CANalyzer .Car2x

Product Information
Table of contents

1 Introduction .................................................................................................................................................. 3
1.1 Benefits at a glance .............................................................................................................................. 4
1.2 Application areas .................................................................................................................................. 4
1.3 Further information .............................................................................................................................. 6
2 Functions.................................................................................................................................................... 6
2.1 Car2x Network Explorer ...................................................................................................................... 7
2.2 Car2x Station Manager ......................................................................................................................... 7
2.3 Car2x Certificate Manager .................................................................................................................... 8
2.4 Analysis functions .................................................................................................................................. 9
2.4.1 Expansions in the Trace Window .................................................................................................... 9
2.4.2 Graphics & Data Windows .............................................................................................................. 10
2.4.3 Map Window .................................................................................................................................... 10
2.4.4 Car2x Certificate Explorer ............................................................................................................ 11
2.4.5 Logging and analysis ....................................................................................................................... 12
3 Hardware – VN4610 .................................................................................................................................. 13
4 Training courses ....................................................................................................................................... 13

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This document presents the application areas and functions of Option .Car2x for CANalyzer. Product information and technical data for the basic functions of CANalyzer can be found in separate documents.
1 Introduction

Future generations of vehicles will be increasingly integrated into a comprehensive data infrastructure (ITS, or intelligent transport systems) which enables direct communication between vehicles (ITS vehicle station) on the one hand and infrastructure (ITS roadside station, or RSU) on the other – referred to as V2X (vehicle-to-everything) and Car2x (car-to-everything) communication.

The .Car2x option extends CANalyzer to include functions for the analysis of V2X-based ADAS functions for this. This domain-specific functionality enables direct analysis of both the Car2x-specific network and transport protocols and their related application messages, including the Cooperative Awareness Message (CAM) and the Decentralized Environmental Notification Message (DENM) in Europe and the Basic Safety Message (BSM) in the US, for example. The respective security mechanisms according to ETSI and IEEE 1609.2 are also supported here.

Figure 1: CANalyzer.Car2x visualizes communication between ITS Vehicle and ITS Roadside Stations. The Trace Window shows the WLAN packets.
1.1 Benefits at a glance

- Direct access to the WLAN packets according to IEEE 802.11p in conformance with ETSI ITS-G5 and IEEE 1609-WAVE for the display and analysis of communication
- Interpretation of Car2x-specific EU and US communication protocols
- Protocol analyzer for checking basic conformity of the network protocols
- Checking of the signature of “secured packets” (authentication and integrity check)
- Support for any application messages defined in ASN.1 thanks to the integrated dynamic ASN.1 interpreter
- Display of transferred vehicle and infrastructure information on a road map: This visualizes the link between positions, the driving situation and the sequence
- Synchronization of the Map Window with other Measurement Windows for subsequent analysis
- Management of certificates which are needed to check the validity of secured packets
- The assignment of received messages to ITS stations using the accompanying certificates enables a station-based analysis as an alternative to the message-based analysis.
- Use of the GPS time as the measurement time
- Gateway functionality for measurements between wireless and vehicle networks such as CAN or Ethernet
- Easy creation and sending of correct and falsified WLAN packets for stimulation of ECUs
- Logging of WLAN packets together with the communication of other bus systems
- Replaying of recorded WLAN packets
- Recording and interpretation of received certificates

1.2 Application areas

The .Car2x option is especially well-suited for analyzing and logging communication of ECUs in the vehicle or in the infrastructure which communicate using the following standards:

- IEEE 802.11p (physical layer)
- ETSI ITS standards
  - GeoNetworking (ETSI TS 102 636-4-1 and ETSI EN 302 636-4-1)
  - Security Header (ETSI TS 103 097)
  - Basic Transport Protocol (BTP) (ETSI TS 102 636-5-1 and ETSI EN 302 636-5-1)
- ETSI ITS application messages, such as
  - Cooperative Awareness Message (CAM)
  - Decentralized Environmental Notification Message (DENM)
  - MAP topology (MAP)
  - Signal Phase and Timing (SPaT)
  - Infrastructure to Vehicle Information Message (IVIM)
- IEEE 1609 – WAVE
  - WAVE Short Message Protocol (WSMP) (IEEE 1609.3)
  - WAVE Service Announcement (WSA) (IEEE 1609.3)
CANalyzer.Car2x thereby acquires both the environment with other vehicles (ITS Vehicle Station) or with infrastructure (ITS Roadside Station) as well as the vehicle's own vehicle networks such as CAN, LIN, FlexRay, Ethernet, etc. (this requires the use of other bus-specific CANalyzer options). Interpretation of the received packets gives you quick access to the data contents of the packets. They can be conveniently evaluated in the Trace Window. Graphic display of the positions of transmitting vehicles or roadside stations in the Map Window gives you a quick overview of the scenario.

For sending and receiving wireless frames, CANalyzer.Car2x supports the dedicated interface VN4610, which is CE- and FCC-certified. During the analysis, the contents of the data packets and their physical packet properties like the wireless channel and reception strength are evaluated. Domain-specific measurement windows are available for this purpose. Logging of the WLAN packets for subsequent analysis, documentation purposes or repeat playback for stimulation of ECUs is also possible. Synchronization of the Map Window with other windows is especially helpful when analyzing logged packets. This allows fast location of certain traffic situations and analysis of the associated communication.

![Map Window for geographic display of transferred vehicle and infrastructure information](image)

**Figure 2:** Map Window for geographic display of transferred vehicle and infrastructure information
1.3 Further information

> **CANalyzer website**
Various documents are available for CANalyzer on the Internet. The demo version also comes with sample configurations for the various application areas as well as detailed online help in which all CANalyzer functions are described. You also benefit from valuable know-how in the form of technical articles and application notes.

> **CANalyzer feature matrix**
Additional information about variants, channel support, and bus system support is available in the feature matrix.
2 Functions
The .Car2x option extends CANalyzer to include V2X-specific functions. WLAN channels are also supported in accordance with IEEE 802.11p. Configuration of up to 32 WLAN channels for simultaneous analysis of control and service channels is possible.

2.1 Car2x Network Explorer
The Car2x Network Explorer is the editor for Car2x databases.

> Display of the contents of any ASN.1-based application messages with a type, range and format
> Configuration of application messages (encoding, protocol and Id/port)
> Configuration of node names and addresses
> Locating of specific elements within the complex structure of an application message

![Figure 3: The Car2x Network Explorer features various functions for Car2x databases, from basic node and message configuration to searching for certain signals of application messages.](image)

2.2 Car2x Station Manager
The Car2x Station Manager is the main unit for managing ITS stations. When receiving messages, they are assigned to the ITS station from which they are sent. By assigning stations to database nodes, CANalyzer can handle the data of the individual stations in the measurement windows.

> Manual or automatic assignment of messages to ITS stations using
  > Signer HashedId8 and MAC addresses
  > Signer HashedId8 only
> MAC addresses only

> Database nodes can be linked to the ITS stations. This enables access to the application messages of individual ITS stations.

> Definition of individual colors for ITS stations

> Optional use of the defined colors for coloring the WLAN packets sent by the ITS stations in question in the Trace Window

> Saving and reloading of assignments of MAC addresses and Signer HashedId8 onto stations

> Specific handling of forwarded application messages with ETSI GeoNetworking (e.g. DENM)

![Image](image.png)

**Figure 4:** In the Car2x Station Manager, colors are selected for ITS stations and the Trace Window coloring is activated for individual ITS stations.

### 2.3 Car2x Certificate Manager

The provision of certificates in the Car2x certificate manager forms the basis for the signature check of received packets.

> Adding, importing, and removing certificates

> Marking of certificates as trustworthy (typically the root certificate)

> Assigning names for certificates to enable easy analysis

> Export of certificates, for example for use in other configurations
2.4 Analysis functions

CANalyzer .Car2x provides domain-specific measurement windows for the analysis of V2X communication (ETSI and IEEE 1609). The basis for this is the Car2x database, which contains the definition and detailed description of the application messages.

2.4.1 Expansions in the Trace Window

- Interpretation and presentation of detailed protocol header information
- Decoding of application messages (raw data and interpretation of the values) defined in ASN.1
- Specific columns for a quick overview of the most important parameters, such as the display of events in a column and the display of the transmission and reception power of frames (configurable)
- Protocol analyzer: Basic protocol tests and validity test of signed packets (secured packets)
- Configurable color marking of application messages, protocols and errors
Figure 6: The Trace Window displays packets with protocol error and invalid signature, among other things. The individual protocol fields are interpreted and additional information (e.g. on errors and warnings to be detected) is output in the detail view.

2.4.2 Graphics & Data Windows

In the Graphics & Data Windows, it is possible to carry out a station-based signal analysis of application messages. The signals can be selected and monitored here.

2.4.3 Map Window

In the Map Window, the display of multiple Car2x objects, like ITS vehicle stations and ITS roadside stations, on map material including synchronization with other windows for subsequent analysis is possible.
Figure 7: The Map Window automatically displays the ITS stations and events of the DENM and BSM. Additionally SPaT and MAP messages are visualized here.

- Automatic display of ITS stations and events
- Listing of detected stations and events in the "ITS stations" and "ITS events" list views
- Synchronization of Map Window and Trace Window. A specific traffic situation can thus be sought and precisely analyzed after stopping the measurement. By double-clicking an event, you can also jump to the corresponding point in the Trace Window.
- The following map material is currently supported:
  - OpenStreetMap
  - HERE
  - custom tile provider can be specified

2.4.4 Car2x Certificate Explorer

The option .Car2x enables you to analyze the security mechanisms.

- Display of known certificates (stored in the Car2x Certificate Manager) and received certificates in the Car2x Certificate Explorer:
  - Checking of the signature or the certification path
  - Display of the signature hierarchy
  - Display of the interpreted certificate contents
  - Export of certificates, for example for use in other configurations
2.4.5 Logging and analysis

> If present, the GPS time of the VN4610 is displayed and logged with the WLAN packets. Measurement data from different vehicles can thus be put into their temporal context.

> Logging of WLAN packets and playback, as well as offline analysis of logged measurement data.
3 Hardware – VN4610

CANalyzer.Car2x supports the 802.11p network interface VN4610.

- Boot time of the VN4610: approx. 5 seconds
- Easy configuration of the WLAN channels, transmission power, protocol layout etc. used, without requiring a reboot
- Synchronized time stamp for CAN and 802.11p (time stamp precision: approx. 1 µs) and with additional Vector network interfaces
- The GNSS time of the VN4610 is copied as an absolute time, whereas the time stamps are synchronized to the GNSS

![VN4610 - 802.11p network interface](image)

For additional information on the VN4610, visit [Products/VN4610](#).

4 Training courses

Our training offer for CANalyzer includes various training courses and workshops at our training facility and at the customer’s facility.

For more information on individual training courses and schedules, visit [www.vector-academy.com](http://www.vector-academy.com)
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