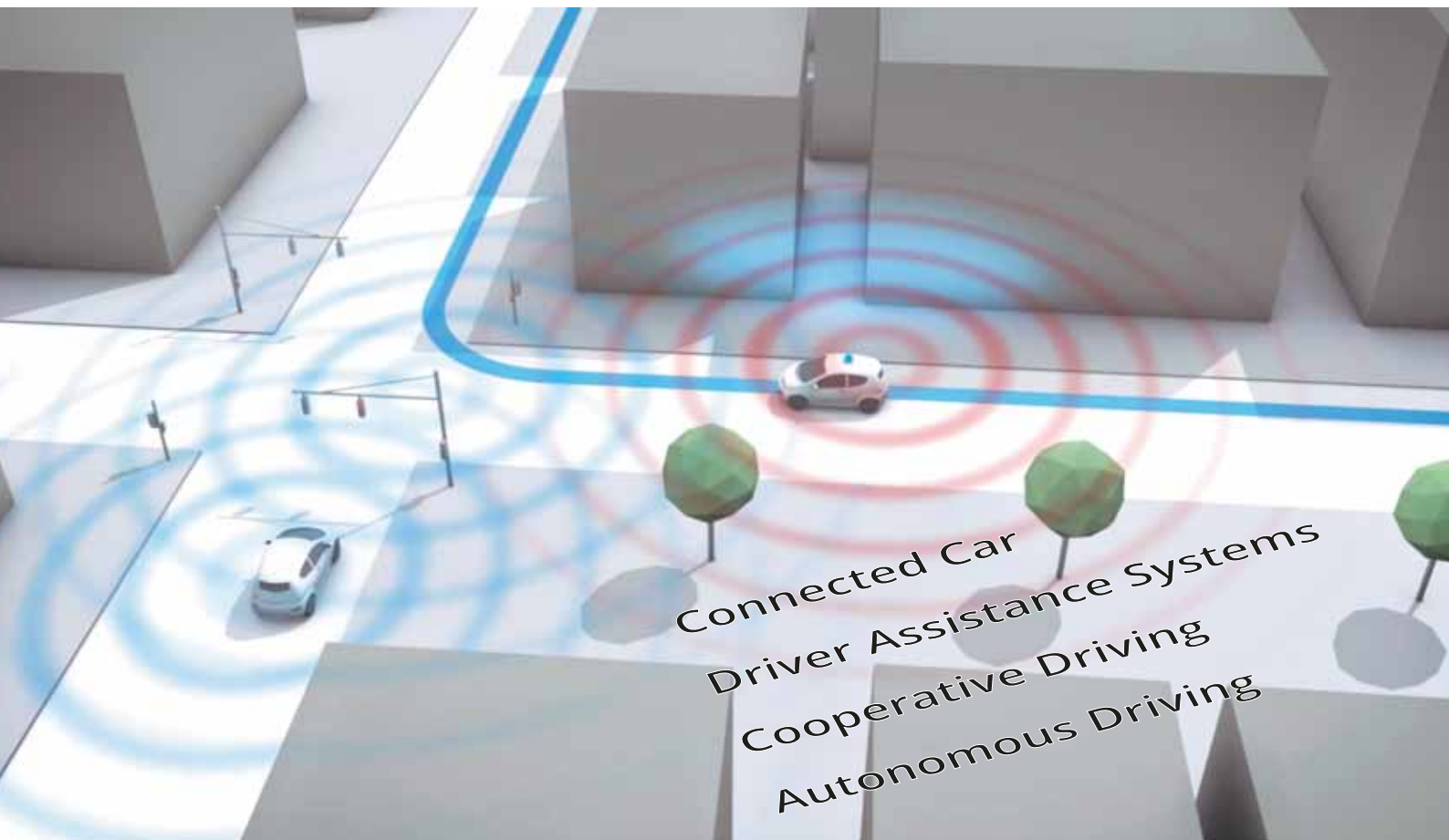


# waveBEE®

## C2X Systems

Router  
Development Platforms  
C2X Diagnosis  
Road Side Units (ITS Stations)  
C2X Software



# Index

<b>waveBEE®</b>	page 1
C2X product lineup	
<b>Selection guide</b>	page 2
Function overview waveBEE®	
<b>Brief description / references</b>	page 3
Short product description waveBEE®	
<b>waveBEE®plus</b>	page 4
Development platform	
<b>waveBEE®extreme</b>	page 5
Development platform	
<b>waveBEE®fleet</b>	page 6
C2X router / application platform	
<b>waveBEE®solo</b>	page 7
Self-sufficient Road Side Unit (ITS Station)	
<b>waveBEE®touch</b>	page 8
Mobile C2X diagnosis system	
<b>waveBEE®Software</b>	page 9
C2X Stack, analysis, tests, simulation	

## Introducing C2X / V2X

C2X / V2X communication uses a dedicated wireless network frequency on which its participants broadcast messages and allows the development of new types of driver information and driver assistant systems. Aside from the optimisation of traffic flow, road safety is of extreme importance, like generating warnings for emergency vehicles, hazardous roads or broken down vehicles.

C2X / V2X communication is one of the key technologies for the connected, autonomously driving traffic of the future.

Please note: Due to simplification the term „C2X“ ist used throughout this document.

# waveBEE® C2X product lineup



## waveBEE® - from the beginning as an inhouse development system to an established and renowned C2X development platform

The first waveBEE® system was developed years ago and updated continuously ever since. In the beginning it was used as an inhouse system by our software engineers for the development of C2X applications. Soon lively customer interest in this open and scalable development platform became apparent.

For many years connected cars and cooperative driving have been key competences of the NORDSYS team. A whole family of C2X products was created based upon this fundamental know-how and the knowledge of soft- and hardware requirements to develop efficiently and successfully.

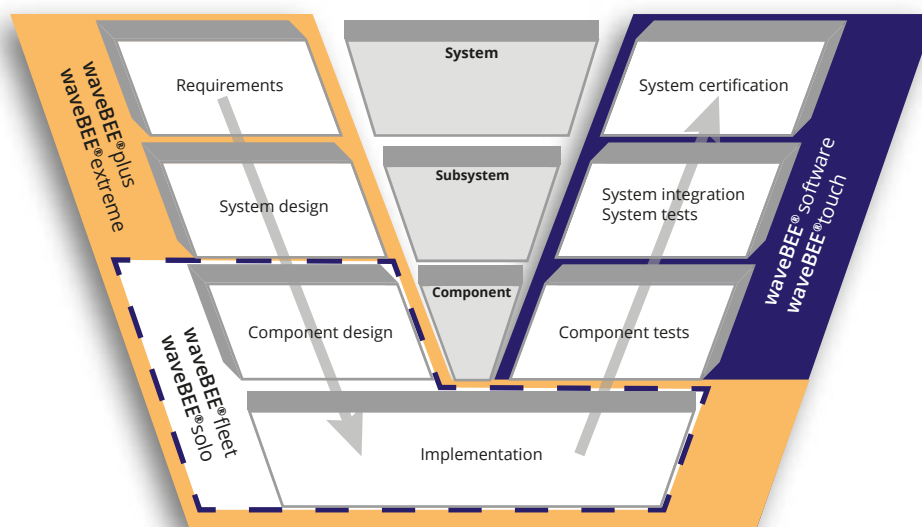
The broad product range offers a wide field of applications beginning with small and compact embedded systems (waveBEE®fleet), as a C2X router, up to high performance open development platforms (waveBEE®plus & waveBEE®extreme) for application development and C2X simulation. These platforms even support the use of third party development frameworks like ADF.

## C2X diagnosis systems and Road Side Units (ITS Stations)

In addition to the router and development platforms the waveBEE® family features the waveBEE®touch, a mobile and self-sufficient C2X diagnosis system. It is capable of showing and analysing C2X communication live in the C2X environment. The integrated functions to record and playback communication data enable the engineer to make detailed analysis of entire C2X fleets on-site while performing integration tests efficiently and without the need of other complex diagnosis systems.

Based upon waveBEE® systems the Road Side Units (ITS stations) are completing the C2X lineup: Independent of existing infrastructure, power supplies and network environments, these all-in-one units are perfectly suited for easy and fast deployment as a C2X infrastructure device to create mobile C2X test sites. They can even be used for the simulation of a traffic management center.

waveBEE® products are used daily by automotive manufacturers, engineering companies, public research institutes and are the systems of choice in recent European ITS corridor projects.



Use of waveBEE® products in the development process according to „V-model“.



## waveBEE® selection guide



	waveBEE®plus Development Platform	waveBEE®extreme Development Platform	waveBEE®fleet Embedded Platform Router	waveBEE®solo Road Side Unit	waveBEE®touch Diagnosis System
system type	open development platform	✓	✓	✓	
	embedded platform / router			✓	
	self-sufficient all-in-one system			✓	✓
applications	custom C2X applications development by NORDSYS	✓*1	✓	✓	✓
	custom C2X applications development by customer	✓	✓	✓*2	
usage	V-ITS-S vehicle	✓	✓	✓	
	R-ITS-S infrastructure	✓	✓	✓	
	P-ITS-S personal				✓
special features	simulation of C2X communication	✓	✓	✓	
	hybrid communication WAVE / cellular	✓	✓	✓	
	live view and diagnosis of C2X communication				✓



## waveBEE® brief description / references



	waveBEE®plus Development Platform	waveBEE®extreme Development Platform	waveBEE®fleet Embedded Platform Router	waveBEE®solo Road Side Unit	waveBEE®touch Diagnosis System
description	Development platform for C2X applications and simulation of C2X communication. Easy to integrate in vehicles with optional Car-Kit accessory set.	Development platform for very demanding C2X applications and complex simulation of C2X communication.	C2X router with object-oriented interface for C2X applications.	Self-sufficient and mobile C2X Road Side Unit (ITS station) for rapid deployment of C2I test environments.	Highly mobile and self-sufficient C2X diagnosis system.
	Software-in-the-loop (SIL) and Hardware-in-the-loop (HIL) with just one system possible.	Software-in-the-loop (SIL) and Hardware-in-the-loop (HIL) with just one system possible.	Pre-series C2X retrofit solution for vehicles.	Completely infrastructure independent (Power supply, network). Also usable as an development platform (contains waveBEE®plus).	Live visualisation, recording, playback and analysis of complex C2X environments on site.
key features	Automotive grade 802.11p (WAVE), ITS G5 stack, open system, framework support (e.g. ADTF), Car-Kit	Automotive grade 802.11p (WAVE), ITS G5 stack, open system, framework support (e.g. ADTF)	Automotive grade 802.11p (WAVE), ITS G5 stack, embedded system, plug and play C2X retrofit solution	Automotive grade 802.11p (WAVE), ITS G5 stack, open system, framework support (e.g. ADTF), HMI touchscreen, battery pack	Automotive grade 802.11p (WAVE), ITS G5 stack, heavy duty device (MIL-STD 810G, IP65, IEC60529)

references	<p>waveBEE® products are used by automotive and commercial vehicle OEMs, tier-1 suppliers, engineering companies and public research institutes. The complete product lineup is used: Starting with the development platforms to Road Side Units to diagnosis and simulation systems.</p> <p>European research projects, like the recent ITS corridors, are featuring the reliable waveBEE® products as well.</p>
------------	---



# waveBEE®plus

## UNIVERSAL 64BIT C2X

## DEVELOPMENT PLATFORM

### TECHNICAL DATA

Construction	Aluminium Heavy duty steel
Weight	3 kg
Dimensions	244 / 65 / 180mm (w/h/d) w/o antennas
Power supply	12 / 24 VDC typical (9-36 VDC)
Certificates	CE, eMark, ISO7637 EN45545-2 compliance
Operating temp.	-40°C - 70°C (with CFast™)
Storage temp.	-40°C - 80°C
System	1.91 GHz Intel® Atom™ E3845 SoC integrated chipset 4 GB RAM 8 GB CFast™ card GPS receiver(max. 10 Hz)
Network	2x Gigabit Ethernet RJ45 WAVE module IEEE 802.11 p
Configuration	4x RS-422/485 (isolated) 1x RS-232 1x DI/DO (6-in/2-out, isolated) 1x CAN (isolated) 1x HDMI, 1x VGA 2x Audio (Line-out/Mic-in) 2x USB 2.0 4x SMA 1x Expansion slot
Expansion slot options	Radio module IEEE 802.11(a/b/g/p) Cellular (LTE/UMTS)
Accessories	Car-Kit (see right side) Bluetooth (external) Quad-antenna (magnet mount) (WAVE, WLAN, LTE, GPS) 12 VDC Power supply

### DESCRIPTION:

The open and modular waveBEE®plus C2X development platform enables the developer to use a single device in both development cycles: software-in-the-loop (SIL) and hardware-in-the-loop (HIL). Future C2X applications can be developed and tested in a software simulation environment on the waveBEE®plus and afterwards implemented into the vehicle without changing the device or platform in the development process.

It combines application unit and communication unit and optimises the workflow to bring applications from the development platform into the target system (vehicle, Road Side Unit), even supporting the use of development frameworks (ADTF, OSGi etc.).

NORDSYS also offers customer specific adjustments and customisation of the C2X stack as well as individual development of C2X applications.

### FIRMWARE / SOFTWARE:

Preconfigured Linux operating system  
ETSI ITS G5 communication stack

### SET INCLUDES:

waveBEE®plus  
1x SMA mini rod-antenna (2dBi)  
1x GPS antenna  
SDK and documentation  
Power supply 0,75 m, 4 mm plugs

### CAR-KIT ACCESSORY SET:

Reversible car installation kit to display and control C2X example applications using an HMI touchscreen.

**Set includes:** Touchscreen 8" with suction cup mount, wiring kit (power supply) for waveBEE® and display (12 V vehicle plug), signal cable for display, antenna cables, quad-antenna with magnet mount (WAVE, WLAN, LTE, GPS), pre-installed C2X example applications (roadworks warning, emergency vehicle, traffic jam)

# waveBEE®extreme

## UNIVERSAL 64BIT C2X

## DEVELOPMENT PLATFORM



### DESCRIPTION:

The open and modular waveBEE®extreme C2X development platform enables the developer to use a single device in both development cycles: software-in-the-loop (SIL) and hardware-in-the-loop (HIL). Future C2X applications can be developed and tested in a software simulation environment on the waveBEE®extreme and afterwards implemented into the vehicle without changing the device or platform in the development process.

It combines application unit and communication unit and optimises the workflow to bring applications from the development platform into the target system (vehicle, Road Side Unit), supporting the use of development frameworks (ADTF, OSGi etc.).

The 64bit waveBEE®extreme is powerful enough to run the security layer (ETSI specification) just in software without the need for additional cryptography hardware decoders (cryptographic hardware support also included).

NORDSYS also offers customer specific adjustments and customisation of the C2X stack as well as individual development of C2X applications.

### FIRMWARE / SOFTWARE:

Preconfigured Linux operating system  
ETSI ITS G5 communication stack

### SET INCLUDES:

waveBEE®extreme  
1x SMA mini rod-antenna (2dBi)  
1x GPS antenna  
SDK and documentation  
Power supply 0,75 m, 4 mm plugs

### TECHNICAL DATA

Construction	Aluminium Heavy duty steel
Weight	5.5 kg
Dimensions	288 / 85,7 / 211mm (w/h/d) w/o antennas
Power supply	12 / 24 VDC typical (9-36 VDC)
Certificates	CE, eMark, ISO7637 EN45545-2 compliance
Operating temp.	-40° C - 70° C (with CFast™)
Storage temp.	-40° C - 80° C
System	1.7 GHz Intel® Core™ i7-3517UE Intel®QM77 chipset 4 GB RAM 8GB CFast™ card GPS receiver (max. 10 Hz)
Network	4x Gigabit Ethernet RJ45 (PoE) WAVE module IEEE 802.11 p
Configuration	3x RS-232/422/485 (isolated) 1x DI/DO (4-in/4-out, isolated) 1x CAN (isolated) 1x DVI, 1x VGA 1x Audio (Line-out/Mic-in) 2x USB 2.0 2x USB 3.0 4x SMA 1x Expansion slot
Expansion slot options	Radio module IEEE 802.11(a/b/g/p) Cellular (LTE/UMTS)
Accessories	Bluetooth (external) Quad-antenna (magnet mount) (WAVE, WLAN, LTE, GPS) 12 VDC Power supply



## waveBEE®fleet COMPACT C2X COMMUNICATION ROUTER

### TECHNICAL DATA

Construction	galvanised, coated steel
Weight	0,5 kg
Dimensions	109,5 / 30 / 125mm (w/h/d) w/o antennas
Power supply	Two alternative inputs: 4-pin socket (6-32 VDC) DC round-socket (6-32 VDC)
Power consumption	0,3 A @12 V typical @ 25° C
Operating temp.	-40° C - 85° C max 95 % humidity
Storage temp.	-40° C - 85° C max 95 % humidity
System	Autotalks CRATON processor Autotalks PLUTON RF Transceiver GNSS module HSM Hardware Security module
Network	10/100 MBit RJ45 WAVE module IEEE 802.11p
Configuration	1x RS-232 2x CAN (DB-9) 1x Audio 3,5 mm 1x microSD Card slot 2x Fakra type Z (WAVE) 1x Fakra type C (GPS)

### DESCRIPTION:

The compact waveBEE®fleet is the system of choice for retrofitting C2X communication and functionality to existing vehicles.

With its included ITS G5 stack the waveBEE®fleet can be utilised as a router to enable existing systems within the vehicle to use C2X functionality based upon IEEE 802.11p (WAVE). The database-driven application interface offers object-oriented access for other systems within the vehicle.

NORDSYS also offers customer specific adjustments and customisation of the C2X stack as well as individual development of C2X applications. With added customised applications the waveBEE®fleet is the ideal all-in-one solution to retrofit C2X communication and applications with just one compact innovative system.

The optional extended developer license enables the customer to develop applications for the waveBEE®fleet as well.

### FIRMWARE / SOFTWARE:

ThreadX RTOS  
ETSI ITS G5 communication stack

### SET INCLUDES:

waveBEE®fleet  
Active GPS antenna Fakra type C 5 m line  
2x DSRC dipole rod-antennas Fakra type Z 5.9 GHz  
12V / 1A 110-240 V power supply  
Documentation (CD)



# waveBEE®solo

## MOBILE & SELF-SUFFICIENT C2X ROAD SIDE UNIT (ITS STATION)

### DESCRIPTION:

The mobile and stand-alone waveBEE®solo C2X unit is the perfect system for C2X field tests by combining our waveBEE®plus development platform, its own power supply with rechargeable batteries and charger and an array of antennas in one box. The battery delivers enough energy to supply the waveBEE®solo non stop for up for 48 hours in typical use cases.

Therefore it is ideal to be used as a highly mobile and infrastructure independent Road Side Unit (RSU / ITS Station). Combine multiple waveBEE®solo to design and configure your own C2X test field anywhere.

The integrated charger for the battery can also be used to power the waveBEE®solo continuously. A continuous power feed can also be established when using the external 12 VDC line in (if used inside a vehicle for example).

NORDSYS also offers customer specific adjustments and customisation of the C2X stack as well as individual development of C2X applications.

The open waveBEE®solo platform is also capable of running third party applications and development frameworks (ADTF, OSGi).

### FIRMWARE / SOFTWARE:

Preconfigured Linux operating system  
ETSI ITS G5 communication stack

### SET INCLUDES:

waveBEE® solo  
Antenna WAVE IEEE 802.11 p N-socket  
Combi-antenna GPS / cellular, fixed mount  
Documentation

### INFRASTRUCTURE-KIT ACCESSORY SET:

Enables the display and control of C2X example applications using an HMI touchscreen.

**Set includes:** Touchscreen 8" inside the construction,  
Pre-installed C2X example applications (roadworks warning, emergency vehicle, traffic jam)



### TECHNICAL DATA

Construction	Aluminium
Weight	30 kg
Dimensions	582 / 385 / 277mm (w/h/d) w/o antennas
Power supply	self-sustaining (battery up to 48 h) external 12V DC line in line in (charging) 230V A/C internal charger internal rechargeable battery
Classification	Protection: IP 66 (using protection caps on external interfaces)
System	waveBEE®plus 1.91 GHz Intel® Atom™ E3845 SoC integrated chipset 4 GB RAM, 8 GB CFast™ card 1 Expansion slot
Network	2x RJ45 (Gbit Ethernet) internal WAVE module IEEE 802.11 p
Antennas	N-antenna (screw connection) 10 dBi 5.1-5.9 GHz WAVE Fixed combi-antenna GPS / cellular
Antenna connections	4x SMA sockets (external access) WLAN, WAVE, LTE/UMTS, GPS N-socket (external access)
Expansion slot options	Radio module IEEE 802.11(a/b/g/p) Cellular (LTE/UMTS)
Accessories	Infrastructure-Kit (see left side) Quad-antenna (magnet mount) (WAVE, WLAN, LTE, GPS) Quad-antenna (screw mount) (WAVE, WLAN, LTE, GPS)



## waveBEE®touch

### MOBILE HEAVY DUTY CAR2X DIAGNOSTIC TOOL

#### TECHNICAL DATA

Weight	1,3 kg
Dimensions	275 / 171 / 32 mm (w/h/d)
Power supply	Li-Ion battery: 5300 mAh (hot-swappable) DC Line-in
Operating temp.	-20° C bis 60° C MIL-STD-810G, Method 501.5 Procedure II MIL-STD-810G, Method 502.5 Procedure II, III
Drops	26 Drops from 1.22 m on concrete MIL-STD-810G, Method 516.6 Procedure IV
Vibration	MIL-STD-810G, Method 514.6 Procedure I
Sand / Dust / Water	IP 65, IEC60529
Network	10/100/1000 MBit RJ45 WAVE module IEEE 802.11 p WLAN module IEEE 802.11 (a/b/g)
System	10" Touchscreen (resistive) GPS receiver 1x Expansion slot
Expansion slot options	WAVE module IEEE 802.11 p WLAN module IEEE 802.11 (a/b/g) Cellular (LTE/UMTS)
Accessories	Li-Ion battery 5300 mAh Li-Ion HD battery : 10600 mAh Shoulder carrier Carycase Wristband Vehicledock

#### DESCRIPTION:

The waveBEE®touch mobile heavy duty tablet enables the operator to capture, log and analyse C2X communication on the fly in realtime directly on site. It is capable of receiving, decoding and interpreting communication based on ETSI ITS and IEEE WAVE.\*

Different message types like CAM, DENM, SPAT, MAP, BSM\* are visualised live on an interactive map and can be analysed in the smallest detail instantly.

The waveBEE®touch is the perfect mobile tool to ensure C2X senders are broadcasting correctly and ideal to be used in any C2X environment for validation and diagnostic purposes.

In combination with the ability to record and replay C2X data the waveBEE®touch visualises and analyses entire C2X scenarios in a multitude of use cases: For research and development, C2X application verification or diagnosis of complex live C2X environments.

NORDSYS also offers customer specific adjustments and customisation of the C2X stack as well as individual development of C2X applications.

#### FIRMWARE / SOFTWARE:

waveBEE®touch Analytics Software

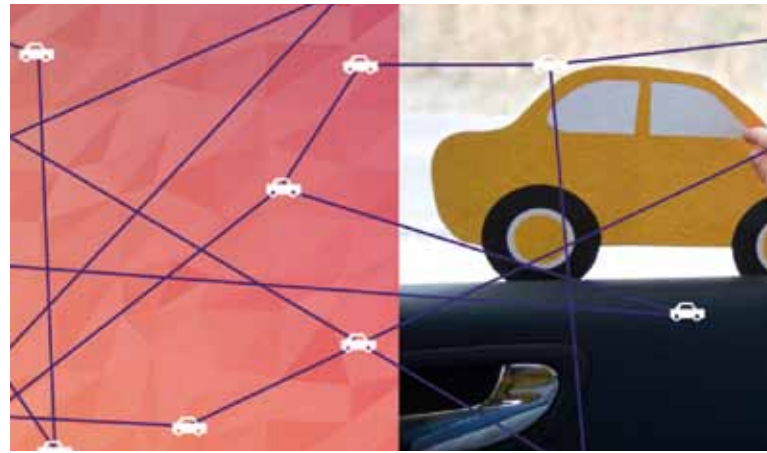
#### SET INCLUDES:

waveBEE®touch Tablet  
Li-Ion battery 5300 mAh (hot-swappable)  
Power supply  
Documentation (handbook)  
12 months free software updates

\* Some features are installed by software updates

# waveBEE® Software

## C2XSTACK, ANALYTICS, TESTS, SIMULATION



### waveBEE® C2X stack

Heart of the waveBEE® software solution is the modular high performance waveBEE® C2X stack. This stack contains the modules GeoNetworking (GN-Service), Basic Transport Protocol (BTP) and Local Dynamic Map (LDM). They are supplemented by the Facility-Modules CA-Service (CAM), DEN-Service (DENM), SPAT-Service (SPAT), MAP-Service (MAP) and Security (SEC).

The software architecture by NORDSYS allows allocating individual services and applications to multiple network nodes. This ensures easy implementation and testing of solutions for serial production, taking manufacturer specific control unit software architectures into account.

Relying on a Continuous Integration Build-Process in combination with platform independent coding, the entire development cycle is based upon a consistent code base - ready to be used in series production.

### Tests, analysis, simulation

The simulation tools of the waveBEE® software are capable of creating complex C2X scenarios and enable the user to perform a multitude of reproducible tests (e.g. penetration or load tests).

In this case the waveBEE® software is part of a test-system which delivers C2X communication for defined traffic scenarios, generating input for the DUT (Device Under Test) or SUT (System Under Test).

The simulation can generate different grades of traffic density and corresponding C2X data traffic: The scale ranges from individual single incidents or messages to mass simulation of a multitude of C2X participants.

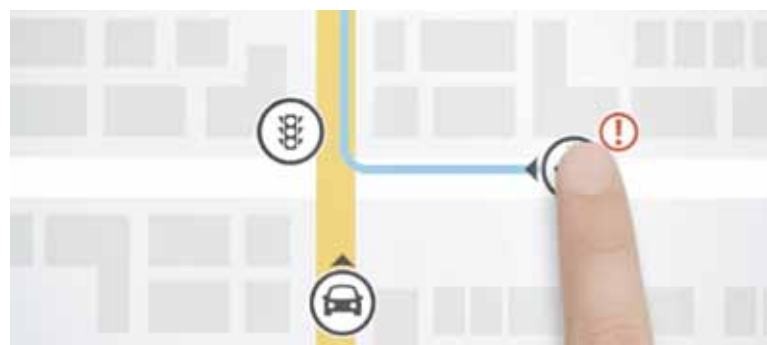
The ability to create reproducible test scenarios by simulation is essential for the standardisation of processes to get reliable and analytically correct test results.

### Designing and customising applications for research & development

The requirements for the functional scope of a C2X stack are evolving fast. Functions for new assistance systems or autonomous driving functions need development of new Facility-Services or adjustment of payloads. Using the waveBEE® product lineup, these new requirements can be developed from R&D state to reach series production level by utilising a structured development process.

There is good reason NORDSYS GmbH is a renowned development partner for automotive OEMs and tier-1 suppliers for many years, especially for creating innovative communication solutions and applications.

**Because of the high dynamic in the topics listed above we recommend an individual discussion.**



NORDSYS GmbH  
Altewiekring 20A  
38102 Braunschweig  
Germany  
T:+49 (0)531-296988-0  
F:+49 (0)531-296988-99  
www.nordsys.de  
info@nordsys.de

Distribution partner:



trading&consulting  
Ferdinand Schuber

FS Trading & Consulting  
Strandstrasse 134  
A-2331 Voesendorf  
Austria  
T: +43 2235 47917-110  
F: +43 2235 47917-200  
www.fstc.at  
f.schuber@fstc.at

#### Copyright / Disclaimer

All materials, content and forms contained in this brochure are the intellectual property of NORDSYS GmbH and may not be copied, reproduced, distributed or displayed without NORDSYS's expressed written permission. NORDSYS® and waveBEE® are registered trademarks of NORDSYS GmbH.

NORDSYS disclaims any responsibility for content errors, omissions, or infringing material and disclaims any responsibility associated with relying on the information provided in this brochure.

© NORDSYS GmbH 2016