Application Note

# C-V2X SCENARIO SIMULATION WITH R&S CMW500 WIDEBAND RADIO COMMUNICATION TESTER

**Products:**

- R&S® CMW500
- R&S® CMW-KAX550
- R&S® SMBV100B
- Vector® CANoe
- Vector® CANoe.Car2x
- Vector® VN4610

Rainer Wagner | GFM341 | Version 3e | 07.2024

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# Contents

# 1 Overview

This application Note is based on CMW500, SMBV100B and Vector CANoe.Car2x Software and guides to how to simulate the specific Cellular Vehicle-to-Everything (C-V2X) wireless environment in respect to road transport scenarios and transmitted messages around the Device Under Test (DUT) like a Telematics Control Unit (TCU). It shows how to verify and validate the C-V2X application of the DUT in laboratory environment. The virtual simulation scenario is not limited to the requirements of CSAE53-2017 specification, and it could be modified by user according to this operating guide with CANoe.

Vehicle-to-everything (V2X) is a new generation of information and communications technologies that connect vehicles to everything. The objective of V2X is to increase road safety and manage traffic efficiently.

C-V2X is designed to offer low-latency vehicle-to-vehicle (V2V), vehicle-to-roadside infrastructure (V2I) and vehicle-to-pedestrian (V2P) communications services to add a new dimension to future advanced driver assistance systems (ADAS). C-V2X as one communications standard defined by 3GPP in Release 14 uses LTE technology as the physical interface for communications. The standard describes two types of communications. The vehicle-to-network (V2N) communications type, exploits the cellular Uu interface, uses traditional cellular link to enable cloud services to be integrated into end-to-end solutions, e.g. to allow road and traffic information for a given area to be distributed to the vehicles.

The second type is referred to as direct or PC5/Sidelink (V2V, V2I, V2P) communications, where data transmission takes place over the PC5 interface. In that type, C-V2X does not necessarily require a cellular network infrastructure. It can operate without a SIM and without network assistance and uses GNSS as its primary source for time synchronization.

Verifying system functionality and performance exclusively by field testing in a real-world environment can be time-consuming, costly and very challenging. Requirements regarding functionality, and consequently the required assistance functions, are constantly changing. Due to this fact, test solutions are needed during the development and introduction phase to verify compliance with the standards. The PC5 direct communications type allows exchange of time sensitive and safety relevant information. Using a mobile communication tester like the R&S® CMW500 together with a C-V2X scenario simulation tool delivers reproducible test scenarios. This is essential for the standardization of verification processes for C-V2X in order to obtain reliable and comparable results, and it helps to demonstrate that end-to-end functionality between two C-V2X devices from different vendors works properly.

# 2 Test solution

The R&S®CMW500, R&S®SMBV100B, along with Vector CANoe.Car2x software provides the necessary tools to develop use cases and verify end-to-end C-V2X functionality on the PC5/Sidelink. The tool set supports the Chinese, U.S., and European intelligent transportation system (ITS) stack versions, making it easier for teams who are working on TCUs that will end up inside vehicles in all three regions. The R&S®CMW500 uses a C-V2X software package to simulate the 3GPP stack including the physical layer in order to transmit and receive data over the PC5 radio interface (see Figure 1).

## 2.1 Simulation, Development and Test of V2X-based Communication Applications

The V2X application testing combines emulation of the V2X scenario described by higher layers such as the ITS profiles with the radio protocol including RF layer emulation to test the RF link in combination with the

ITS application. The R&S®CMW500 option R&S®CMW-KAA550 C-V2X LTE application adapter from the LTE V2X Test Suite R&S® CMW-KAX550 links the Vector test tool CANoe with the RF connectivity emulated by the R&S®CMW500 mobile radio tester (see Figure 1).

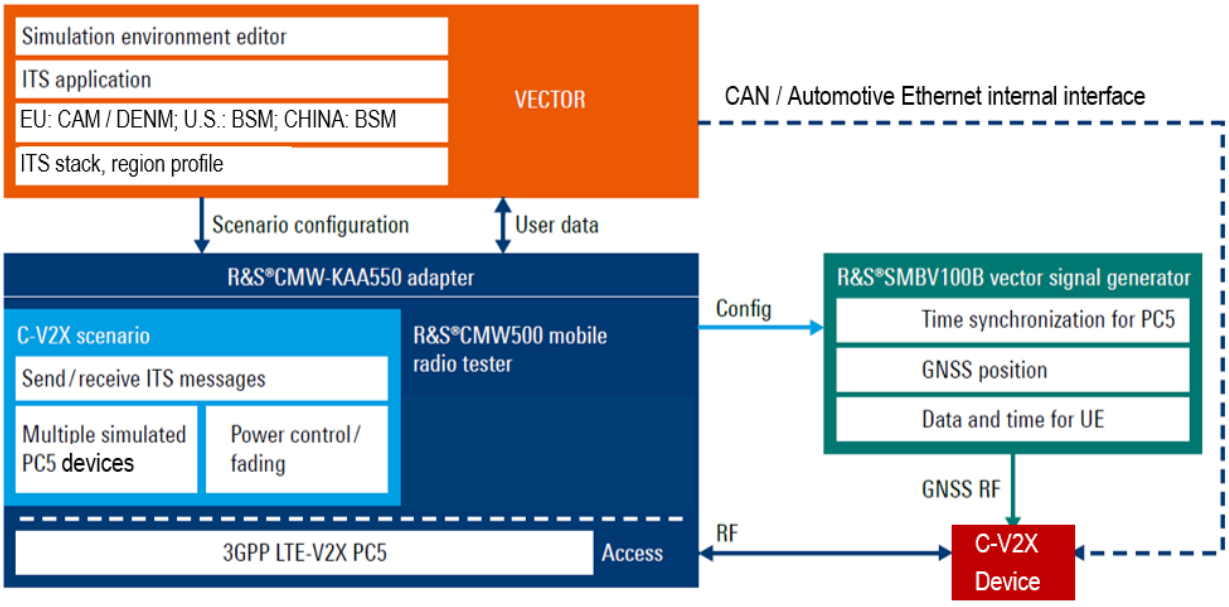



Figure 1 : C-V2X application and RF test solution.

The Vector's CANoe.Car2x is a software tool for development, testing and analysis of entire ECU networks and individual ECUs. It supports the entire development process – from planning to startup of entire distributed systems or individual ECUs. CANoe's versatile functions and configuration options are used by network designers, developers and test engineers at OEMs and suppliers. Time-critical sequences are processed in the real-time area. The CANoe option .Car2x is particularly suitable for application and function development of ECUs that receive their information on the basis of C-V2X application messages. CANoe .Car2x offers a range of functions designed to configure and run traffic scenarios so that the functions of the ECU can be tested comprehensively. This allows you to stimulate your C-V2X capable TCU according to the situation and test the implemented functions in a targeted manner. The tool that is completely adapted to the requirements of the C-V2X domain. Therefore CANoe .Car2x supports the most common standards and protocols published by IEEE (US), ETSI (EU) and CCSA (China) worldwide. This includes application messages such as CAM, DENM, SPaT, MAP, IVIM and BSM, as well as the underlying protocols such as GeoNetworking for the EU, IEEE 1609 (WAVE) for the US and DSRC Short Message Protocol (DSMP) for China.

The incoming bus data is read via a bus interface, provided with a time stamp there, and then processed promptly. Transmission of data to the bus also takes place in the real-time area. Users can create and simulate detailed traffic situations to verify C-V2X connectivity including security and certificate management for the intended application. An easy to handle graphical scenario editor helps users create traffic scenarios. When a scenario is started CANoe .Car2x generates the corresponding ITS communications messages based on the configured test scenario using the relevant ITS stack variant for the target market (North America, Europe, China) inline with specifications.

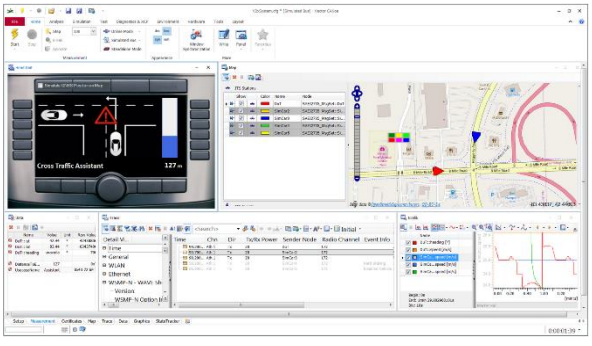
The messages and route information for that scenario are forwarded to the R&S®CMW500 and the SMBV100B via the R&S®CMW-KAA550 C-V2X LTE application adapter for Vector which is included in the CMW® -KAX550 LTE V2X Test Suite, providing the radio access layer to the DUT. This allows stimulating a TCU in line with the particular situation and to test the implemented functions such as:

- ► Intersection Collision Warning (ICW）
- ► Emergency electronic brake light (EEBL)
- ► Left-turn assist (LTA)
- ► Intersection movement assist (IMA)
- ► Congestion control – stimulated with multiple simulated cars

## 2.2 Brief introduction of the used instruments and tools

R&S®CMW500 functional radio communication tester that provides signaling test solutions for multiple technologies like LTE, WCDMA, GSM, WLAN, Bluetooth etc. It provides high quality, customized, automated test environment for functional tests. It enables developers and test teams to simulate radio access networks and includes a fully integrated end-to-end data solution. R&S®CMW500's RF hardware supports all 3GPP-defined bandwidths up to 6 GHz. The R&S®CMW500 offer dedicated measurement for C-V2X testing using multiple test scenarios to verify trans-mission and reception of C-V2X direct communications (PC5) based on 3GPP Release 14.

The R&S® SMBV100B vector signal generator provides a frequency range from 8 kHz to 3 GHz or 6 GHz. It supports signal generation for all major digital communication standards including 5G NR, LTE, and WLAN. It also supports GNSS simulation with support for GPS, Glonass, Galileo, BeiDou and QZSS/SBAS




CANoe from Vector is the comprehensive software tool for development, test and analysis of individual ECUs and entire ECU networks. It supports network designers, development and test engineers throughout the entire development process – from planning to system-level test. The option .Car2x is particularly suitable for application and function development of ECUs that receive their information on the basis of V2X application messages. The option Car2x offers a range of functions designed to configure and run traffic scenarios so that the functions of the ECU can be tested comprehensively. This allows you to stimulate your Car2x control unit according to the situation and test the implemented functions in a targeted manner.

The Vector VN4610 interface is a special solution for IEEE 802.11p and CAN (FD) based applications. It is designed to optimally match CANoe Option .Car2x. This makes the VN4610 the ideal extension the CANoe.Car2x test tool for getting your 802.11p-based ECUs on the road to series production.
The VN4610 supports receiving and transmitting of IEEE 802.11p frames which are used for the implementation of Car2x/V2X applications. The built-in GNSS receiver supplies the current time and the current position. All provided time stamps can be synchronized to UTC time.

# 3 Test setup for the V2X simulation system

Figure 2 shows the necessary components for the V2X application testing:

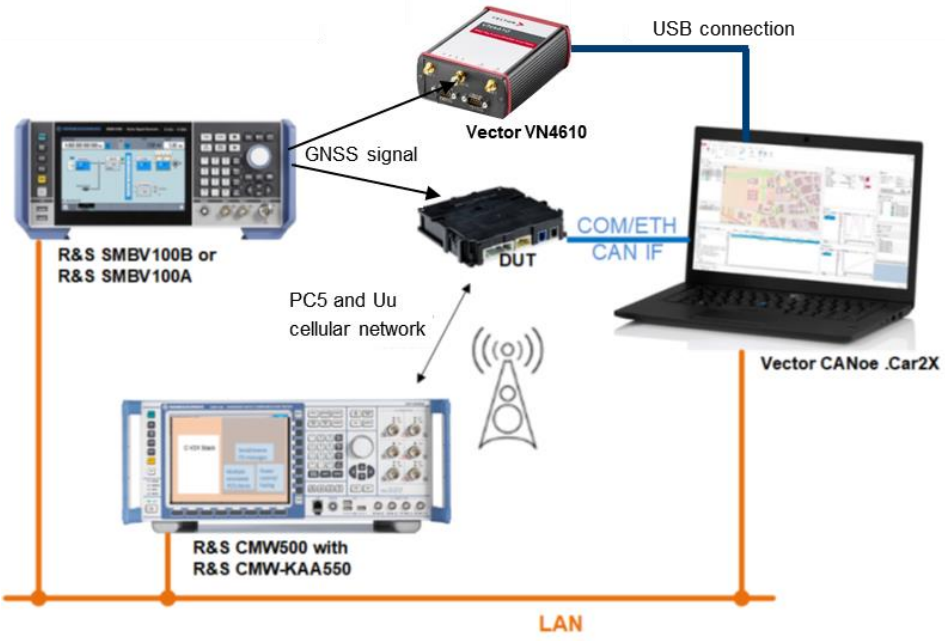



Figure 2: general connection of components for the C-V2X simulation system

The C-V2X simulation system consist of the following components:

- R&S® CMW500: simulates multiple vehicles and covering the access layer（PHY，MAC，PDCP，RLC).
- R&S® SMBV100B: simulates the GNSS signal, which is used by DUT for time synchronizing and navigating.

- ► Vector CANoe software with Option Car2x：used for network, transport and application layer tests of the ITS protocol stack. It can also be used to simulate kinds of C-V2X application scenarios.
- ► Vector VN4610 802.11p/CAN (FD)/GNSS Interface
- ► PC: runs the Vector CANoe .Car2x software. The performance of the test solution depends mainly on the right PC configuration. The recommended configuration will follow in the next update of this application note.

## 3.1 Hardware setup

### 3.1.1 R&S Instrument connection

Figure 3 shows the necessary rear panel connections between the R&S® CMW500 and the with an R&S® SMBV100B:

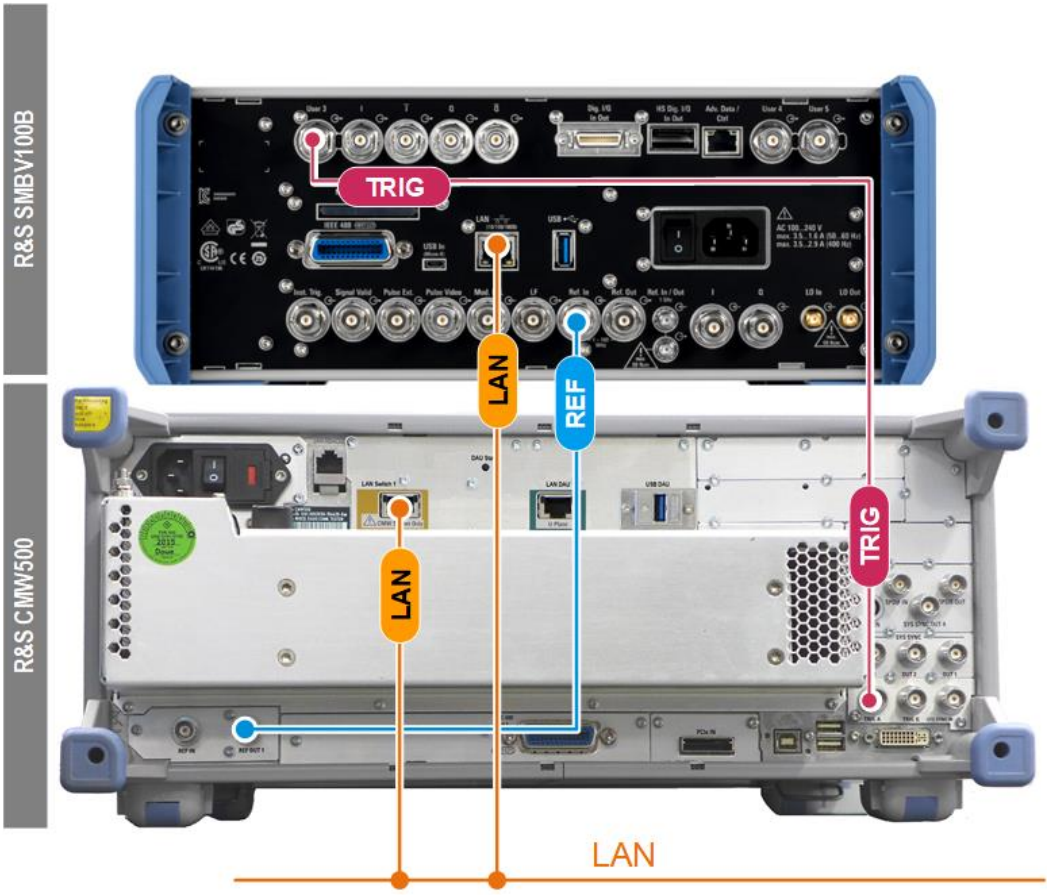



Figure 3: Rear panel connections with R&S SMBV100B

REF = Reference frequency (10 MHz)

LAN = Local area network connections

TRIG = Trigger; synchronization

The R&S®CMW500, R&S® SMBV100B and PC communicate via a gigabit Ethernet connection. The R&S®CMW500 is the master for reference frequency ("REF OUT1") and trigger. The two signals synchronize the R&S® SMBV100B via the connectors Ref. In and User 3.

- ► Connect the R&S® CMW500 *TRIG A* port with the R&S® SMBV100B *User3 port*
- ► Connect the R&S® CMW500 SWITCH port with R&S®SMBV100B LAN Port,
- ► Connect the Vector CANoe.Car2x PC also via LAN

### 3.1.2 Device under test connection

Figure 4 shows the front panel connections of the DUT with the R&S® CMW500 and the R&S®SMBV100B:


Figure 4: Front panel RF connections with R&S SMBV100BSoftware setup

DUT = device under test, typically a TCU

RF GNSS = RF connection for the positioning satellite signal

RF V2X = LTE V2X RF connection (PC5)

- ► Connect the DUT to the bidirectional "RF 1 COM" connector on the front panel of the R&S® CMW500.
- ► For GNSS signals, connect the PC5 interface of the DUT to the RF 50 Ω output connector on the front panel of the R&S® SMBV100B.

### 3.1.3 CMW500 Adapter configuration

► On the R&S® CMW500 start the R&S® CMW-KAA550 C-V2X application adapter and select the folder *Scn Execution parameters*

► Configure the IP address or UDP ports of the R&S® SMBV100B and the CANoe.Car2x PC (Figure 5).

Example: SMBV100B IP: 10.33.0.67, CANoe.Car2x PC IP: 172.22.1.240

► Choose the right settings for the GNSS Configuration (Figure 5)

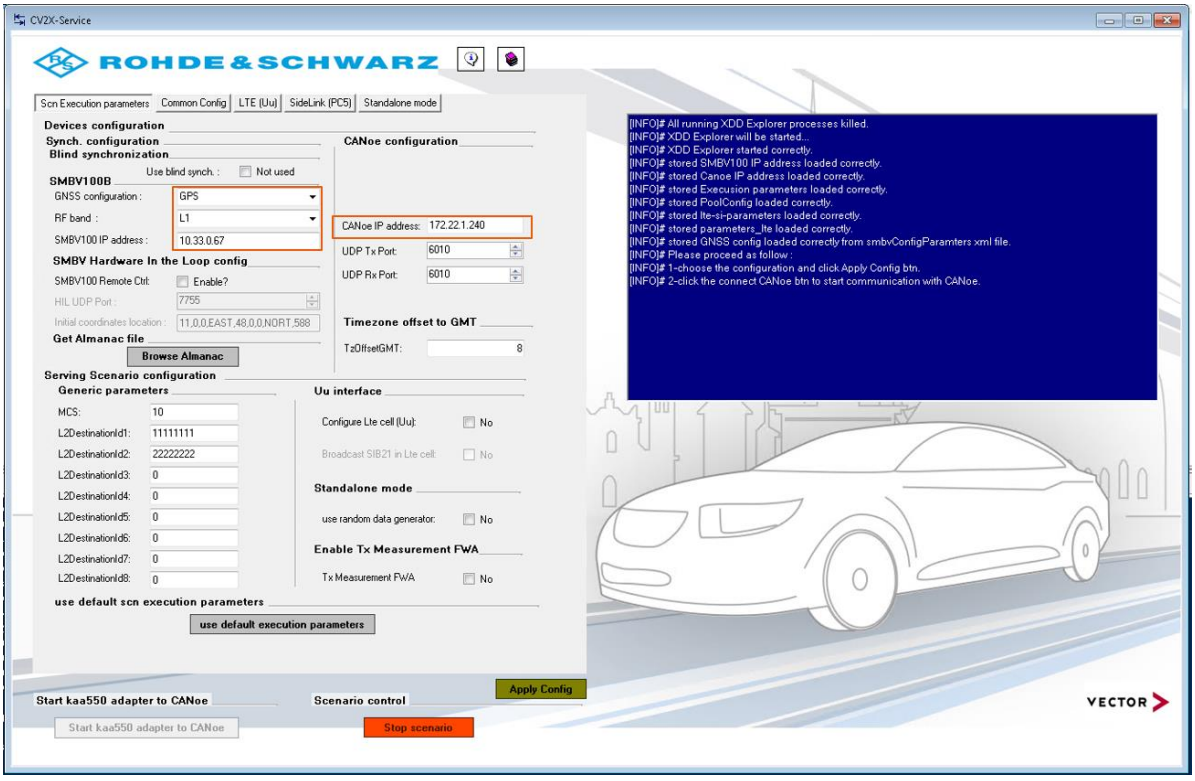



Figure 5: Configuration of Scn execution parameters

► Choose the *Common Config* folder and set pools configuration compatible to the used DUT (example see Figure 6)

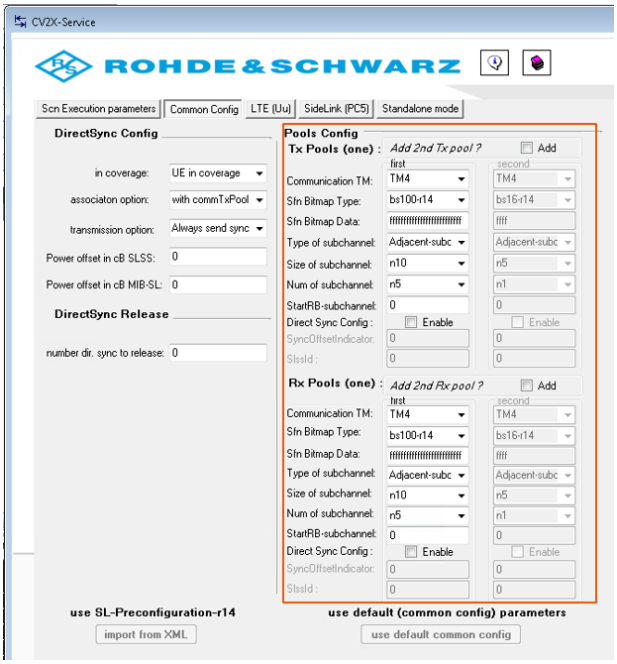



Figure 6 DUT pools configuration

► Choose the *SideLink (PC5)* folder and configure the PC5 parameters of the DUT (see example in Figure 7Figure 7)

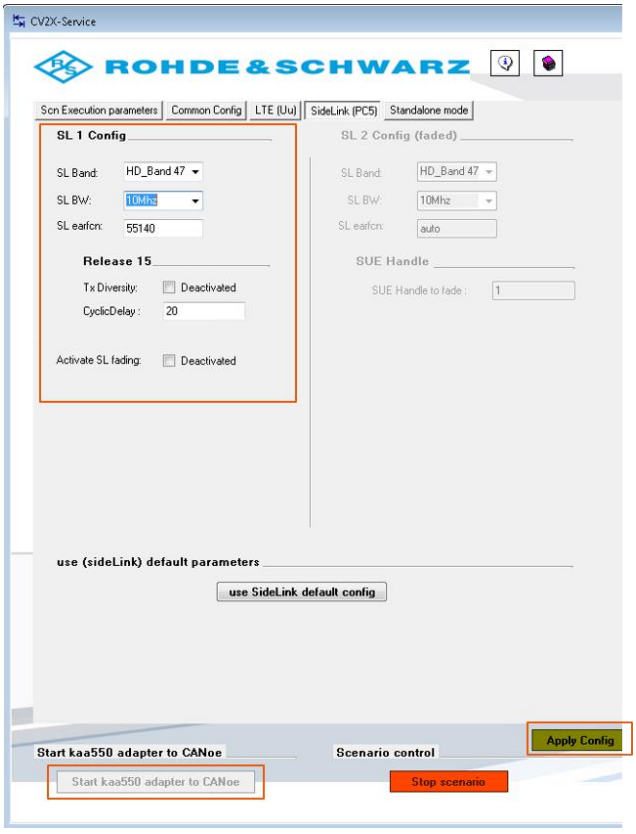



Figure 7: PC5 configuration

► After all the parameters are filled in, Apply Config and Connect CANoe (Figure 7)

## 3.2 Vector VN4610 hardware configuration

Vector VN4610 hardware is used in this setup only as a receiver of precise GNSS timestamp and position from SMBV100B vector signal generator.

### 3.2.1 Wiring

Connecting Vector VN4610 hardware:

- ► Please connect the output of GNSS signal of SMBV100B to the *GNSS* connector of the VN4610 via type-N to SMA cable
- ► Connect USB cable to VN4610 and CANoe PC
- ► Connect VN4610 power supply to the *Sync/Power* connector of VN4610

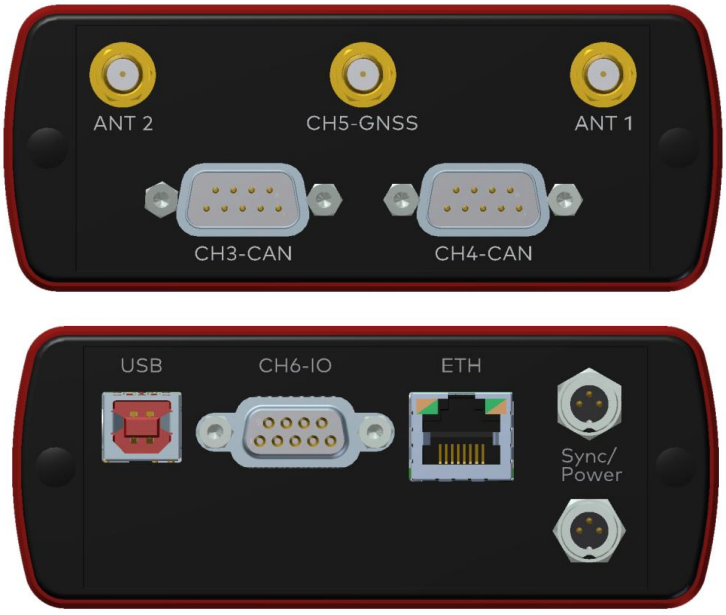



Figure 8 : VN4610 connectors layout

**Attention**: The GPS signal power level at SMBV100B output must be reduced so that the signal power level is lower than **-30 dBm**. Much stronger signal power levels may lead to the permanent damage of the GPS receiver in VN4610.

**Attention:** The GNSS connector of VN4610 provides DC voltage to power GNSS antennas. Optionally, but in case of GNSS recognition problems, use an inline **DC blocker between VN4610 and SMBV100B output connectors.**

Upon powered up and receiving a valid GPS signal, the *GNSS* LED of the VN4610 will start blinking red and 5-30 seconds later in green. Please do not start CANoe measurement until *GNSS* LED lights in green, otherwise the date/time jumping can affect the correct timestamp processing.

### 3.2.2 VN4610 Channel and time sync configuration

To use Vector VN4610 as time and GPS position source, one W11p and GNSS channel on the device must be assigned to Ath1 and GNSS1 CANoe application channels, respectively. This procedure can be done over Windows control panel applet *Vector Hardware* or via *Vector hardware manager* (available via CANoe ribbon *Hardware* | *Network Hardware*, button "*Driver…*" in *Network Hardware Configuration* dialog see (Figure 9 to Figure 12).

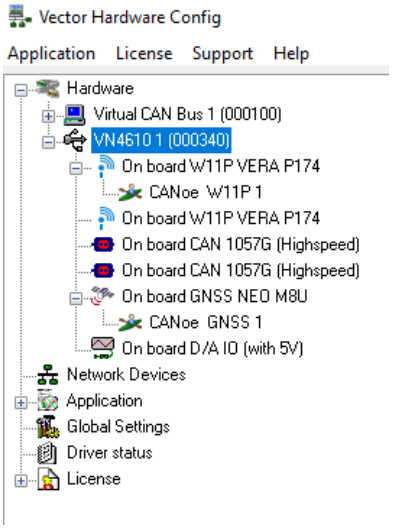



Figure 9 : Vector Hardware windows control panel applet

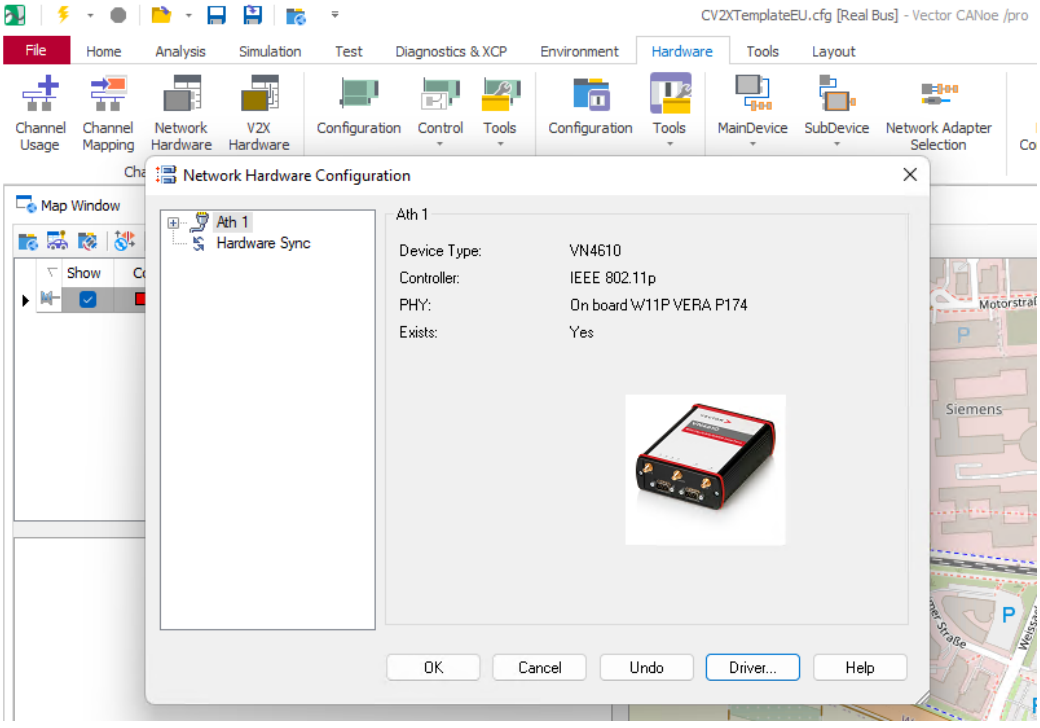



Figure 10 : Correctly mapped VN4610 hardware channel

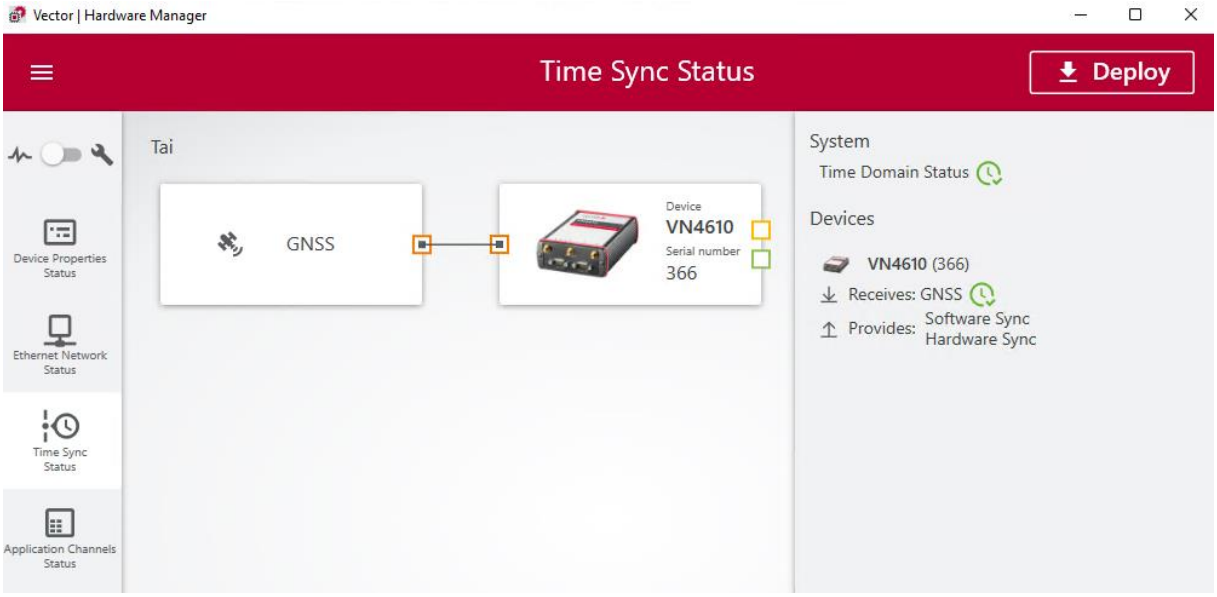



Figure 11 : Correctly configured GNSS time reference

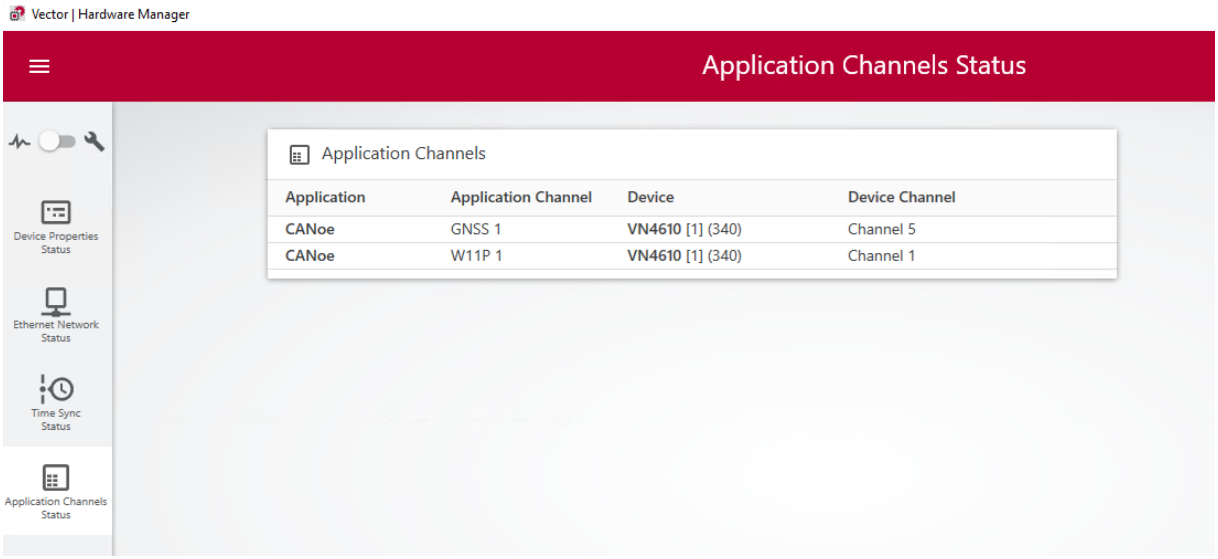



Figure 12 : Correctly mapped VN4610 channels in Vector Hardware Manager

# 4 Setting up Vector CANoe C-V2X template configuration

The C-V2X template is a set of three CANoe configurations separately for regional EU, US and China C-V2X protocols and application stacks. Choose the configuration corresponding to the region of your device under test.

The latest version of C-V2X template configuration package can be downloaded here:

https://support.vector.com/kb?id=kb_article_view&sysparm_article=KB0012458

## 4.1 One-time preparations

**Connecting CMW500 and CANoe via Ethernet**

Please connect CMW500 via Ethernet cable to a USB to Ethernet adapter or additional Ethernet NIC card on your CANoe PC. The windows and company firewall must allow bidirectional UDPv4 communication for the chosen Ethernet adapter attached to your Windows PC running CANoe. Using a separate additional Ethernet device for communicating with CMW500 hardware is recommended for at least two reasons:

- the regular Ethernet adapter is usually connected to a company network and usually is not configurable without losing connection to the company intranet.
- heavy or sporadic load on the main (company) Ethernet adapter will degrade the C-V2X packet delivery latency between CANoe and CMW500.

Please make sure that:

- IP addresses of the CMW500 and CANoe PC ethernet adapter are matching with ones shown in CMW500 panel of the CANoe configuration.
- *Use local UDP loopback only* checkbox is deactivated
- CANoe measurement will start in *Real Bus* mode (CANoe ribbon *Home* | *Measurement* | *Real Bus* combobox)

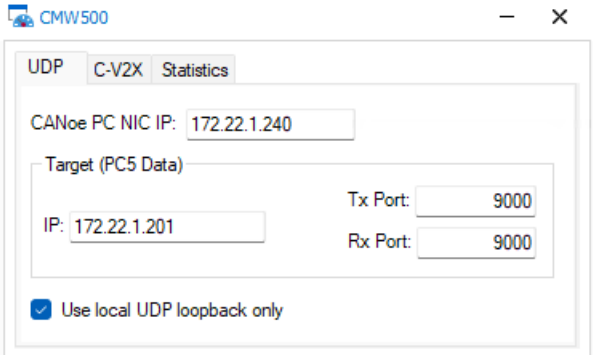



Figure 13 : CANoe panel containing CMW500 settings

**Attention:** The most of company firewalls block the UDPv4 bidirectional connection (on port 9000, specified in CMW500 CANoe panel). Please let configure the firewall to allow that kind of connection to be able to communicate with CMW500.

**Enabling CANoe C-V2X mode**

By default, CANoe uses regular Car2x W11p/DSRC physical layer. The *C-V2X PC5* physical layer must be enabled in *CANoe Options* dialog once before working with C-V2X related CANoe configuration files. This setting will remain active for all next CANoe starts/configurations. Once activated, the C-V2X specific lower frame layers and corresponding CANoe behavior will be used instead of W11p/DSRC ones.

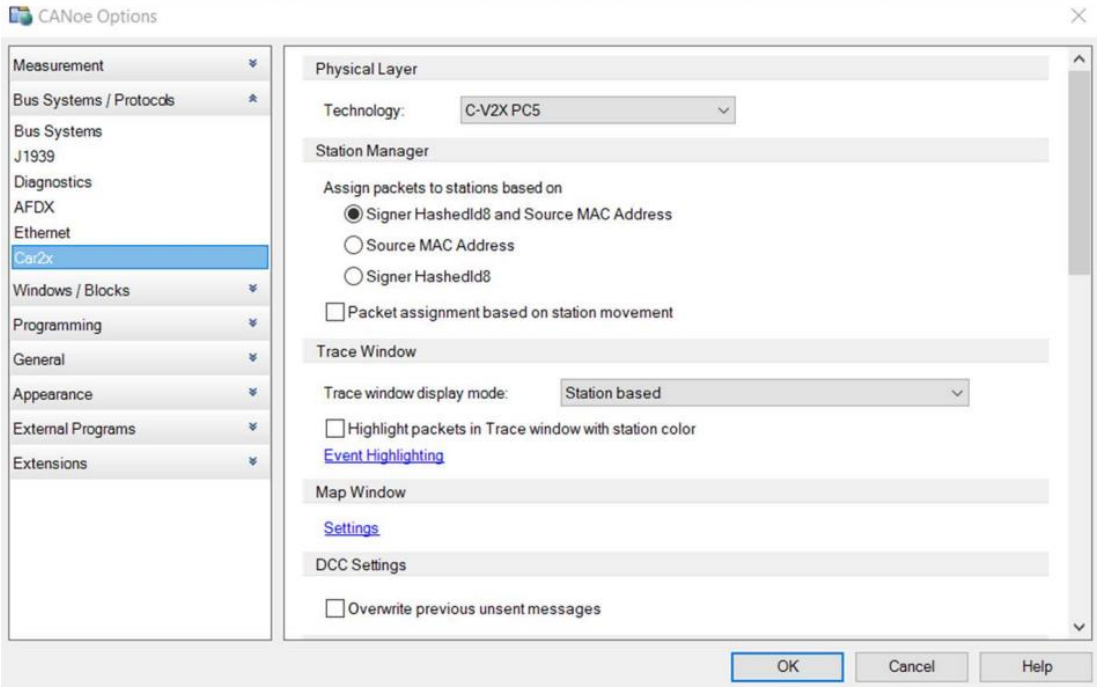



Figure 14 : Choosing C-V2X PC5 as physical layer

# 5 C-V2X scenario handling in CANoe

## 5.1 Scenario start modes

The scenario currently loaded in CANoe Scenario Manager window (CANoe ribbon *Environment* | *More* | *Scenario Manager*) will not start automatically with the CANoe measurement start. When *Start on Rx* checkbox is activated, the scenario will start upon receiving the first C-V2X packet from CMW500. Alternatively, the scenario can be started manually over the *Start/Restart* button.

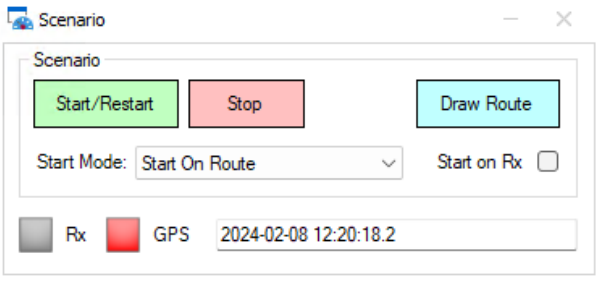



Figure 15 : Scenario control CANoe panel

## 5.2 GNSS route file and scenario route handling

The route of GPS signal (file *Route/Route.nmea*) and the scenario route file (*Route/Route.kml*) loaded during the C-V2X scenario start shall be at the same geographic location and must have the same geometrical shape. Since the setup containing CMW500 is stationary and uses the simulated GPS signal from SMBV100A/B, the (NMEA) route used for creating the GPS signal in SMBV100A/B can be simple equal to the DUT node route in the CANoe C-V2X scenario.

In case you need to use some different route, please consider creating a relatively long route (more than a couple of minutes), since many C-V2X devices need longer to get the GNSS fix initially. Another good option here is to create a route which starts and ends at the same point and enable the cyclic repeating of the route readout in SMBV100A/B:

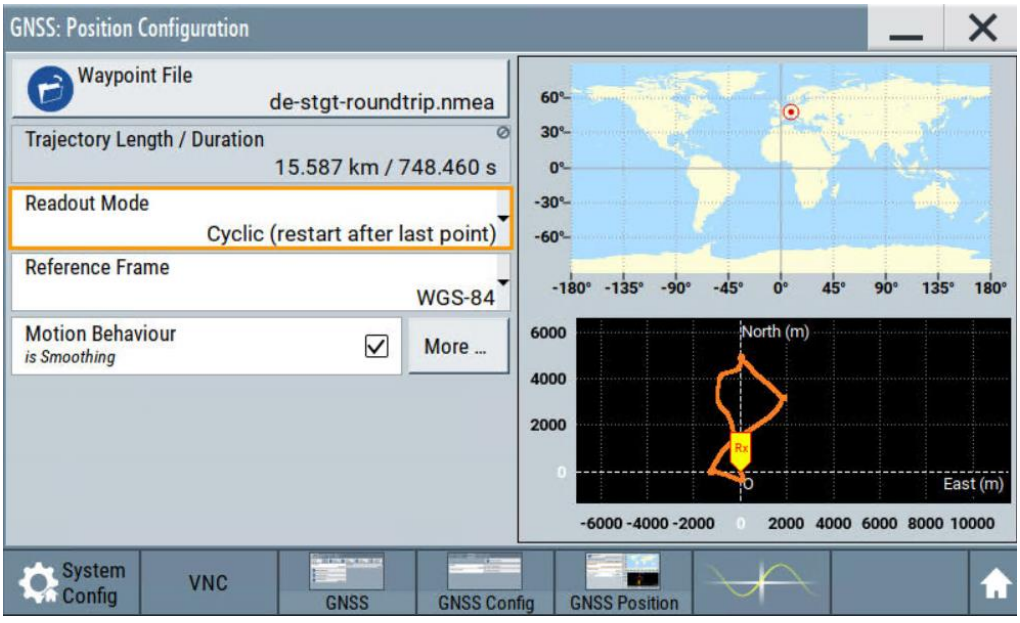



Figure 16 : Enabling cyclic repeating of the GNSS route readout in SMBV100 A/B

You can create the NMEA route file for use in SMBV100A/B by importing *Route.kml* file in the new C-V2X scenario file *Vector Scenario Editor*, ribbon *Home* | *Tools* | *Import* button and exporting it via *Export* button in NMEA format. After importing the route, please add a station(vehicle) to this route from the context menu of the route and specify a nonzero speed in the *Speed* attribute keypoint(s) in *Timeline* window. After exporting, the resulting NMEA route file for use in SMBV100B will reflect the vehicle movement speed profile in the scenario:

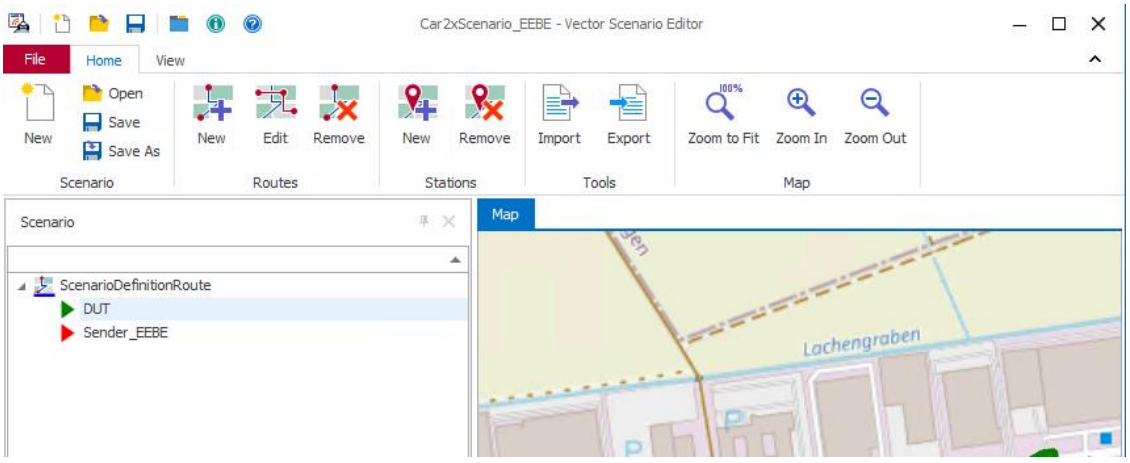



Figure 17 : Converting route file formats in Scenario editor

It is important to use a route file which is physically valid and plausible by means of inertia law, this ensure that calculated angular velocity and acceleration values will have a meaningful value range. So, the shape of the route shall not have sharp turns/corners, use at least 3-5 route points arranged at multiple meter radius around the intersections/turns. Also, the speed profile along the route shall be physically correct, this means the speed must be decreased before entering a sharp turn.

# 6 Using CMW500 with existing C-V2X CANoe configurations

This chapter describes the procedure of extending some existing CANoe configurations with CMW500 communication support.

- ► Download the latest version of C-V2X template configuration (download link see Chapter 4) and extract the achive file.
- ► Copy following subfolders from C-V2X template package to your CANoe configuration folder:

  *UDPConnectors*, *CAPL*, *Nodes*, *Panels*, *Route*

  Also copy following files:

  *RouteControl.vsysvar*, *Scenario.vsysvar*

  directly near your CANoe configuration file.
- ► In CANoe dialog *System Variables Configuration* (located in CANoe ribbon *Environment* | *Symbols* | *System variables*), please add the

  *UDPConnectors/UDPSockets.vsysvar,*

  *UDPConnectors/CMW500/CMW500.vsyvar,*

  *Scenario.sysvar* and *RouteControl.vsysvar*

  CANoe system variable files to the referenced files:

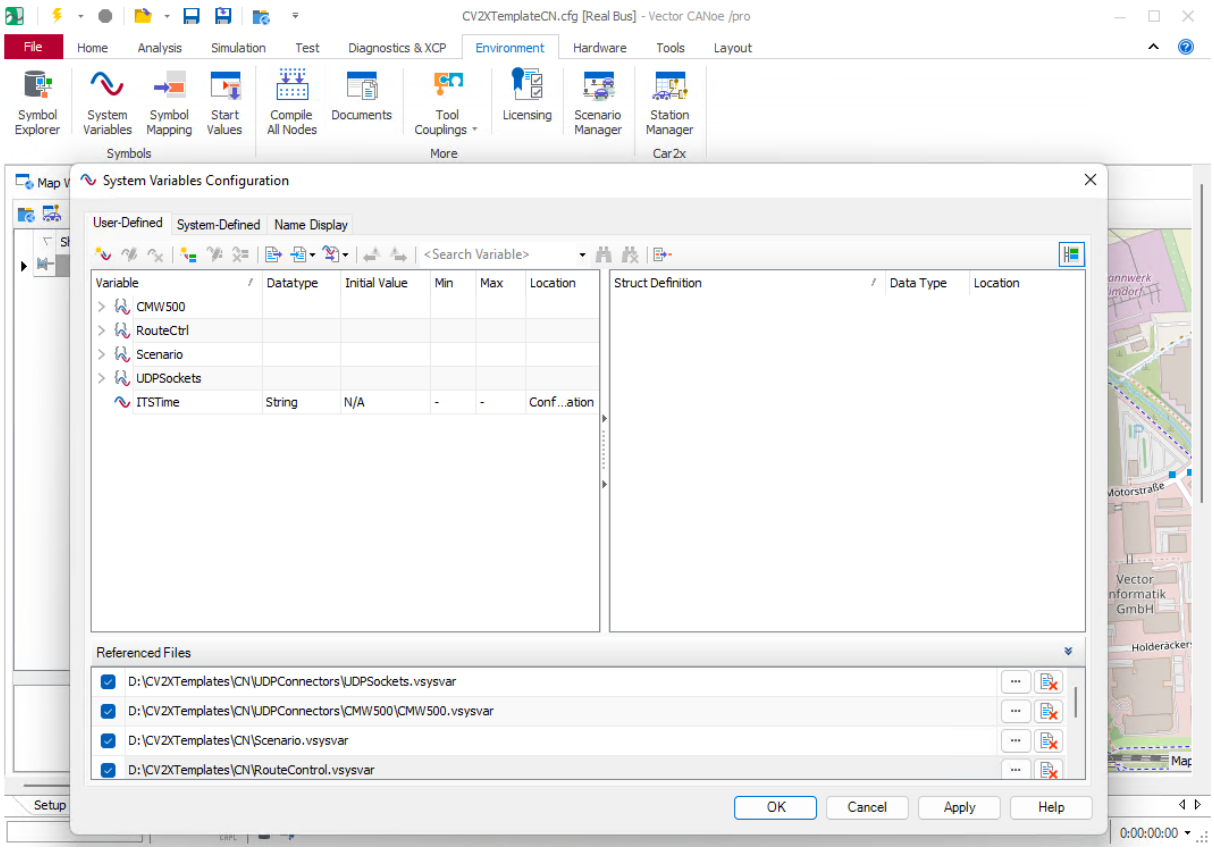



Figure 18 : Converting route file formats in Scenario Editor

► Refer CMW500 and Scenario CANoe panel files in your CANoe configuration by adding them in *Panel Configuration* dialog (CANoe ribbon *Home* | *More* | *Panel* | *Panel Configuration*):

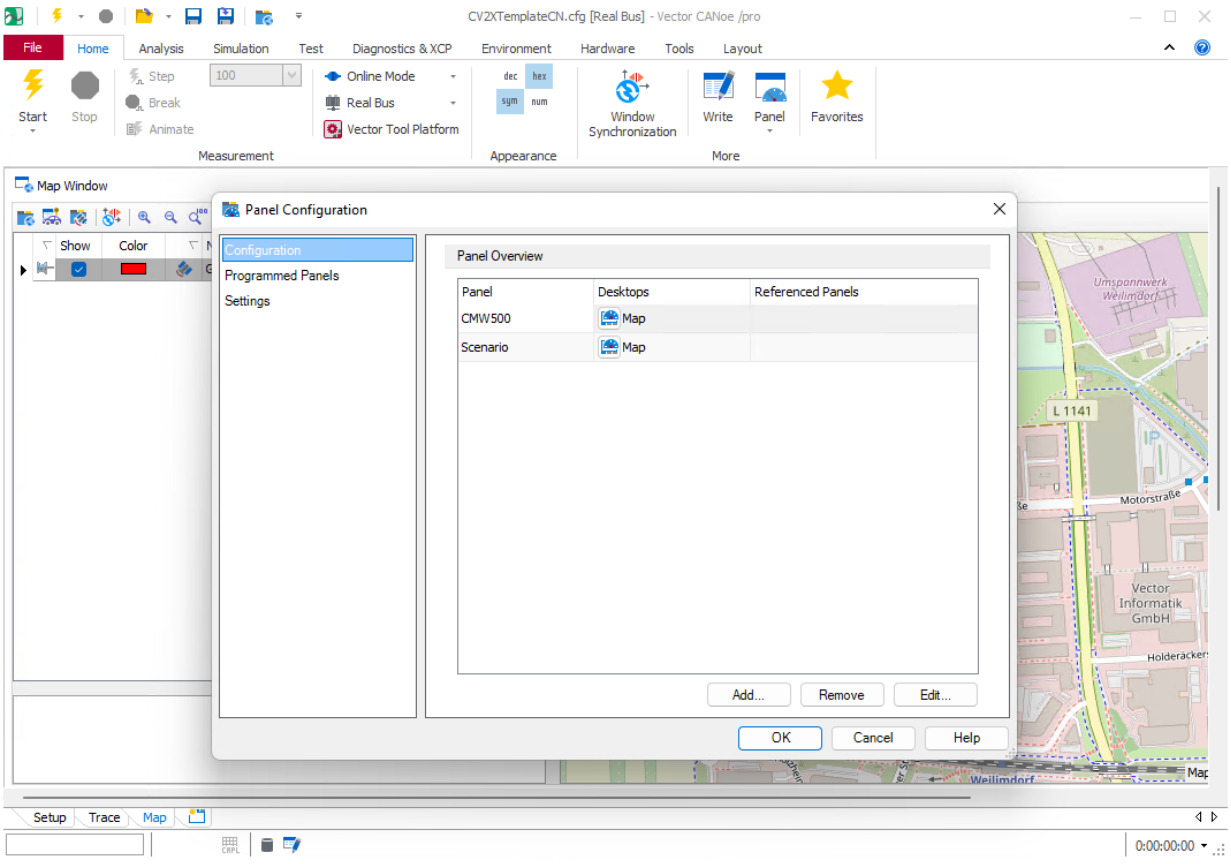



Figure 19 : Adding CMW500 and Scenario panels to the CANoe configuration

After adding the panels to your configuration, choose MDI window mode in the context menu of both panels and move both panel windows to a convenient place within CANoe main window.

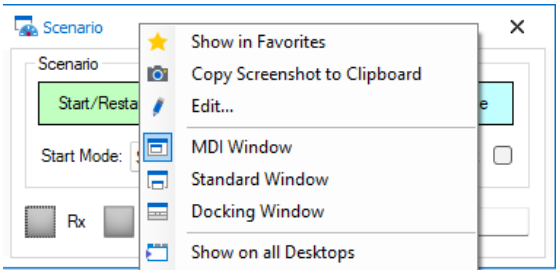



Figure 20 : Switching panel window mode

► Add *UDP_Communication* and *Scenario_Control* network nodes to the database:

In Simulation Setup window (CANoe ribbon *Simulation* | *Setup* | *Simulation Setup*), open the database file of your CANoe configuration:

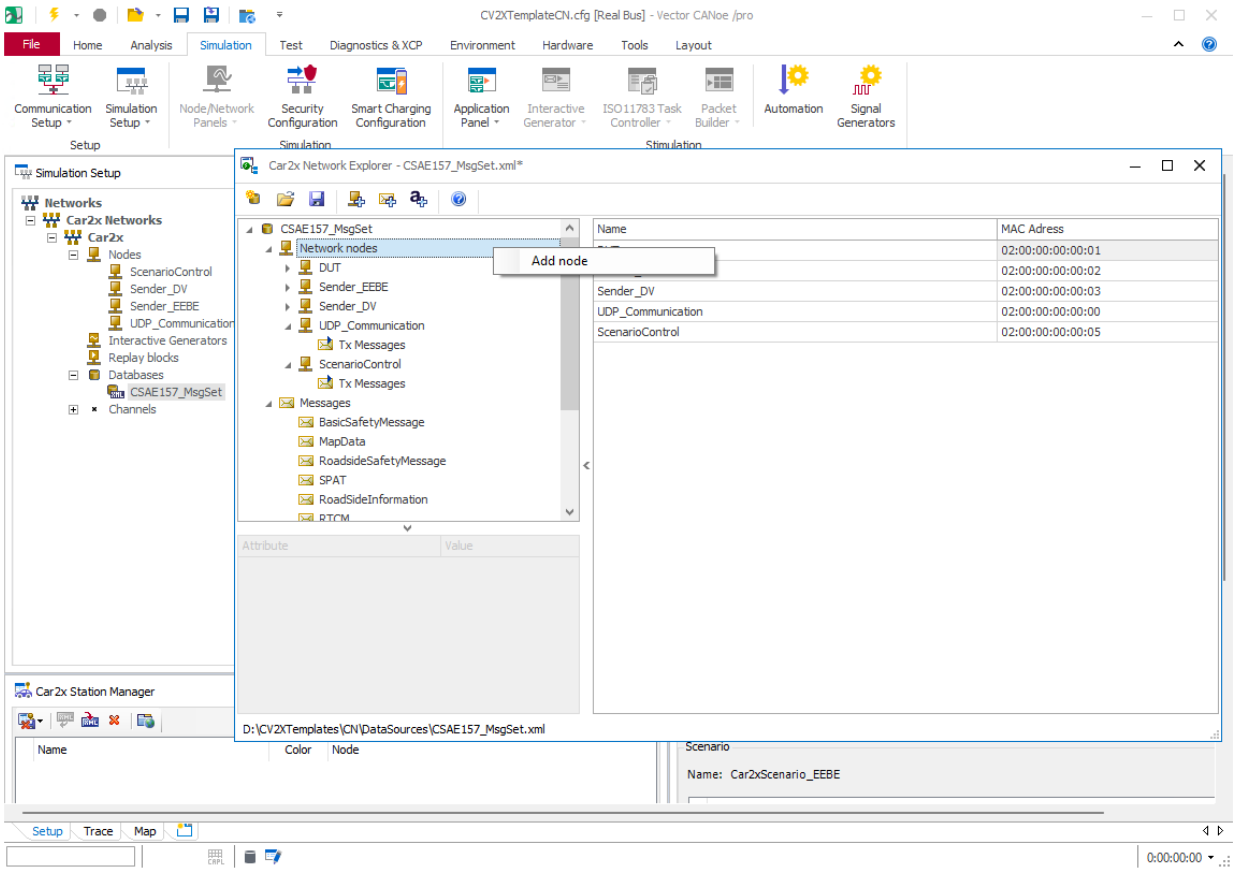



Figure 21 : Adding UDP_Communication and ScenarioControl nodes to the database

The database file opens in *Car2x Network Explorer*. Please Add two new network nodes (via context menu or *Add node* button in the toolbar). Rename both new nodes to *UDP_Communication* and *ScenarioControl* respectively. Save the changes and close the *Car2x Network Explorer* window.

► Insert *UDP_Communication* and *Scenario_Control* CAPL network nodes in Simulation Setup

In Simulation Setup window (CANoe ribbon *Simulation* | *Setup* | *Simulation Setup*), insert two new network nodes in the Nodes context menu of your Car2x network (in network tree on the left side of the Simulation Setup window):

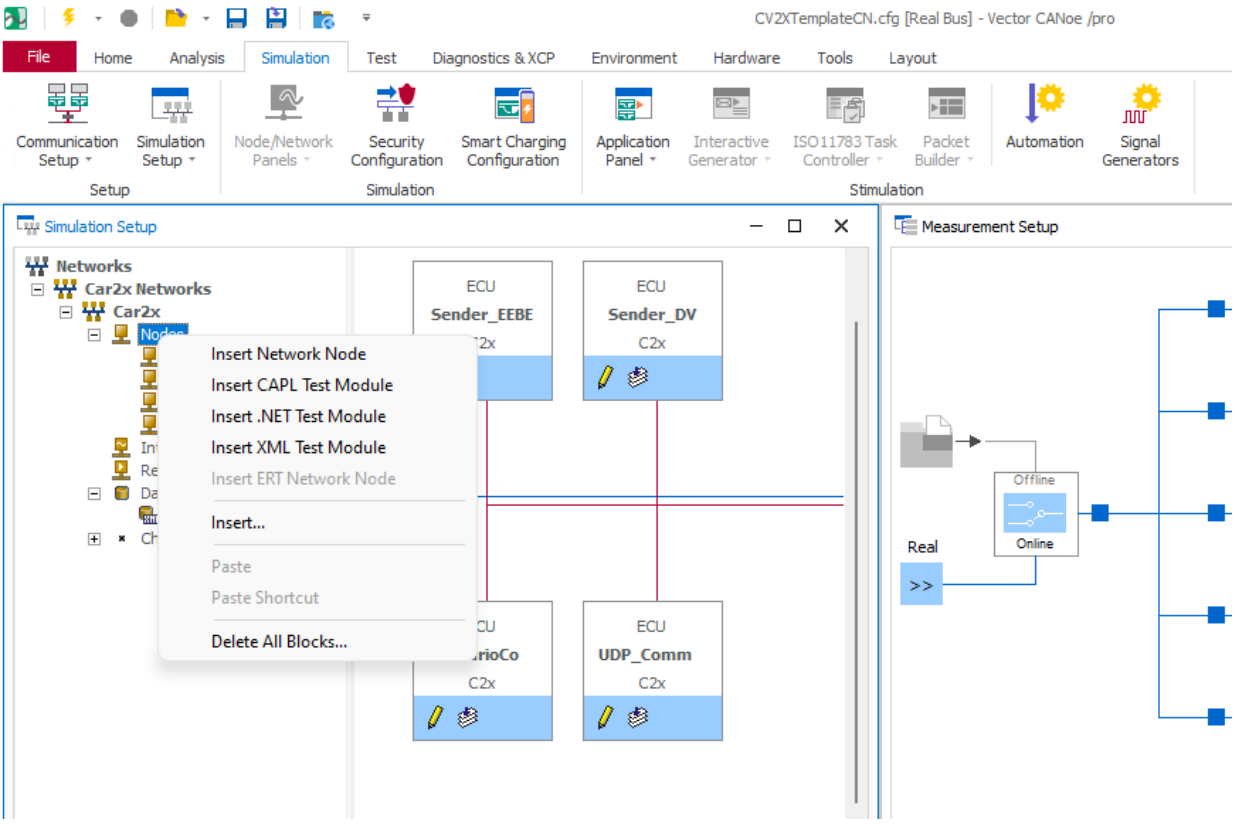



Figure 22 : Adding UDP_Communication and ScenarioControl nodes to the CANoe simulation setup

By selecting *Insert Network Node* command (see screenshot above), the *Node Configuration* dialog box appears. Please rename the node to *ScenarioControl*, choose *ScenarioControl* node in *Network node* combobox and refer *ScenarioControl.can* CAPL file by choosing it via File… button in *Node specification* control group:

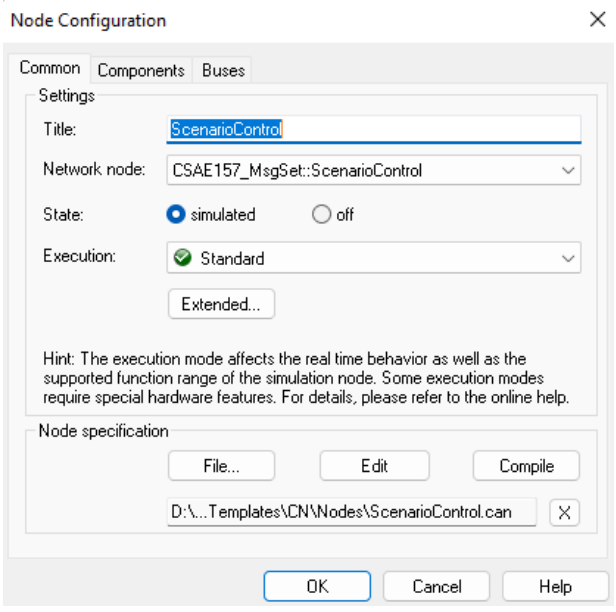



Figure 23 : Configuring UDP_Communication and ScenarioControl network nodes

Repeat the procedure for second new node in the CANoe Simulation Setup for *UDP_Communication* node name and *UDP_Communication.can* file.

► Adding attributes to the Scenario stations

Each station (vehicle) in Car2x scenario must have an DeviceId attribute for identification of the C-V2X sending stations at the side of the CMW500. Please choose *Add Attribute* command from the context menu of the station at the left (gray) side of the *Timeline* window in *Vector Scenario Editor*, name the attribute “DeviceId” (case sensitive) and set the data *type* and *interpolation* to *integer* and *const* resp.

The value of the DeviceId attribute must be unique for every station in the scenario.

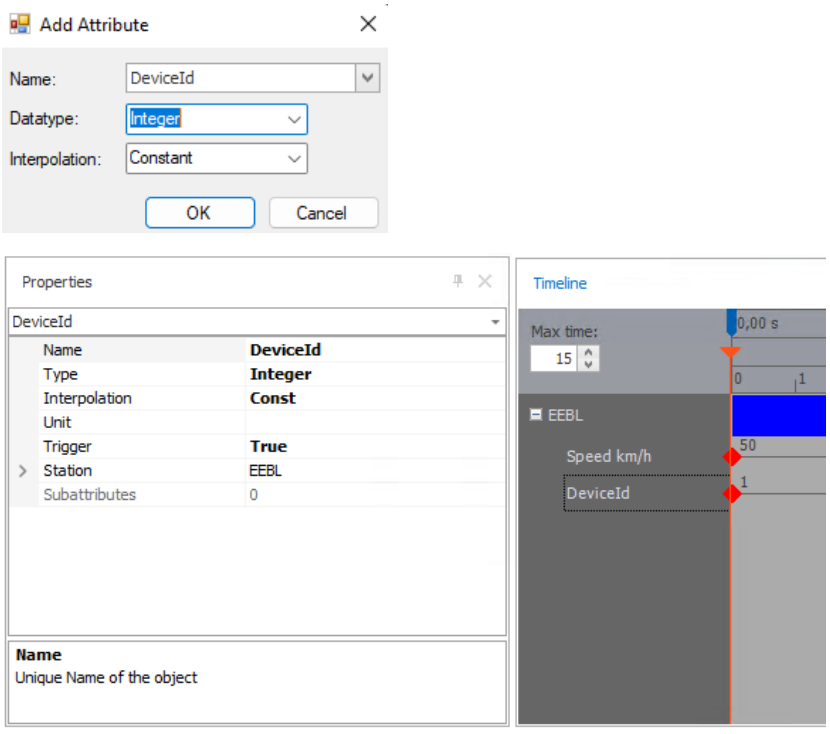



Figure 24 : Adding DeviceId attribute to the scenario station

Each station (vehicle) in the scenario must have a corresponding network node with the same name in the database and in CANoe Simulation Setup. The procedure of creating the database and Simulation Setup nodes is the same as described above for *UDP_Communication* node, only the node name and used CAPL file in *Node Configuration* dialog differs. If no special behavior of the vehicle is required, please use the CAPL file *Nodes/Generic_Sender.can*. In case you already have an existing CAPL file for some network node in CANoe Simulation Setup with some specific logic implemented, following changes must be applied to the CAPL code in order to enable C-V2X communication of this node via CMW500:

1) In includes section, please include reference to following CAPL Include files:

```
includes
{
  // … other CAPL includes
  #include "..\UDPConnectors\CV2XTxRxInterface.cin"
  #include "..\CAPL\MeasurementEvents.cin"
  #include "..\UDPConnectors\UDPSockets.cin"
  // … other CAPL includes
}
```

2) In before-send (OnPreTx) CAPL callback function of every C-V2X message (*BasicSafetyMessage*, *CAM*, …) used for this node/vehicle, a call to the function *API_SendCV2XFrameData* must be added to enable sending this message to CMW500 (marked bold). Please make sure that OnPreTx CAPL functions return 0 value (no send), since *API_SendCV2XFrameData* already sends the C-V2X message data to CMW500 over UDP.

```
on start
{
  C2xRegisterCallback(kPreTxIndication, "OnPreTxBasicSafetyMessage",
"BasicSafetyMessage");
}
// Callback function: called before sending BSM message
long OnPreTxBasicSafetyMessage(long packet)
{
  // … other CAPL code
  if (C2xIsScenarioStarted() == 1)
  {
    return API_SendCV2XFrameData(packet);
  }

  return 0;
}
```

# 7 Summary

The test solution presented in this application note allows testing safety-critical C-V2X applications in a lab environment, providing reliable and repeatable results. The Vector CANoe Car2x software tool in combination with Rohde & Schwarz instruments provides the ability to create complex and reproducible C-V2X scenarios to stimulate a C-V2X capable TCU in line with the configured situation and to test the implemented functions in a targeted manner. The test solution is a future-ready investment, with the option to be extended with an R&S®CMX500 radio communication tester to accommodate future C-V2X releases, including 5G New Radio (5G NR), to keep up with the latest developments of C-V2X.

# 8 Literature


[1] R. Stuhlfauth, *White Paper: Wireless Communications for Automotive Applications,* Rohde & Schwarz, 2021.

[2] *Application Card: Scenario Based Testing of Safety-critical Cellular V2X Applications in a Lab Environment,* PD 3609.3059.92, Version 01.01: Rohde & Schwarz, 2019.


# 9 Ordering Information

| Designation | Type | Order No. |
|---|---|---|
| R&S CMW500 “5G ready" | R&S®R&S CMW500 | n.a, |
| IoT Enabler | R&S®CMW-KP030 | 1211.1847.02 |
| LTE V2X test suite | R&S®CMW-KAX550 | 1211.5007.02 |
| LTE R14 PC5 measurement | R&S®CMW-KM570 | 1211.3010.02 |
| Vector signal generator, base unit incl. ARB (64 Msamples, 120MHz RF bandwidth) | R&S®SMBV100B | 143.1003.02 |
| Frequency range 9 kHz to 3.2 GHz | R&S®SMBVB-B103 | 1423.6270.02 |
| Baseband real-time extension | R&S®SMBVB-K520 | 1423.7676.02 |
| GPS | R&S®SMBVB-K44 | 1423.7753.02 |

Vector CANoe :

| Designation | Type | Order No. |
|---|---|---|
| Software tool for creation and execution of simulation, communication analysis and testing of ECUs in distributed systems. Supports bus system CAN. | CANoe | 55000[1)] |
| Upgrades CANoe with Car2x functionality | CANoe.Car2x option | 55013[1)] |
| 802.11p/CAN (FD)/GNSS Interface | VN4610 [1)] | |

[1)] please contact your local Vector representative

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