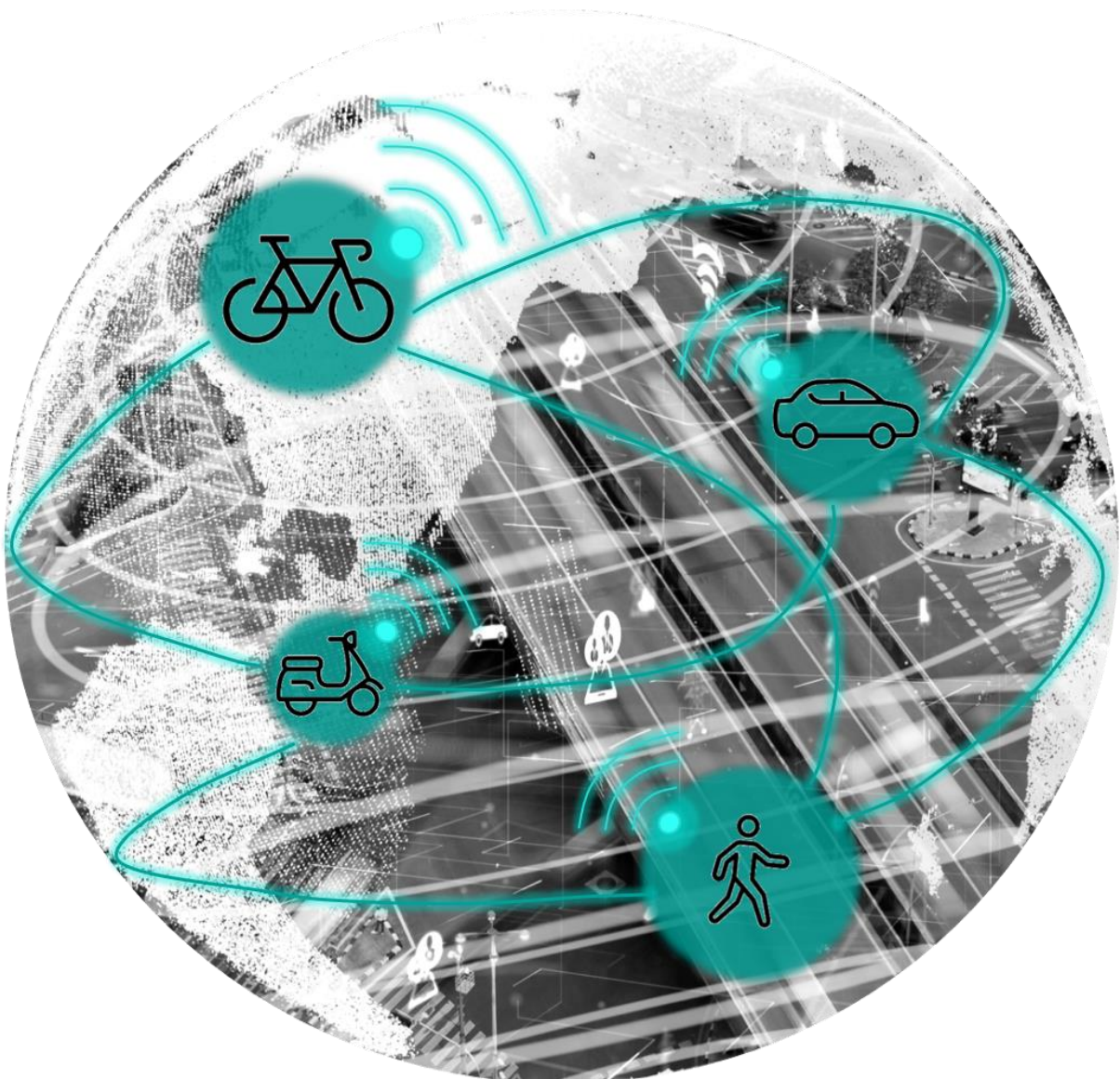


# V2X FOR VRU (Vulnerable Road User): Making All Traffic Participants Visible

## JOYNEXT Whitepaper

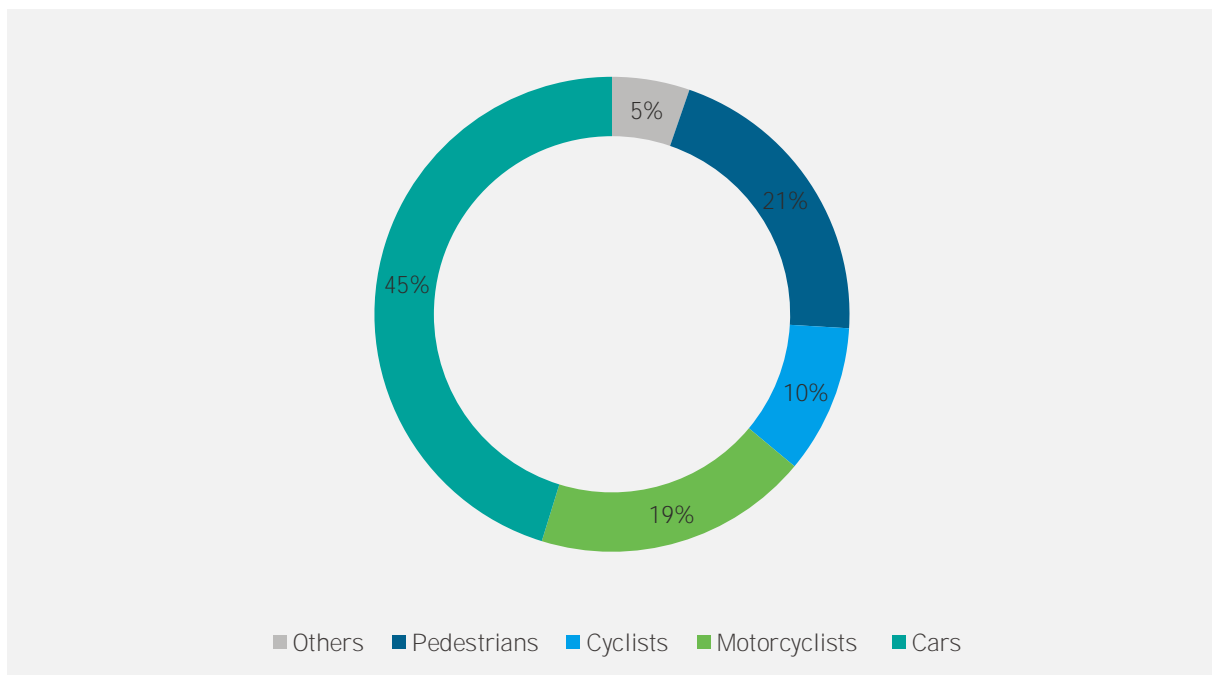


## ▶ CONTENT

01   Why VRU protection is paramount	3
02   How could V2X protect VRU	4
Use Case “Blocked view”	4
How V2X works	6
03   V2X for VRU solutions	8
V2X network solution	8
V2X smart infrastructure	9
V2X direct solution (Bike gadget)	9
04   Challenges	11
05   Summary	12
06   About JOYNEXT	13
Contact us	14
07   Sources	15

## ► 01 WHY VRU PROTECTION IS PARAMOUNT

Why safeguarding of VRU (Vulnerable Road User), like pedestrians, cyclists and motorcyclists is a compelling need and a crucial topic illustrates the statistics below. In the year 2020, half of the traffic fatalities in the EU were VRU.



TRAFFIC FATALITIES EU IN 2020 (Decae, 2022)

In numbers, out of total 18,800 road deaths in the EU (2020), 3,883 deaths were pedestrians, 1,901 cyclists and 3,520 motorcyclists or moped riders (Decae, 2022). While vehicles, such as cars or trucks, are already equipped with smart intelligent solutions like blind spot assists, hazard breaking assists or some of them even with a V2X (Vehicle-to-Everything) communication solution, VRU are not yet equipped with these technologies. They are unable to recognize other traffic participants ahead of time, in order to receive a warning signal. More importantly they are not able to make others aware of themselves, not to be overlooked. Active safety systems for VRU are still missing.

Two-wheelers are in demand as never before: The majority of the citizens in the EU consider the motorbike as the most essential transport mode next to the car in 2019 and 23.6% of the European citizen were using their bikes regularly (Statistisches Bundesamt, 2022). Post pandemic, the sale of bikes and e-bikes is still booming, especially sales figures of fast e-bikes have tripled since 2016 (Janson, 2022).

Due to the increasing and the aging population, these numbers are highly anticipated to rise. As a result, V2X communication will play a vital role in implementing the European Commission's goal, to reduce road deaths to zero by 2050 ("Vision Zero"), by making VRU visible just like cars already are.

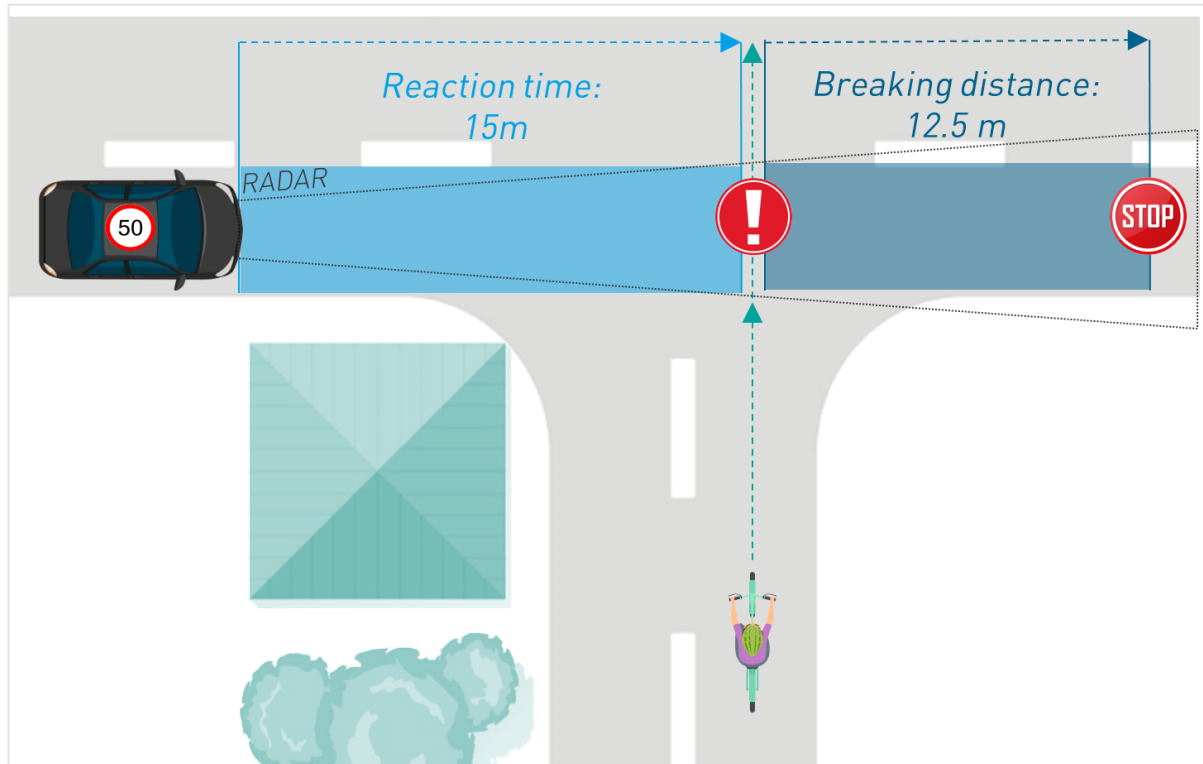
## ► 02 HOW COULD V2X PROTECT VRU

It is apparently and imperatively necessary, that VRU show their presence and their location in an active way. The following "blocked view" use case will describe how V2X can primarily support to protect the VRU and how this technology works.

### USE CASE "BLOCKED VIEW"

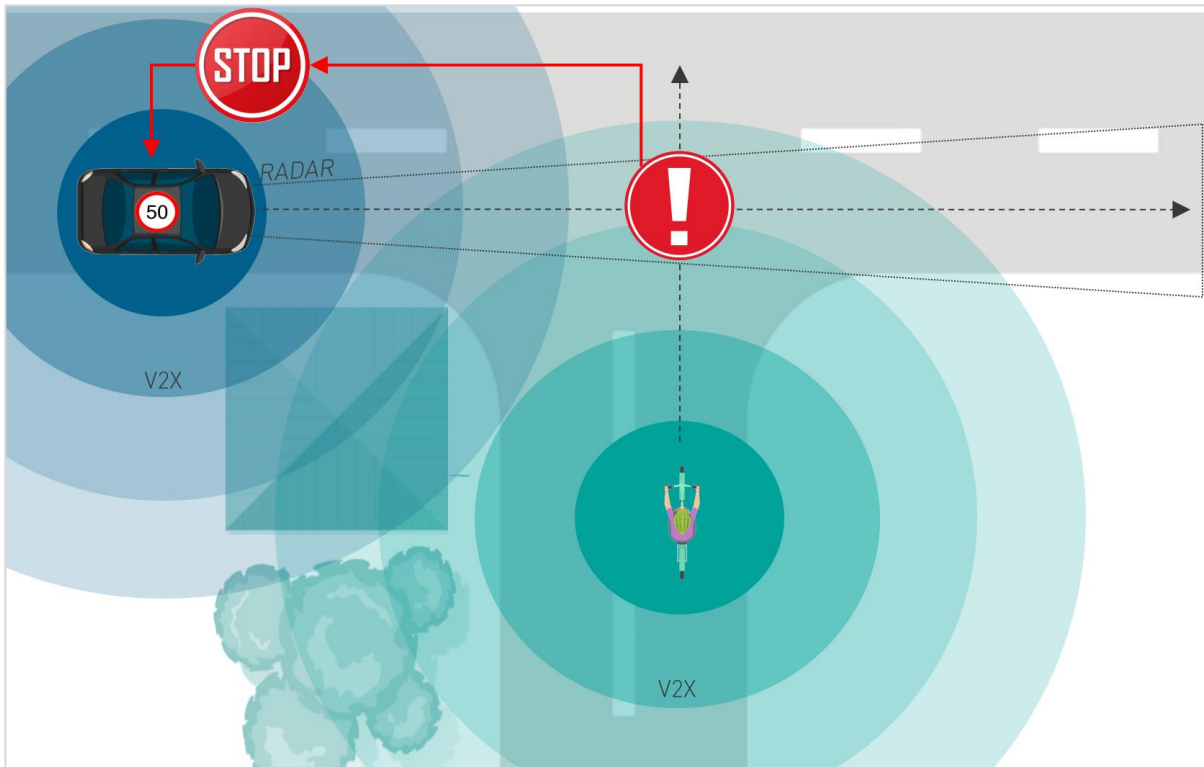
Currently vehicles are mainly equipped with sensors which are only able to detect a limited (visible) range (e.g. radar or cameras only detect a range from approx. 200 to 300 meters around the vehicle) and give a warning for an approaching VRU within this limited range (without consideration of restrictions due to bad weather conditions or obstacles in front of the sensors). In comparison, V2X could already enable an early warning, even if the VRU is not yet in sight range of other road users (communication range of approx. one kilometer).

As depicted below, if a cyclist suddenly appears behind a parked car or behind a building, a driver approaching with 50 km/h has a stopping distance of 27.5 meters (Assumption: reaction time [ $\sim 1$ s] leads to a distance of 15 meters plus breaking distance of 12.5 meters). An accident may be inevitable.



CRASH SCENE WITHOUT V2X FOR VRU (Own figure)

In contrast as pictured below, the usage of a V2X wireless safety sensor could help to provide early warnings and detect all road users who may be affected in a dangerous situation and warn them before a possible collision. Our solution provides the current position of the road user, additional data like speed or direction of motion and may provide a path prediction of possible future movement. In case the motion paths are crossing, the affected road users will get an alert message. In this case, thanks to the V2X information, all road users are aware of the presence of others and potentially dangerous situations. Thus, they can react to avoid collisions.



WARNING SCENE WITH V2X FOR VRU, WITHOUT COLLISION (Own figure)

Using haptic, acoustical and / or visual signals are conceivable ways to warn the driver early. A connection with existing systems like the emergency breaking assist, (car breaks on its own, before the driver notices the cyclist) is a logical extension.

## HOW V2X WORKS

The USE CASE “BLOCKED VIEW” highlights the need for equipping all road users with V2X technology, to be able to send a warning to other road users and vice versa. With this technology they would be able to receive warnings from and about others.

New vehicles and car lines are already equipped with V2X systems today. The infrastructure will gradually be extended with V2X as well and finally this technology will also be implemented in the micro mobility sector-including cyclists, pedestrians and other two wheelers like motorcyclists. Hence, the amount of V2X systems on the street is increasing constantly.

A V2X system is a component which connects these road users via radio technology. There are two different technologies, which can be used for V2X communication: The WiFi based DSRC (Dedicated Short-Range Communication) and the Cellular based C-V2X (Cellular-V2X). One of the major issues in V2X communication is that these two technologies are not directly compatible with each other. This means that devices which support V2X communication but are based on DSRC cannot automatically send and receive information to V2X devices which use C-V2X and vice versa: Depending on the region of deployment and the different local preferences for the technology selected have to be considered, to be able to provide the suitable solution for that region.

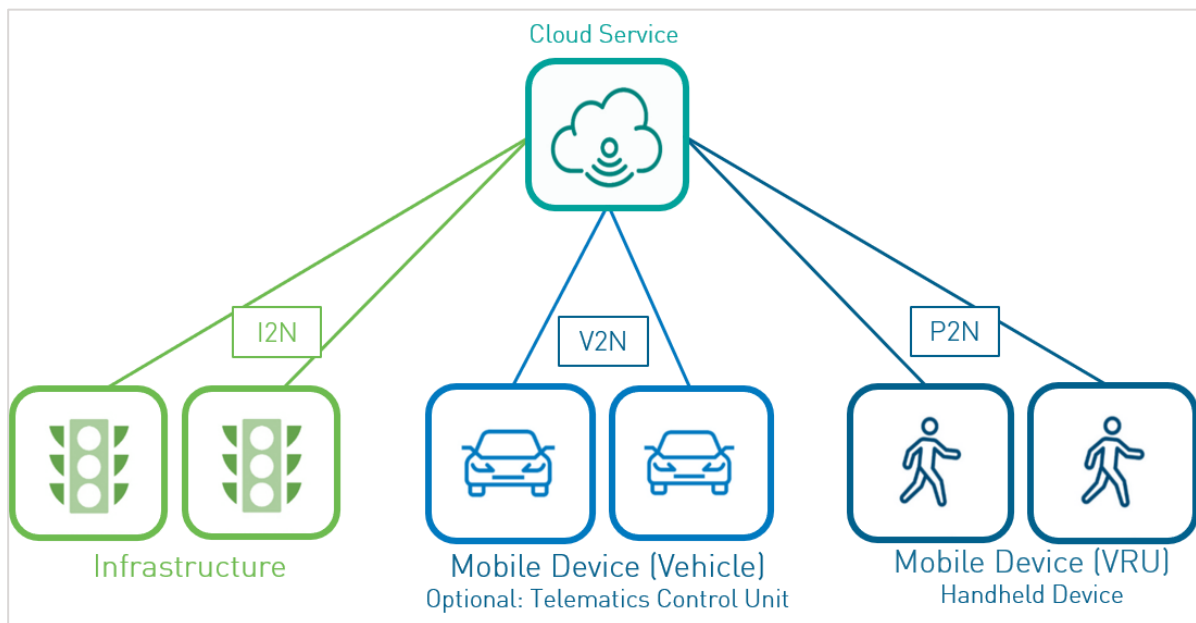
In the European market the DSRC technology has become established, while in North America and in China the C-V2X standard is used. Both, DSRC and C-V2X allow direct communication between the road users without any additional infrastructure like cell towers or WLAN hot spots. V2X in general enables low latency, secure and reliable communication within a range of approximately 800 meters to 1 kilometer. It is possible to extend the communication range via cellular network based on 4G or 5G.

The V2X system provides the information about the presence & motion of the user and can also use incoming signals from other road users to make the driver aware or even to trigger the ADAS (Advanced Drives Assistance Systems) within the vehicle in case of critical situations.

The most fundamental pre-conditions to determine the exact position (“Here I am”) are the positioning accuracy and the predictable future movement. Both pre-conditions are difficult to achieve, but essential. In addition, it is also important that the latency for communication exchange is as low as possible. By using V2X, a near-real-time latency of < 50 milliseconds is expected to be achieved.

## ► 03 V2X FOR VRU SOLUTIONS

As highlighted above, it is mandatory to enable drivers, cyclists, motorcyclists and pedestrians to provide information about their position and receive warning signals from other road users too. We consider possible solutions for VRU protection in the following.



COMMUNICATION PATH V2X FOR VRU VIA SMARTPHONE APP (Own figure)

### V2X Network Solution

Since the huge amount of users almost completely use smartphones regularly, it is preferred to enable a smartphone based V2X solution to make it available for as many users as possible and avoid the need for an additional gadget. The number of smartphone users worldwide is continuously growing and according to forecasts, it will even rise from 3.9 billion users in 2020 (= 49.43% of the world population) up to 4.5 billion in 2024 (=56.68% of the world population) (Tenzer, 2021) – in some countries it is even higher (e.g. about. 80% of German population using smartphones on daily basis) (Bitkom Research, 2019) (Davies, 2021).



The smartphones of any road user can then be connected to a cloud service via cellular network like 4G or 5G to exchange position & movement information to receive predictive alerts in case of potential collisions.

## V2X Smart Infrastructure

Another way to increase traffic safety will be the usage of already existing components in the infrastructure. This includes traffic lights or classical street signs on streets and intersections. These infrastructure components can be used as detection zones, perceiving road users like cyclists or pedestrians. Therefore, different sensors (like camera or LiDAR), with object detection algorithm to determine the presence and proximity of the road users, come into use. This information will be provided to the vehicles via V2X. Drivers will be aware of the proximity of VRU, even if they cannot see them directly (non-line-of-sight) or they cannot communicate with them (VRU without V2X). However, this V2X smart infrastructure solution requires high infrastructure costs and a high density.

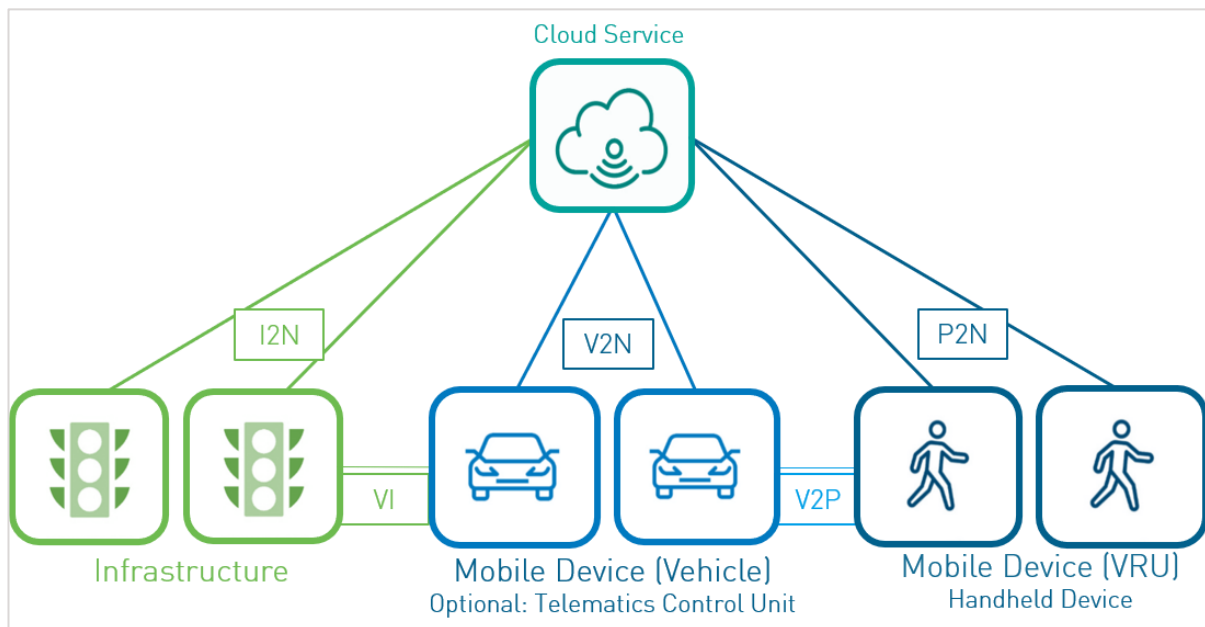
To overcome the problems of possibly higher latency time, high maintenance and installation costs or technical dependencies (e.g. smartphones do not support V2X direct communication with other road users in near proximity), a third and parallel technical direct solution will bridge the time and could use already available solutions.

## V2X Direct Solution (Bike Gadget)

With a bike gadget, a direct communication (V2P = vehicle-to-pedestrian) with equipped vehicles and infrastructure become possible.

All road users are able to communicate with each other, using different technologies (e.g. cellular network for V2N =vehicle-to-network), P2N = pedestrian-to-network or I2N = infrastructure-to-network). Furthermore, the road user is able to communicate directly via V2P (vehicle-to-pedestrian) or V2I (vehicle-to-infrastructure).

It operates in the licensed ITS bands (Intelligent Transport Systems), independent from cellular network and without interference with other technologies. This is the perfect environment to enable secure, reliable and fast data exchange in every road situation to achieve “Vision Zero”.



COMMUNICATION PATH V2X FOR VRU VIA HANDHELD DEVICE (Own figure)

With the help of a hybrid technology approach, both technologies collaborate. The long-range communication (cellular network) is covered by the smartphone app and cloud service, while the short-range communication (direct communication) is enabled by the bike gadget. This hybrid communication approach will help to increase the V2X market penetration rate. V2X direct exchanged data will be visible and usable for users of cloud services, the V2X network exchanged data will be visible and usable for users of V2X direct exchanged data.

This direct solution provides a great advantage: Even if there is only one of these communication technologies available, the V2X smartphone app as main gateway enables it to see all road users – no matter which technology they are supporting.

## ► 04 CHALLENGES

In addition to all the V2X for VRU solution advantages, the level of development must be mature and well considered. To give a warning for potential collisions, it is necessary to understand and predict the VRU behavior and to recognize the transport mode of all relevant road users.

The technical dependencies and challenges are also not trivial. On one hand, we have to equip road users with a wireless technology, as soon as possible. On the other hand, we need to make the usage easy and uncomplicated. The exchanged data has to be precise enough to avoid false warnings (e.g. positioning accuracy) and needs to provide high reliability and valuable content to enable precise collision warnings.

All these points are crucial to build trust in the V2X for VRU solution. Once the trust is gained and many users are acquired, it is possible to quickly increase the awareness of the solution and gain a large market penetration. Hence, a smartphone app solution for VRU protection is a potential chance and challenge at the same time.

## ► 05 SUMMARY

To reduce road casualties of all road users to zero over the next 30 years, an active integration of VRU is indispensable and unavoidable in increasingly growing urban regions. All road users, especially fast and heavy vehicles, have to detect VRU as early as possible to avoid a collision and likewise a warning for VRU is necessary too, to protect them in the best possible way. The end user has to recognize the benefit of the V2X for VRU solution. Only with this holistic perception of the environment, the psychological aspect of feeling safe comes into effect, thereby making everyone's journey risk-free.

## ► 06 ABOUT JOYNEXT

Driven by the needs of users, JOYNEXT works with dedication on forward-looking intelligent connectivity solutions for all road users. We focus on relevant and current topics, such as V2X and are pioneers in VRU protection. JOYNEXT considers this inadequate VRU protection to gradually create a solution for enhanced safety for VRU.

We provide a holistic solution for all road users, integrating into V2X ecosystem - [Our V2X for VRU solution](#) based on smartphone and V2X gadget makes hybrid communication possible.

In case of upcoming collisions (intersecting trajectories calculated in cloud or gadget), VRU- and vehicle warnings, based on data exchange, are generated. Our AI based transport mode recognition (automatic detection – pedestrian-, cyclist- or driver mode) will increase the acceptance of the user due to simplicity of the app use. In addition, path prediction (forecast of future movement based on current and past motion data) will enable more smooth and improved collision detection due to knowledge of future path.

JOYNEXT is a Tier1 supplier in the automotive industry and has been a development partner and system supplier to very well-known car manufacturers for over 20 years. Our Connected Infotainment and Connectivity Gateway technologies are on the road millions of times worldwide.

With more than 1,500 employees worldwide, JOYNEXT takes connected vehicles to a new level. We are represented at 7 locations with 4 R&D centers in China and Germany. Dresden is the European headquarter of JOYNEXT, with about 600 employees, most of them engineers and developers, who drive innovation and development of new products and services for our worldwide customers. “

## CONTACT US

For any suggestions or question, please scan the following QR code to contact us.



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