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
3 Hardware .................................................................................................................................................................................10
4 Training ................................................................................................................................................................................10

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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

Upcoming vehicle generations are becoming more and more integrated into a comprehensive data infrastructure that enables direct communication between vehicles (ITS Vehicle Station) on the one hand and with infrastructure (ITS Roadside Station) on the other hand. This communication occurs in accordance with WLAN standard IEEE 802.11p (ETSI ITS-G5 and IEEE 1609 WAVE).

Option .Car2x extends CANalyzer by adding WLAN channels according to IEEE 802.11p. This enables direct analysis of both the Car2x-specific network and transport protocols and their related application messages. In the Car2x environment, these application messages are the Cooperative Awareness Message (CAM) and the Decentralized Environmental Notification Message (DENM) in Europe and the Basic Safety Message (BSM) in the USA, for example. Signed packets (Secured Packets) are also supported here.

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

In addition to the display of information in a special Map Window, the typical CANalyzer analysis blocks like Trace, Data and Graphics Windows are also available.
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 display and analysis of communication
- Interpretation of Car2x-specific EU and US communication protocols
- Check 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
- Easy creation and sending of correct and falsified WLAN packets for stimulation of ECUs
- Management of certificates which are needed to check the validity of secured packets
- The assignment of received messages to ITS stations by means of transmitted certificates enables a vehicle based analysis as an alternative to the message based analysis.
- Visualize the location and driving direction of several objects on a map
- Synchronization of the Map Window with other Measurement Windows for subsequent analysis
- Use of the GPS time as the measurement time
- Gateway functionality for measurements between wireless and vehicle networks such as CAN or Ethernet
- 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

Option Car2x is especially well-suited for analyzing and logging communication of ECUs in the vehicle or in the infrastructure, which communicate over 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)
- IEEE 1609 – WAVE
  - WAVE Short Message Protocol (WSMP)  
    (IEEE 1609.3)
  - WAVE Service Announcement (WSA)  
    (IEEE 1609.3)
  - WAVE Security Services (WSS)  
    (IEEE 1609.2)
  - WAVE Peer-To-Peer Protocol  
    (IEEE 1609.2)
SAE J2735 – DSRC application messages, such as
- Basic Safety Message (BSM)
- Signal Phase and Time (SPaT)
- Map Data Message (MAP)

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 the receiving of WLAN CANalyzer.Car2x exclusively uses a dedicated wireless adapter or a wireless adapter already installed in the vehicle together with other applications. This is especially advantageous if a test vehicle is already equipped with a wireless adapter and, as a result, additional cabling expense for the power supply and antenna can be eliminated. You can easily evaluate the communication by interpreting the data packets and displaying the packet properties, such as radio channel and reception strength. Logging of the WLAN packets for subsequent analysis, for documentation purposes, or for replaying the packets to stimulate ECUs is possible. The synchronization of the Map Window with other windows is especially helpful when analyzing logged WLAN packets. This allows fast location of certain traffic situations and analysis of the related communication.

Figure 2: Map Window visualizes location and driving direction of ITS objects
1.3 Further Information

> Vector Download Center
Various documents are available for CANalyzer on the Internet. The demo version 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

Option .Car2x extends CANalyzer by adding WLAN-specific functions as well as WLAN channels according to IEEE 802.11p:

> Configuration of up to 8 WLAN channels for simultaneous analysis and stimulation of control and service channels.

> Interpretation and display of protocol header information including validity check of signed packets (secured packets) as well as decoding of application messages (defined in ASN.1) in the Trace Window.

> Signal analysis of application messages (defined in ASN.1) in the Graphics Window and Data Window

> Display of multiple Car2x objects, such as ITS Vehicle Stations or ITS Roadside Stations, on map material including synchronization with other windows for subsequent analysis. The following map material is currently supported:

> OpenStreetMap

> Microsoft MapPoint

> MappleG

> MappleX
> Individual graphic files (JPG, BMP, or GIF)

> Car2x Station Manager as central unit to manage ITS Stations:
  > Manual or automatic assignment of
    > HashedId8
    > MAC addresses
to ITS Stations.

> Database nodes may be mapped to ITS Stations. This enables the access to application messages of individual ITS Stations.

> Define individual colors for ITS Stations

> Optional use of the defined colors for highlighting WLAN packets sent from the concerning ITS Stations in the Trace Window

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**Figure 4:** In the Car2x Station Manager colors of ITS Stations are chosen and the highlighting of Trace Windows for single ITS Stations can be activated.

> You configure analysis filters for the desired ITS objects in the Trace Window via drag & drop from the Map Window.

> WLAN Packet Builder for creation and interactive sending of correct and falsified WLAN packets

> The Car2x Network Explorer is the user interface for Car2x databases:
  > Configuring of node names and addresses
  > Configuring of application messages (encoding, protocol, and Id/port)
  > Locating of certain elements within the complex structure of an application message
The Car2x Network Explorer has various functions in store for Car2x databases: From basic node and message configuration to searching for certain signals of application messages.

> The provision of certificates in the Car2x certificate manager forms the basis for the signature check of received packets.
> Adding, importing, exporting, and removing certificates
> Marking of certificates as trustworthy (typically the root certificate)
> Assigning names for certificates to enable easy analysis

Figure 5: The Car2x Network Explorer has various functions in store for Car2x databases: From basic node and message configuration to searching for certain signals of application messages.

Figure 6: Provision of certificates in the Car2x certificate Manager
Display of known certificates (stored in the Car2x Certificate Manager) and received certificates in the Car2x Certificate Explorer:

- Check of the signature respectively the certification path
- Display of the signature hierarchy
- Display of the interpreted certificate contents
- Export of certificates, for example, for use in other configurations

Figure 7: Recording of received certificates in the Car2x Certificate Explorer including display of signature hierarchy and certificate contents

- If present, the GPS time of the WLAN device is displayed and recorded with the WLAN packets. Measurement data of different vehicles can thus be put into their temporal context.
- Logging of WLAN packets as well as replay and offline analysis of recorded measurement data
Figure 8: The WLAN Packet Builder allows convenient creation and sending of WLAN packets without programming. In this way, you create both correct and faulty packets.

3 Hardware

CANalyzer.Car2x currently supports the following IEEE 802.11p wireless adapters:

- Cohda Wireless MKx
- Continental CCU
- Delphi CRPU
- Denso WSU
- NEC Linkbird

No WLAN adapter is required for offline analysis of recorded WLAN packets.

4 Training

Our training offer for CANalyzer includes various training courses and workshops in our training facilities or at the customer’s site.

For more information about individual training courses and schedules, go to: www.vector-academy.com