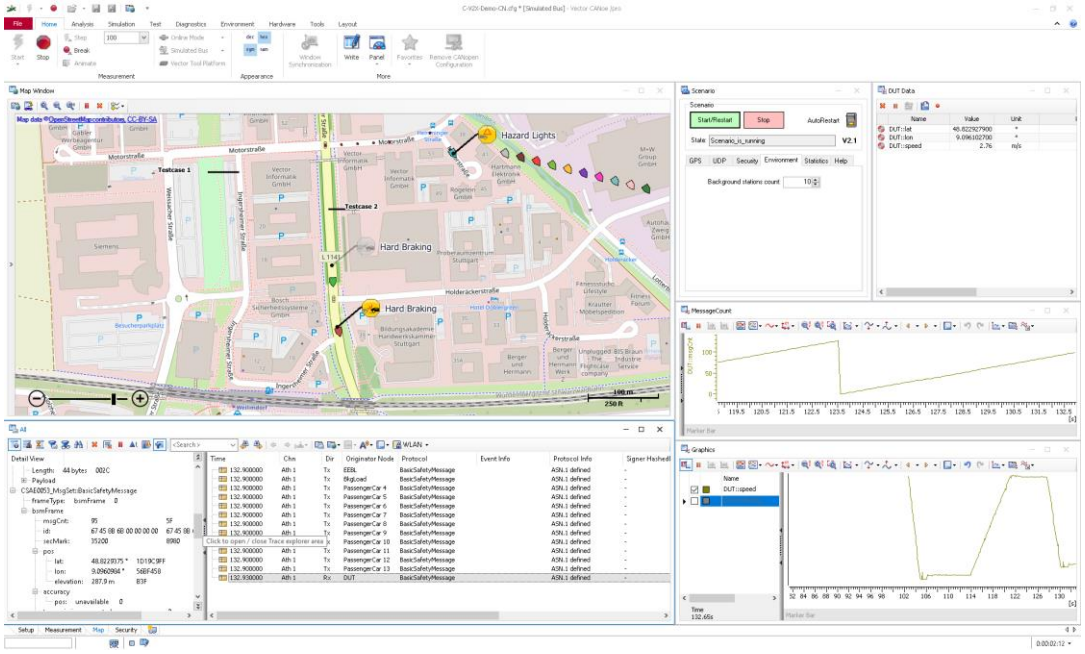
SCENARIO EDITOR

- GUI for easy and fast traffic scenario configuration
- Multiple virtual cars
- GNSS route definition
- Flexible parameter configuration (speed, signal strength…)
- CAPL interface for fine adjustment of the scenario
- Scenario loaded and played back by CANoe – C-V2X communication and waypoints created according to scenario



SIMULATION AND TEST

- CANoe imports scenario file
  - **Start and stop** a scenario
  - **Callback functions** if keypoints changes or scenario status changes
- Interpretation of ITS relevant protocols
- Support of relevant standards
  - ETSI (EU), WAVE/SAE (US), GB31024 (CN)
  - Security header generation
- Application message support
  - CAM, DENM, Spat/MAP, IVI, BSM,…
- Map window for visualization of the scenario
- Trace/Graphic/Data window for specific measurement and DUT specific data
- Internal programming environment for advanced stimulation and analyzing (CAPL)
- The test solution allows bus connectivity
  - CAN, LIN, FlexRay, Ethernet to analyze results or stimulate the ECU remotely

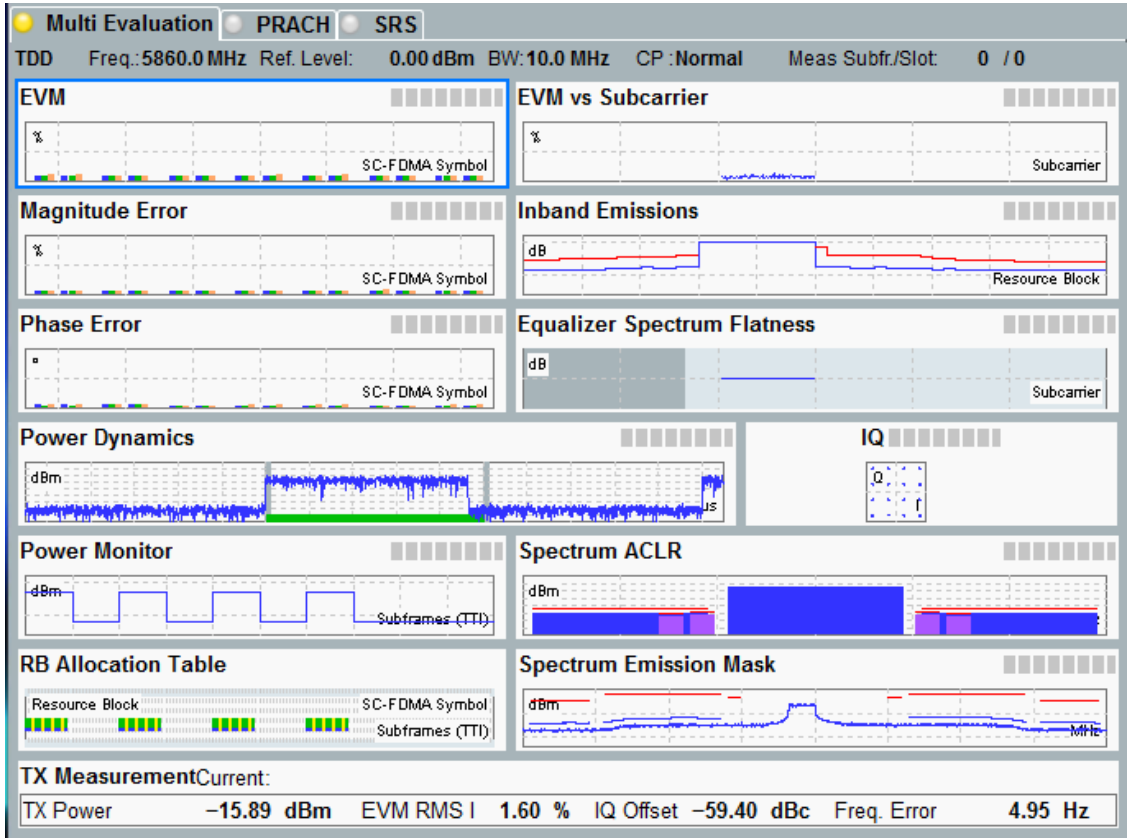


OUTLINES

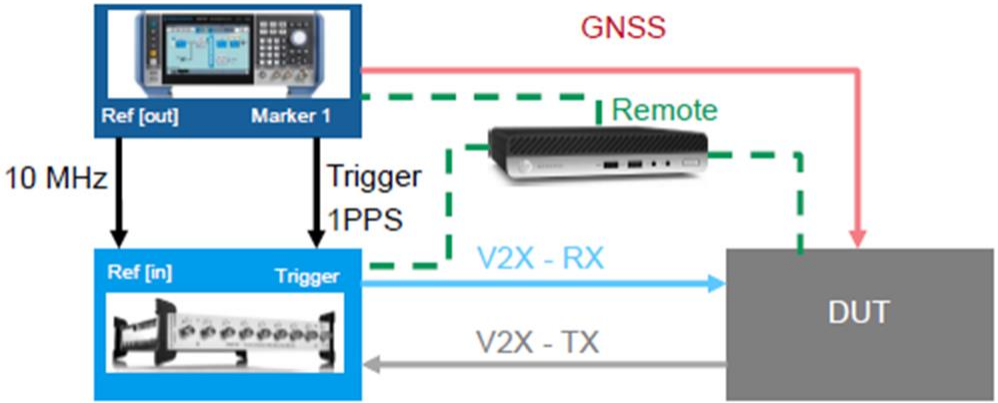
- Conformance testing
- Application testing
- **Production testing**

LTE R14 C-V2X TX MEASUREMENTS CMW-KM570

- Error Vector Magnitude (EVM)
- EVM vs. Subcarrier
- Magnitude Error
- Inband Emissions
- Phase Error
- Equalizer Spectrum Flatness
- Power Dynamics
- IQ Constellation
- Power Monitor
- Spectrum ACLR
- RB Allocation Table
- Spectrum Emission Mask
- TX Power
- Frequency Error



C-V2X PC5 RF MEASUREMENTS USING CMW100



*Recommended setup
**Setup will depend on chipset vendor's suggested method of testing

- **TX-Test:**
  - CMW-KM570 LTE R14 C-V2X PC5 Measurements
- **RX-Test:**
  - CMW-KW570 LTE R14 C-V2X PC5 WINIQSIM2
    - Require CMW-KW500 WINIQSIM2
    - Generate your own waveform (ARB) files
    - Play CMW-KV1xxA C-V2X pre-defined ARB-files
  - Chipset specific
    - CMW-KV110A (Qualcomm)
    - CMW-KV118A (Hisilicon)
- Support CMW100 K06
- **Also supported on CMW500 (requires MUA/TRX160)**

CMW100
5G NR / C-V2X

LTE-A, WCDMA, GSM, CDMA2000, TD-SCDMA, WLAN, Bluetooth, ZigBee, GNSS, Broadcast technologies (Arb files), Non-Signaling mode.