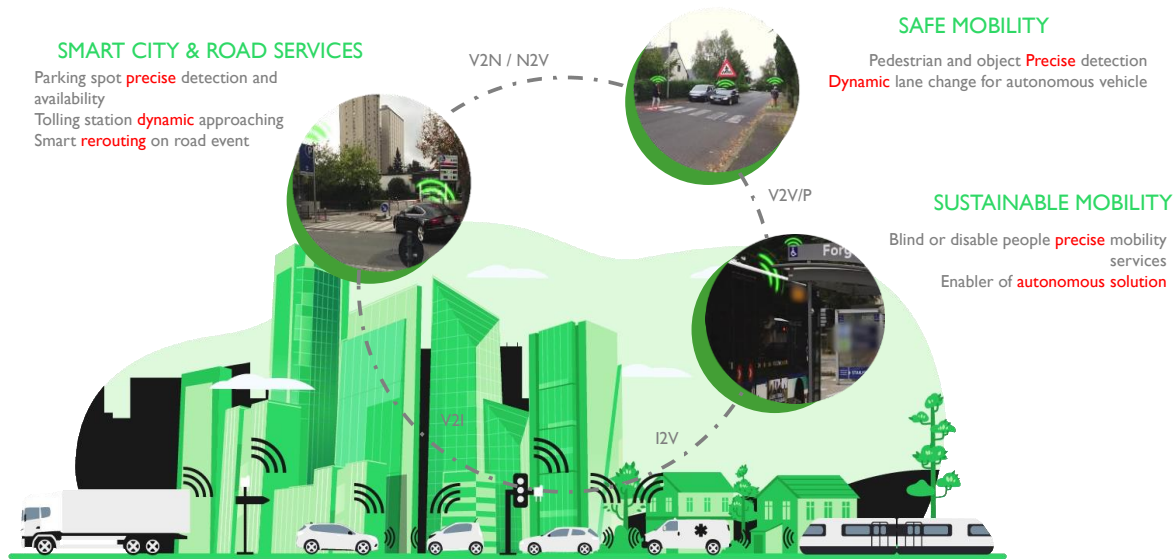


Geoflex & YoGoKo White Paper

How V2X combined with High Accuracy GNSS can set expectations for localized services ?



Old school GPS

Over the last two decades GPS has gradually become a de facto piece of equipment for cars. “Satnav” is nowadays present in every car, from high end down to entry-level vehicles.

Since the early days of GPS, the lack of accuracy has been masked by map matching strategy that is keeping the car position stitched to the road defined on the satnav map while in reality the position computed from the GNSS chipset is jumping all around, with errors of few meters and sometimes much more, left and right of the road.



In this example, the ground truth is in green, and clearly the GPS in red is drifting a few meter away and appears in the wrong lane.

From the automotive engineers perspective, who have easily noticed since a long time the limitations of standard GNSS (including GPS constellation as well as GLONASS, Beidou and Galileo), GNSS data as a precise source of localization are not efficient in favor of the bells and whistles brought by Computer Vision and Lidar.

The revolution of Precise Point Positioning (PPP)

Born in 2012, Geoflex has embraced the market opportunity offered by the multiplication of GNSS constellations and multiple frequencies and the well understanding of GNSS root cause of errors to offer a cutting-edge cloud-based GNSS augmentation service.

Using a technology known as Precise Point Positioning (PPP), initially developed by the French space agency (CNES), Geoflex offers an accuracy which goes down to 2 cm horizontally with 68% confidence level in open sky conditions and a truly worldwide coverage. This means about 100 times more accurate than a standard GNSS device (3-10 meters errors). In more typical mix-urban situation where buildings can mask partially the satellites, the Geoflex PPP performance for a multi-frequency GNSS is about 30cm in horizontal plan with 68% confidence level, and 65 cm with 90% confidence.

To support continued positioning in environments without satellite view, such as tunnels, the position can be further improved with sensor fusion (for example using sensors IMU and/or optical/wheel odometry etc.). In addition, a global analysis of GNSS-PPP with tight hybridization based on a global fault tree and FMCA (Failure Mode and Effect Critical Analysis) analysis paves the way for a safety architecture initially developed by Geoflex to meet the stringent requirements of the railway industry fully compliant with the automotive market expectations.

Geoflex's centimetric accuracy, robustness and safety opens up a wealth of automotive applications, as well as a wide number of location-based services. This white paper will look at the benefits of high accuracy GNSS technology combined with V2X applications.

The V2X technology

Vehicle-to-everything (V2X) refers to a communication channel between a vehicle and any entity that may affect, or may be affected by, the vehicle. V2X technologies can be split in more specific types of communication as V2I (vehicle-to-infrastructure), V2N (vehicle-to-network), V2V (vehicle-to-vehicle), V2P (vehicle-to-pedestrian).

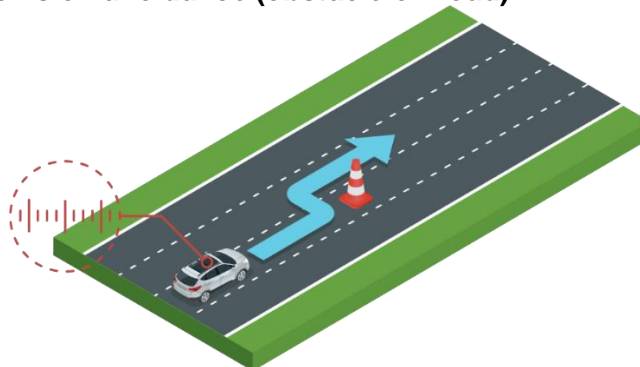
The main motivations for V2X are road safety, traffic efficiency, energy savings, and mass surveillance. The U.S. NHTSA estimates a minimum of 13% reduction in traffic accidents if a V2V system were implemented, resulting in 439,000 fewer crashes per year.

V2X adoption started in 2010 with the adoption of DSRC (Dedicated Short Range Communication) by a few car manufacturers. Today with ubiquity of connected cars, there is an acceleration of the integration of V2X into car manufacturer roadmaps. There are two types of V2X communication technologies depending on the underlying technology being used: WLAN-based or cellular-based (5G offer low latency especially useful of V2X scenarios). V2X fuels new Advanced Driver Assistance scenarios. By using direct and indirect communication between road users and connected infrastructure, V2X solutions will enhance the vehicle digital perception of the world.

As part of standard C-ITS (Cooperative Intelligent Transportation System) messages Cooperative Awareness Message (CAM) supports localization of road users. Positioning is then paramount to trust V2X communication. The advent of V2X protocol provides multiple services from road safety to user services with a common protocol able to bridge communication across different car brands. A CAM message is triggered every hundred milliseconds to address those services and provide "position as a service" for the digital economy of tomorrow. Furthermore, given the high confidence level on the position accuracy, the position can be certified. This is key for safety applications.

Which new use cases can be solved with high precision GNSS and V2X?

Hazard detection and collision avoidance (obstacle on road)



Hazard detection sent to infrastructure and other vehicles

Since 2014, a high number of car sensors have been introduced to support road safety. However, when an obstacle cannot be detected due to a hidden scene or a complex intersection, over the air

communication supported by V2X will share the precise localization of the obstacle. Precise positioning is key!

The association between YoGoKo V2X and Geoflex precise positioning answer new use cases to reduce road fatalities. With several field test in 2022, those technologies have been validated and the need of accurate position of users has been confirmed. During those tests, different level of alert was provided to the driver and to the vulnerable to avoid collision.

Awareness: alert given to user allowing anticipation of risky events. Alert sent between 2 and 4 second before the event.

Warning: alert given to user allowing direct action from the driver to avoid the accident. Alert sent at 1.8 second latest.

Collision avoidance: information given to the vehicle to react automatically on risk of collision with a defined obstacle.



Collision avoidance alert concerning pedestrian sent via V2I and V2V communication.

Improved localization for e-call service

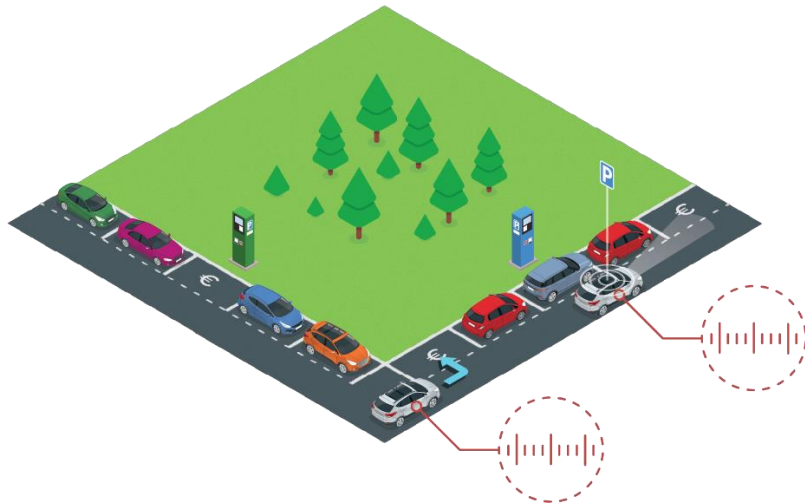
There has been a mandate in Europe for all vehicles sold after since March 31th 2018 to have a mandatory e-call service for all cars sold on the continent. This new regulation is expected to save more than 12.000 lives per year due to road casualties. This e-call service connects a user to a PSAP (Public Safety Answering Point) and in parallel send a set of data coming from the car (called MSD), where we find latitude and longitude coordinates. The eCall PSAP shall have access to an appropriate Geographical Information System (GIS) or an equivalent system allowing the eCall PSAP operator to identify the position and heading of the vehicle with a minimum degree of accuracy as defined the MSD coordinates.

Well, today that “minimum degree of accuracy” is given usually by mono-frequency GNSS receiver with no corrections, which could lead to errors up to 15 m. Building eCall on top of a high accuracy GNSS service such as Geoflex PPP will bring down the error to less than 1 m, which is sometime necessary to tell the right side of the highway or which side of a canyon and save time with more efficient guidance for the rescue crew.

Parking spot detection

Vehicles have become connected sensors on wheels, and the opportunity to use large car fleets to collect data is being fulfilled. Within the reality of car data, location data has a significant role to play as an enabler: “Where” is often as important as “what”.

Metric and sub metric accuracy will open up completely new opportunities, some of which go beyond the automotive industry, serving markets such as smart city, utilities, etc. Cars will become the ground sensor enabling digital twins of the real world. A few examples are: detection of empty parking spot on the street, detection also of pot holes and redirected immediately to local road authorities, etc..

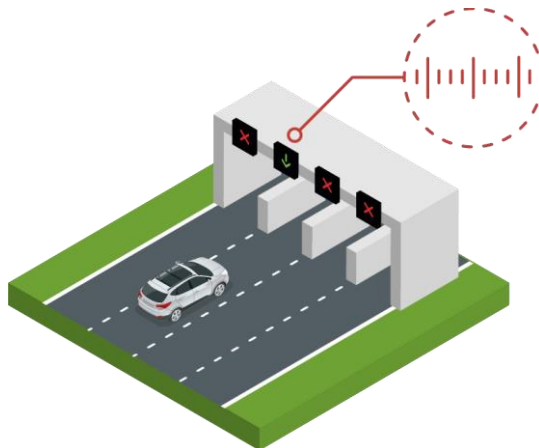


Parking spot detection and parking payment with a certified position

Better management of road infrastructure

For a better management of the road with possible congestion there is an interest to get a digital twin of the road network and a data channel to address road users. With a V2X channel connecting cars to toll gates, you can use current position of each car connected to the infrastructure to send messages to help to manage load balance.

For instance, a toll gate can in advance depending of possible car profiles (car pool, digital payment...) send a gate recommendation which follows a rule for optimizing load balance across the gates available.



Toll gate V2X flow for gate guidance

Conclusions

In the automotive industry, until recently, GNSS has been considered essentially as an enabler for turn-by-turn navigation. Geoflex and YoGoKo believe is that soon enough, GNSS-PPP and V2X will open new use cases for location-based services, and make “position as a service” a critical technological brick for future services encompassing smart cities, digital life of the road users... Indeed tomorrow with the stake of digital economy, connected cities with multiples mobile objects, the technology will position precisely one against the others: pedestrian, cyclist, delivery robots, cars, trucks ... Their positioning accuracy needs to be fine grained to be “future proof” to new use cases.

There is a high potential of services that can leverage on that extra communication mean and position accuracy for safety purposes, better management of the digital flow of vehicles and further cars data monetization schemes.