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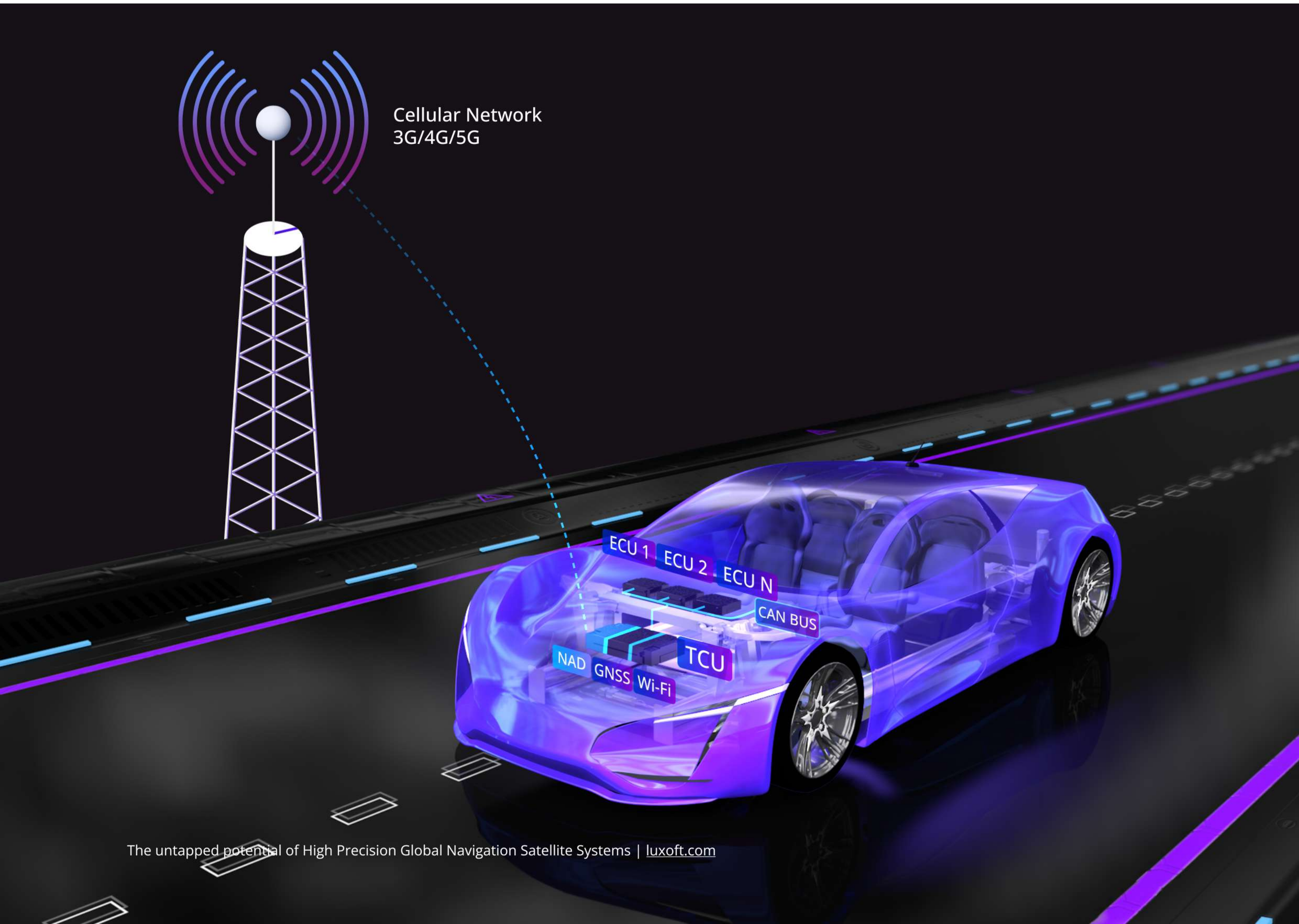
The untapped potential of **High Precision Global Navigation Satellite Systems**

The accuracy of High Precision Global Navigation Satellite Systems (HP-GNSS) mean they could be used to great effect in autonomous driving. These systems are already available, so let's take a look at how they work, how they're used and their further potential use cases.

The modules of Telematics Control Units

Telematics Control Units (TCU) are on-board key units used in the automotive industry to achieve connected mobility of the vehicle. The main purpose of the TCU is to connect vehicles to the outside world using different wireless technologies like cellular, V2X, satellite, Wi-Fi, e-call etc. Depending on the use case of the vehicle, the TCU collects data using its own wireless modules (like cellular modem, Bluetooth, Wi-Fi, etc.) or from other units (ECUs like odometer or airbag sensors) in the vehicle. One of the key modules of a TCU is the Global Navigation Satellite System (GNSS) — this is used for satellite navigation in the vehicle.



What is GNSS?

GNSS refers to a classification or grouping of different types of satellites which provides timing and positioning data to GNSS receivers.

You might have heard of Global Positioning Systems (GPS), which sometimes people use interchangeably for GNSS. However, this is only one of the groups of satellites used by the GNSS system. Different GNSS systems are used in different locations — examples include the USA's GPS, Russia's GLONASS, Europe's Galileo and China's BeiDou.

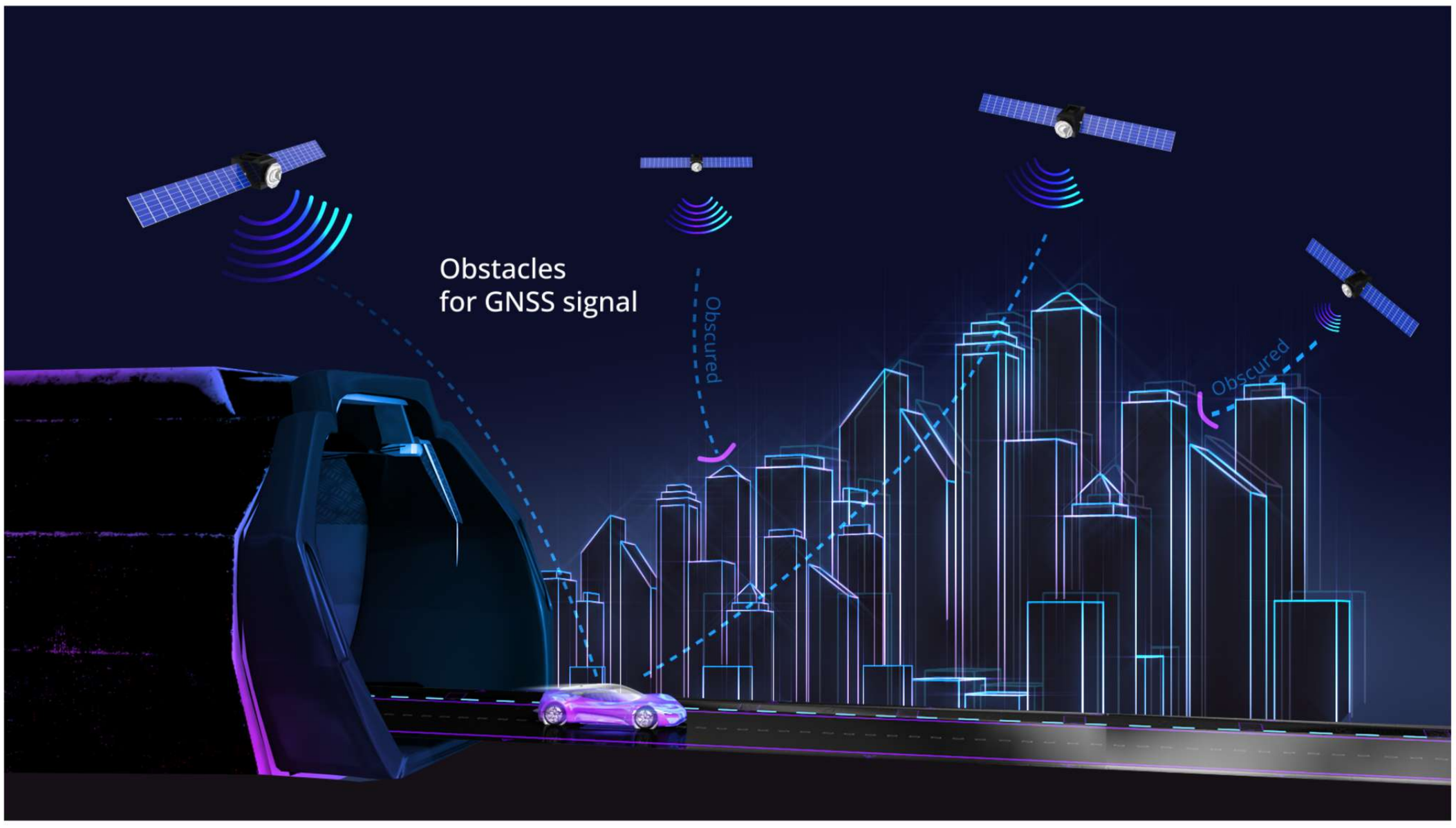
Major groups of satellites for GNSS: GPS, GLONASS, GALILEO, BeiDou

How is GNSS used in automotive?

In the automotive industry, GNSS is commonly used for two main purposes in passenger vehicles; in-vehicle navigation (usually called sat-nav) and location services for emergency calls. It's also used for fleet management systems and tracking stolen vehicles, moreover there's a trend of several new use cases for GNSS in automotive. However, as you might have seen, from time-to-time GNSS signals are lost when the vehicle is in a dense area or a tunnel.

A note on dead reckoning

Similarly, you may have also noticed that in some cases your navigation system shows you almost the correct location even if you are in a tunnel. This is because you have dead reckoning capability in your vehicle. This technique leverages sensor data via Inertial Measurement Units (IMU) to provide location tracking. Dead reckoning implementations could be very complicated and are a topic for a separate blog post.



GNSS vs HP GNSS

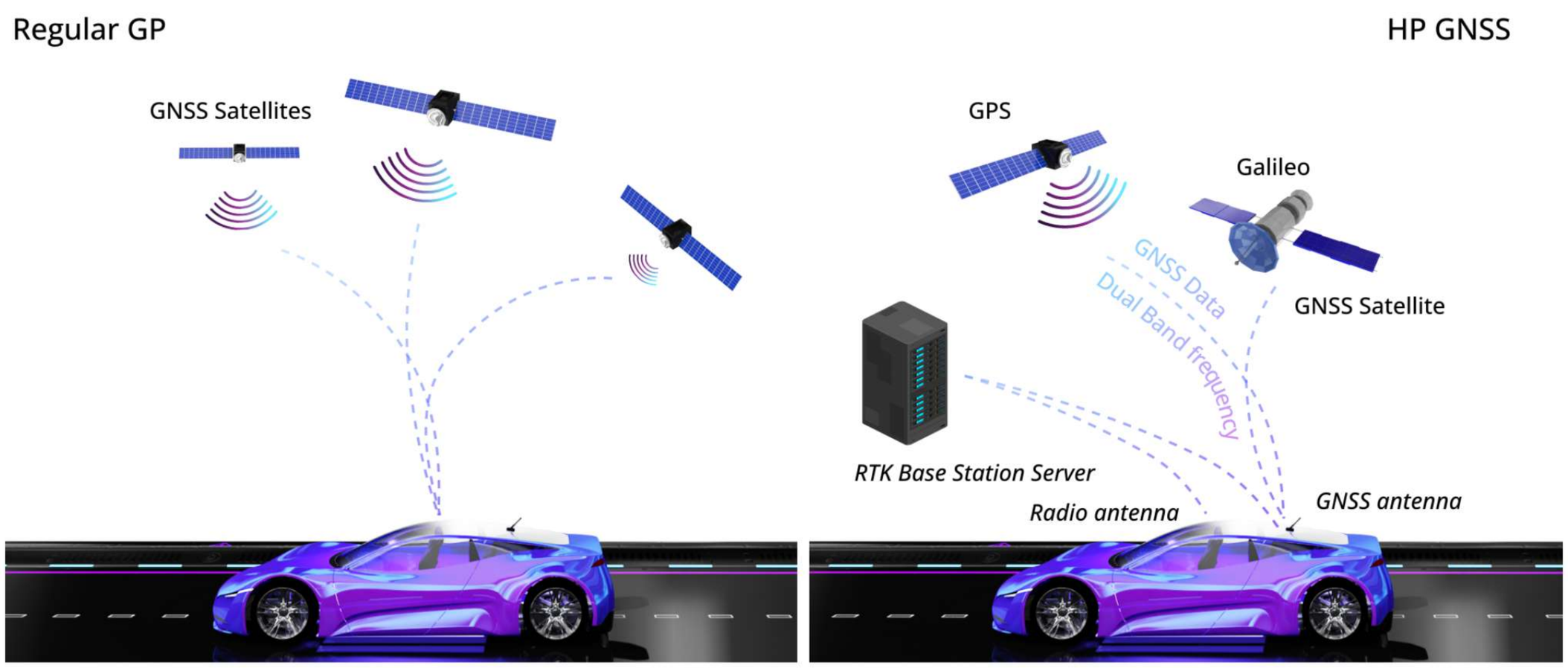
If we can use techniques like dead reckoning to get data from sensors, then why is the position provided by GNSS sometimes far from the actual location? This is caused by a number of factors including the atmosphere (the ionosphere and troposphere can delay or distort the signal) and multipath errors (signal interference in dense areas when a signal is reflected by building, trees, mountains etc.). As mentioned earlier, traditionally GNSS has been used in the automotive industry for navigation and positioning purposes for different applications like E-call, stolen vehicle tracking etc. — a big reason for this is the accuracy and precision provided by traditional GNSS (≈ 2-10 meters).

In comparison, HP-GNSS could provide up to decimeter or centimeter level accuracy and improve the reliability of the data.

This is achieved by:

- Mitigating errors using different correction techniques (e.g., Real-Time Kinematic (RTK) algorithm)
- Accepting signals from multiple GNSS systems in conjunction with regional satellite systems
- Using dual frequency of GNSS

This improves the signal strength and the availability of signals, and provides redundancy. Due to the upcoming uses cases related to precise location, the 3rd Generation Partnership Project (3GPP) has also integrated position integrity services in its release. This means that in the future we'll be able to take advantage of 5G positioning services for HP-GNSS to improve reliability and correctness.



Comparing traditional GNSS with HP-GNSS

HP-GNSS potential

HP-GNSS opens many possibilities in every industry, by providing better and precise locations and leniency to errors. For example, delivering packages using drones is hard in metropolitan areas, but when using HP-GNSS, the possibility of delivering to exact locations would be improved. The same is true for the agriculture and robotics industries, where HP-GNSS can help improve the user experience as well as improve overall industry use cases.

HP-GNSS in automotive applications

Using the HP-GNSS in a vehicle can enhance the user experience of navigation by providing the precise location on a map. Other location-based services can also be improved using this technology, some examples include:

- E-call
- Assistance in case of vehicle break down
- Improved car sharing
- Stolen Vehicle Systems
- Real-time info of a fleet
- Real-time parking
- V2X applications (road works, emergency vehicles, platooning etc.)
- New map creation

HP-GNSS usage in autonomous driving

The biggest potential application of HP-GNSS in automotive concerns autonomous driving. In the automotive industry, most OEMs have achieved level 2 capability for autonomous driving, yet due to functional safety regulations, it’s a challenge to progress further. Usually, the position of the vehicle is achieved in advanced driver assistance systems (ADAS) using radars, Lidar, cameras and other sensors. However, these technologies and sensors are limited by challenging weather and light conditions, and cannot give precise information in such environments.

HP-GNSS can help overcome some of the problems related to precise location and environmental issues — it has an advantage over the traditional ADAS sensors and is not limited by adverse weather conditions so can give a precise location in such environments.

Achieving a high level

By combining the HP-GNSS with other ADAS techniques, a high level of automated driving capability can be achieved. For example, the lane level navigation (when a navigator application suggests an exact lane to drive in) has the pre-requite of exact positioning of the vehicle — this can be achieved using HP-GNSS. Combining the precise location from HP-GNSS with other supportive sensors from ADAS will improve the user experience and add redundancy for achieving the high standard of safety regulations.

Similarly, this fusion of HP-GNSS and other technologies can help improve all other ADAS functionalities like collision detection or avoidance, Intelligent Speed Assistance, lane change etc. where the need for a precise location of the vehicle is a must for performing operations. With the help of HP-GNSS, ADAS technology and high-definition maps, autonomy will not be limited to any specific condition. At Luxoft we have over 20 years' experience in the automotive industry, with leading experts on both locations-based services using HP-GNSS and ADAS technology. We can help automakers capitalize on the possibilities that HP-GNSS offers and further develop ADAS capabilities. In the future, it will be possible to achieve a high level of automation even in the worst conditions thanks to the precise and exact location services provided by HP-GNSS.

If you'd like to know more about how to benefit from the latest technologies in the telematics domain like HP-GNSS, reach out to one of our experts for a consultation or read more about how we could benefit you here.

Note: Differential GPS is out of scope

GNSS - Global Navigation Satellite System

HP-GNSS - High Precision GNSS

TCU – telematics control unit

V2X – vehicle-to-everything

eCall, e-call – emergency call

IMU - Inertial Measurement Units

ECU – electronic control unit

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Roohul is a solution architect in the telematics domain at Luxoft.
He has expertise in designing complex and secure software systems for automotive industry, mainly in the area of telematics.
In his role as solution architect, he is involved in providing solutions for future telematics products as well as acting as technical advisor to customers.

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Kirill leads the automotive telematics domain as part of Connected Mobility Solutions in Luxoft. His daily duties are to support pre-sales activities, oversee and direct engineering projects, and he works in developing partnership in the telematics space. Kirill has a diverse background in the IT industry — from high load distributed back-end systems to modern web and mobile applications, and in-vehicle embedded development.

About Luxoft

Luxoft, a DXC Technology Company delivers digital advantage for software-defined organizations, leveraging domain knowledge and software engineering capabilities. We use our industry-specific expertise and extensive partnership network to engineer innovative products and services that generate value and shape the future of industries.

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