



Where Are You on Precise Positioning?

How GNSS is Helping Drive Automotive Autonomy

Quick question. When it comes to your autonomous vehicles, would you rather they could:

- Sense where they are?
- See where they are?
- Know where they are?

When lives and livelihoods are on the line, the answer is all of the above. Absolute positioning augments sensors and cameras with Earth-fixed data, enabling an “all in” approach to precise positioning. This adds valuable intelligence and precision to your sensor fusion array along with a host of other operational and business advantages.

Vehicles know
where they and
other vehicles
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Taking Redundancy to the Next Degree

The most effective and safe road to autonomy is built on a multimodal, sensor-rich approach. Delivering the advantages of GNSS (global navigation satellite system, which includes GPS), precise positioning is the only sensory method to provide absolute position, velocity and time.

Integrating absolute positioning with existing sensory technologies (lidar, cameras, and already-mapped data) equips autonomous vehicles with preexisting information,

real-time observations and known positioning. This comprehensive sensor array goes a long way toward providing the ubiquity, precision, reliability and integrity monitoring required to enable true autonomy. And the redundancy of radar, cameras, LIDAR, wheel odometry and absolute positioning ensures there are no single points of failure, empowering safe, uninterrupted autonomous operation.



A Priori Is a Priority

Albert Einstein said you can't use an old map to explore a new world. When it comes to autonomous vehicle operation, even the newest and best maps aren't very effective if vehicles don't know their own precise location within them. Think: a mall map minus the "you are here" arrow.

Using the World Geodetic System 1984 (WGS 84) — a three-dimensional coordinate reference frame for establishing latitude, longitude and altitude — absolute positioning delivers a real-time layer of centimeter-level accuracy. This bolsters localization accuracy and decreases the frequency at which high-definition maps need to be updated.

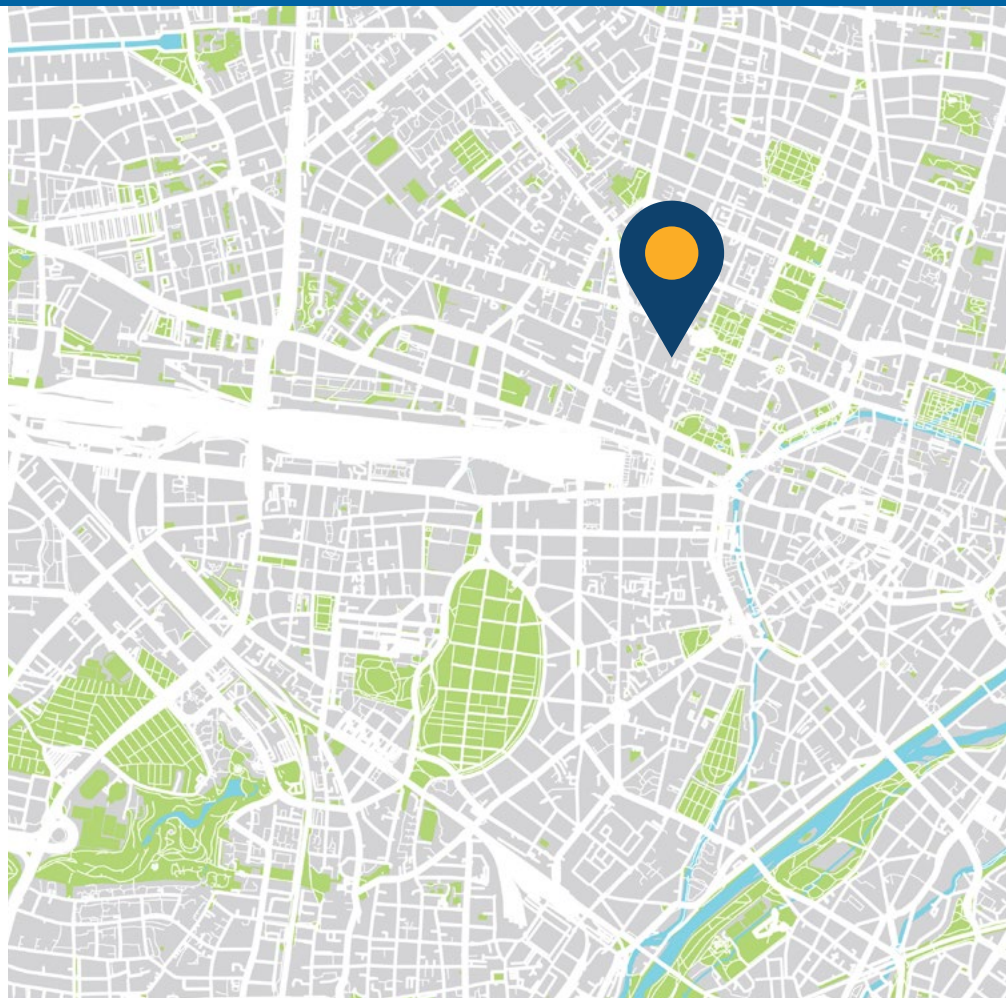
Now autonomous vehicles anywhere can use a common frame of reference with precision maps and other vehicles. In other words, vehicles know where they and other vehicles are at all times.

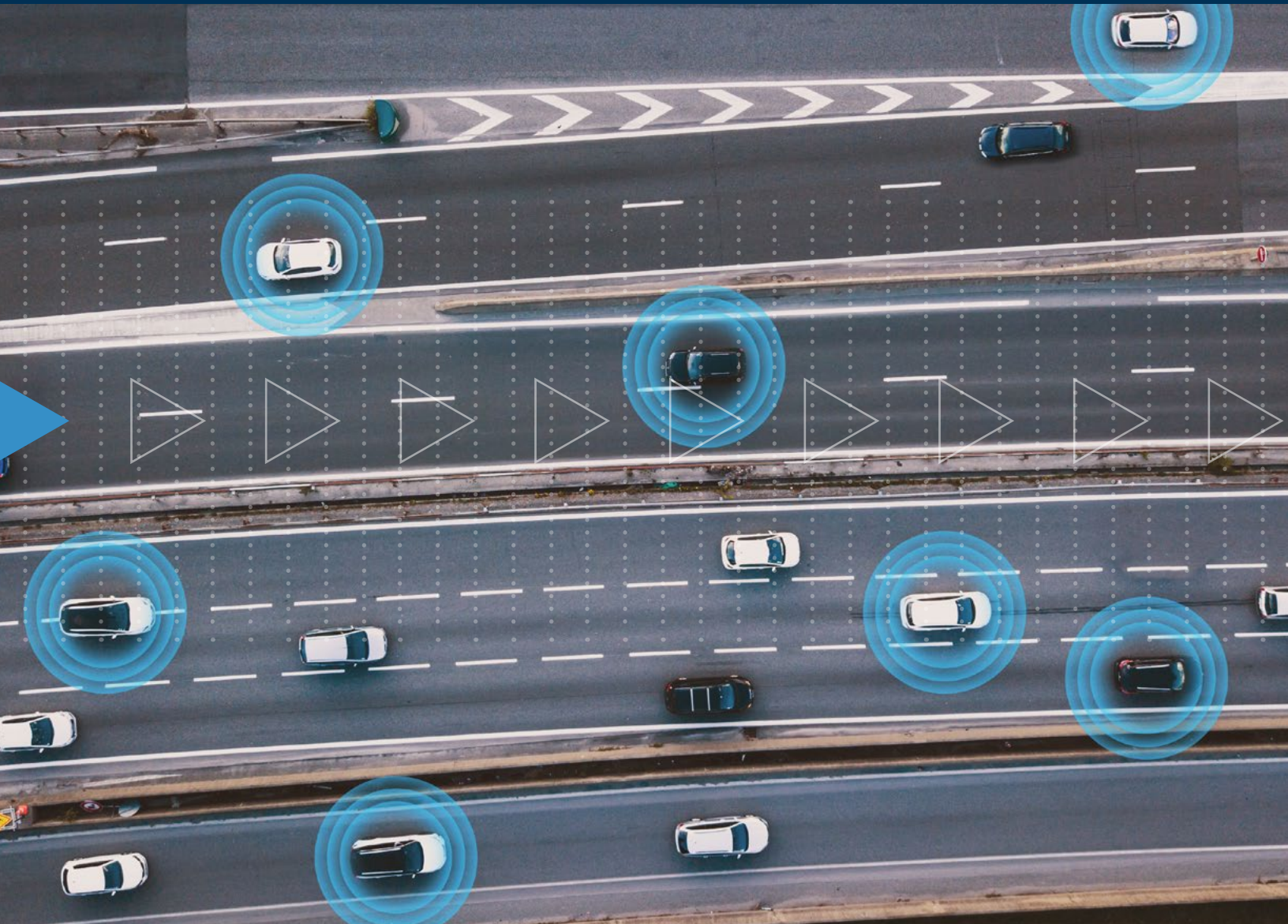
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Higher Accuracy

Are you on an on-ramp or the surface street below? You don't need to be an Einstein to understand that the answer to this question is critical to reliable and safe autonomous vehicle operation.

In addition to latitude, longitude, velocity and time, precise positioning provides spatial data. This data-rich localization enables vehicle systems to know exactly where they are on — or above — the Earth's surface. This elevated information alone makes merging absolute positioning's centimeter-level, 3D accuracy into your autonomy sensor suite a smart idea.





Data Confidimus

Absolute positioning greatly improves redundancy, meaning the data the positioning system provides can be trusted. Added to that, protection levels guarantee that the estimate of errors is always within very specific parameters (as low as one error in 100s of millions of signals).

The higher the integrity and protection levels, the safer and more effective autonomous vehicle operation. When data feeds can be trusted to such a high degree, autonomy systems such as ADAS (advanced driver-assistance systems) have the confidence in position and velocity to operate at peak capacity.



Convergence. Corrections. Continuance.

The fact that satellites hundreds of kilometers above the Earth's surface provide pinpoint location accuracy is out of this world. But it's also understandable that signal transmission can run into unavoidable problems, which makes it essential to monitor and correct signal integrity before and after broadcast.

Just as autonomy is evolving, so too is the thinking about the best ways to optimize GNSS corrections (the time from first observation of the satellite signal to position reporting), particularly in suboptimal conditions. On their own, real-time kinematics (RTK) and regional VRS networks are limited in their ability to provide extended coverage across vast geographies.

In response, Trimble Autonomy has developed Trimble RTX, a precise-point positioning solution that uses a single, global network for worldwide centimeter-level positioning. This family of real-time GNSS positioning services available via IP/cellular or satellite delivery worldwide:

- Delivers real-time, sub-lane level accuracy
- Relies on a single global network
- Enables precise positioning for dynamic applications like auto, without the constraints of a local base station or base station network
- Offers pre- and post-broadcast integrity monitoring of data streams
- Works with inertial technology to maintain continuous positioning and orientation despite interference and obstructions

The Overhang Hangover

Legacy thinking was that satellite-based positioning wasn't fully reliable, so it was relegated to a secondary system. Yes, tree lines, tunnels, bridges and urban environments, which can interrupt satellite signals, will always exist, meaning distorted or disabled satellite connectivity will too.

But modern-day vehicle sensors and inertial/dead-reckoning systems help mitigate these issues when satellite signals are interrupted. Now there is virtually always reliable data to fill in the gaps, so autonomy can remain safely functional regardless of environmental obstacles.

With modern advancements in absolute-positioning systems and sensor-suite redundancy, the sky's the limit — even when the sky's obscured.

Decreasing Costs. Increasing Value.

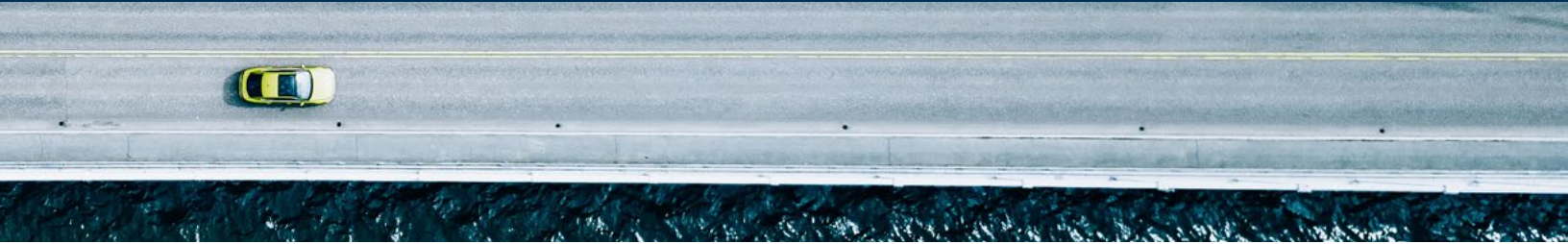
Inevitably, all roads lead to the bottom line. Historically, precise positioning was cost prohibitive, particularly for automotive applications. But times and price points have changed. Precise positioning solutions are now more affordable and add significant incremental value to any ADAS or autonomy system, both in performance and reliability.

First off, the price of GNSS receivers is rapidly decreasing. They and associated correction services are a fraction of the cost of other ADAS sensors, making GNSS sensors the most affordable in an autonomous vehicle.

But the real savings comes in redundancy. (Sensing a theme yet?) Adding absolute, precise positioning to an ADAS to augment visual sensor systems is a relatively inexpensive addition, while positioning modules and equipment have also dropped in price over time. This sensor suite works as a cohesive system, providing a layered approach that ensures reliable, safe autonomous navigation with more cost-effectiveness.

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Integrity is Integral

When vetting autonomy partners and absolute positioning systems, it's critical they check certain boxes.

The best absolute positioning systems have built-in integrity monitoring and are ASIL certified and ASPICE compliant. These features and assurances ensure that your system performs and is rated to the industry's highest standards.

It's also wise to carefully evaluate potential partners. Make sure the company you choose to work with has extensive, applied experience in your industry. Also look for a partner that delivers a full-spectrum offering, sparing you from having to piecemeal together varied solutions. Lastly, look for a company committed working with you as a true consultative partner, so you both grow, learn and improve together.

Explore the Ins and Outs of All-In Positioning

Visit autonomy.trimble.com to discover how Trimble Autonomy can help you achieve greater positioning accuracy and redundancy with industry-leading absolute positioning expertise and solutions.

