V2X-Locate
Location is Everything in V2X
Whitepaper

November, 2020

Introduction

V2X systems will prevent injuries, save lives, and reduce congestion.   Cities all over the world are deploying the V2X infrastructure that will interact with similar in-vehicle technology to connect vehicles to each other, forming a cooperative and intelligent transport 'system.'

Accurate vehicle positioning is critical to the effective delivery of V2X technology. Without highly accurate vehicle positioning, V2X technology will not deliver the results expected of it in all road user scenarios for reasons described in more detail below.   Consequences include, but are not limited, to:
   1) Actual collision warnings will not be delivered which could lead to injury or even loss of life.
   2) Vehicles will issue false collision and other inappropriate warnings. A vehicle that thinks it is travelling down a sidewalk as opposed to in its lane, will deliver an endless series of false warnings as it tries to warn the driver that is about to collide with parked vehicles.

Accurate vehicle positioning is important for the safe and reliable operation of V2X systems ALL of the time, not just most of the time.

The relevance of accurate vehicle positioning

V2X systems traditionally use Global Navigation Satellite System (GNSS) technology to determine vehicle position. While GNSS technology, supplemented with Real Time Kinematic (RTK) corrections, can deliver the required accuracy on open roads, it simply doesn't work well in the 'urban canyons' of cities. The multipath reflections present in these city environments with tall buildings dramatically reduces the accuracy of GNSS technology, and even RTK corrections cannot help. The same is true for dead reckoning, which also does not solve the problem in urban canyons. Furthermore, GNSS doesn't work at all in tunnels or underground parking.

This means that a cooperative intelligent transport system will work best when vehicles are in open sky environments, such as highways, but will not be as accurate in city environments, leading to missed or false alarms. Other than the obvious safety risks, the repercussions of introducing a technology that does not have the expected performance all of the time is counterproductive to efforts to secure buy-in from governments, road transport authorities and even consumers.

The automotive industry needs a V2X solution that it can market to consumers with confidence. The technology must work no matter where the vehicle is in use.

Are industry standards being met?

The requirement of accurate vehicle positioning is quantified in several standards globally. For example, SAE International specifies a 1.5m requirement must be met 68% of the time [1]. However, in many important use cases, GNSS, even assisted by dead-reckoning sensors and RTK corrections, fails to provide a reliable position. Typically GNSS positioning performance degrades in areas such as
•   Urban canyons
•   Tunnels
•   Parking garages
•   Any other compromised sky view environment – even a tree-lined street.

A state-of-the-art automotive grade dead reckoned GNSS positioning system with RTK corrections, driven in a straight line, within the urban canyon environment of downtown Manhattan in New York City is shown in Figure 1. Such failures result in unpredictability and uncertainty of a vehicles position, leading to potentially erroneous decision making and unsafe manoeuvres, effectively compromising the efficacy of a cooperative intelligent transport system.
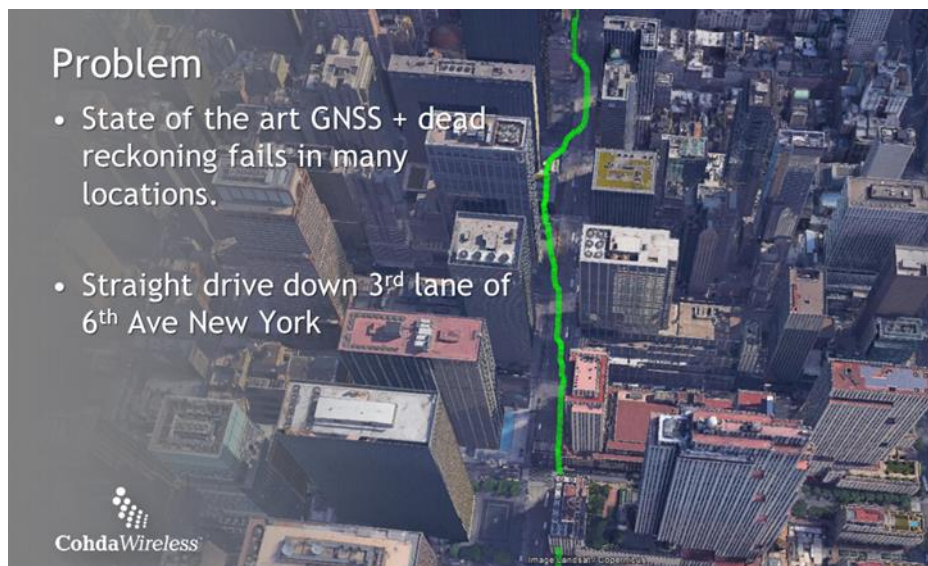

Figure 1: PROBLEM WITH STATE OF THE ART DEAD RECKONING GNSS

Cohda's V2X-Locate solution solves this issue.   V2X-Locate makes it possible for a connected intelligent transport system to work in ALL road transport environments, not just where GNSS technology works.

V2X-Locate – The solution

Cohda's breakthrough positioning software achieves:
- ✓ Sub-metre positioning accuracy:
  - o 95% of the time everywhere (indoors, outdoors, underground),
  - o In real time.
It is the only positioning system able to meet the location accuracy requirements.

By using DSRC or C-V2X signals and Cohda's enhanced signal processing and positioning algorithms, Cohda has developed a product to provide accurate vehicle position irrespective of GNSS availability and/or quality.

With V2X, vehicles communicate with other devices (vehicles, infrastructure, pedestrians, etc) using wireless communication systems such as Dedicated Short Range Communication (DSRC) or cellular (C-V2X) communication.   In V2X deployments, vehicles are equipped with On-Board Units (OBU), while infrastructure is supported by installation of Road-Side Units (RSU) at fixed locations. Thus, the location of these RSUs is well known to any vehicle which is within communication range.

A connected vehicle with V2X-Locate uses ranging measurements to these fixed RSUs to enable enhanced positioning accuracy, even in complex environments, as demonstrated in Figure 2. Note that Cohda's V2X-Locate is a software solution and does not require the modification of existing RSUs.
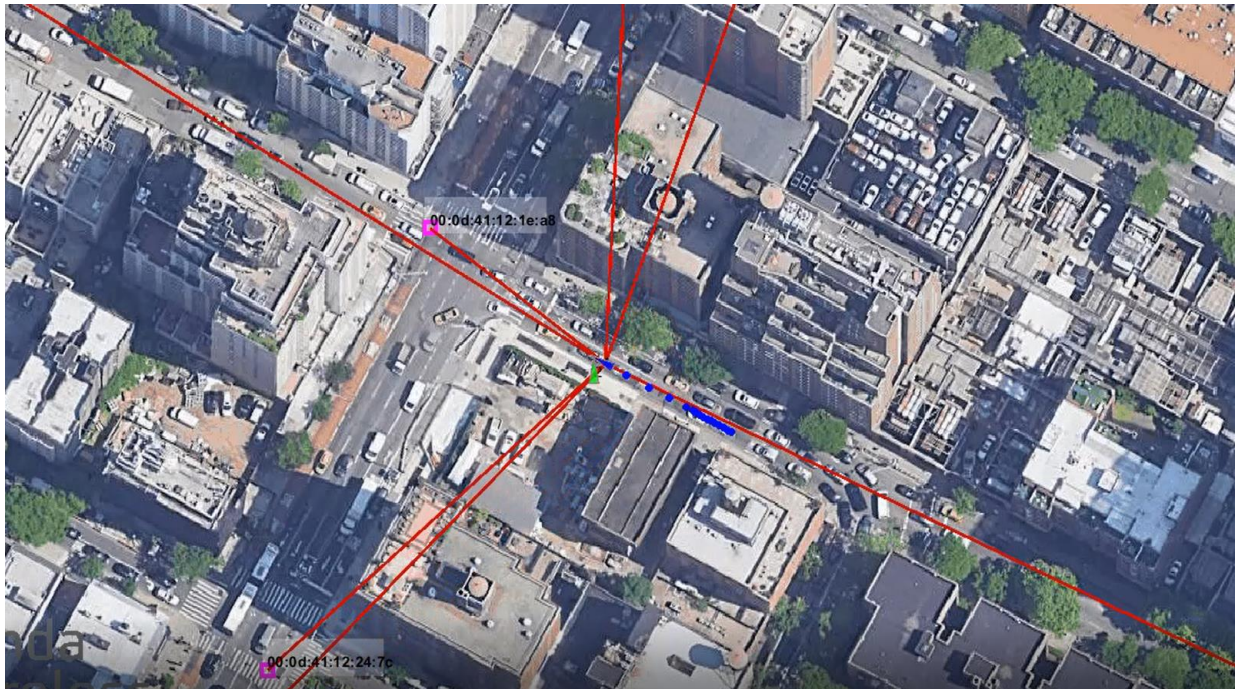

Figure 2: HOW V2X-LOCATE WORKS

The vehicle shown accurately determines ranges to the infrastructure RSUs as illustrated by the example pink squares and red lines. Through advanced signal processing, the V2X-Locate solution is able to correctly identify the correct range between OBU & RSU, regardless of the existence of multipath signals. These ranges from spatially separated RSUs are fed into Cohda's enhanced positioning engine to accurately position the vehicle, and at the same time V2X-Locate performs sensor fusion with GNSS and Dead Reckoning for the best location estimate possible. Figure 2 in action.

V2X-Locate is additional software that provides information at the facilities layer of the software stack of the OBU. It is hardware-agnostic and works with all radio chips.

The performance of V2X-Locate compared with a state-of-the-art automotive grade GNSS module in urban canyon is shown in Figure 3 below:
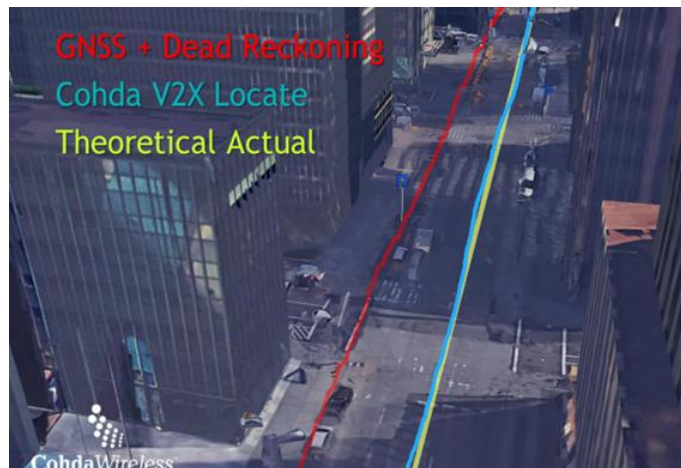
Figure 3: V2X-LOCATE VS. GNSS & RTK IN NEW YORK 6TH AVE.

It is clear from this illustration that the driver of the vehicle reliant on GNSS and RTK corrections-only positioning would receive a range of incorrect warnings about vehicles having stopped in the lane ahead when they are in fact vehicles parked at the side of the road. Similarly, the driver would not be made aware of actual hazards and dangers unfolding in the lane the car is travelling in.

Similarly, these videos demonstrate the accuracy of Cohda's V2X Location solution in the environment of tunnels and underground car-park scenarios in comparison to GNSS.

Implementing V2X-Locate – the only solution able to meet current accuracy requirements

V2X is a game-changing technology which will revolutionise the road transport system but it must be able to perform reliably and to a high standard at all times.

V2X-Locate allows V2X solutions to work effectively and consistently in all driving environments, from open road freeways to suburban corridors, tree-lined streets and on the streets of cities and towns where there are buildings, tunnels and underground car parks.

OEMs can deploy V2X-Locate technology simply and cost effectively as it is available as part of Cohda's V2X Facilities Layer Software and does not require any additional hardware

The V2X-Locate solution is not intended to replace GNSS solutions, but instead complements and integrates this technology through the sensor fusion of GNSS, Dead Reckoning and RTK thereby creating a solution that not only operates in ideal GNSS environments, but also in GNSS challenged environments to enable a reliable cooperative, intelligent transport system solution.