xona space systems

Satellite Navigation from Low Earth Orbit

April 15, 2024

Bryan Chan
Co-founder, VP Corporate Strategy
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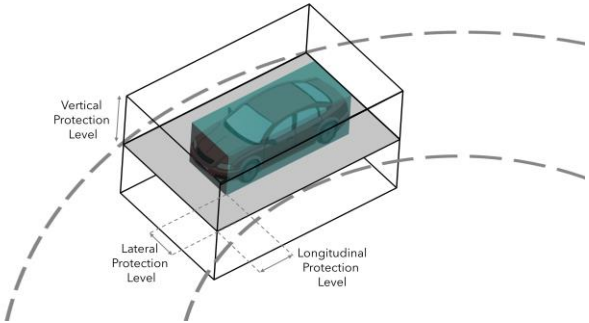
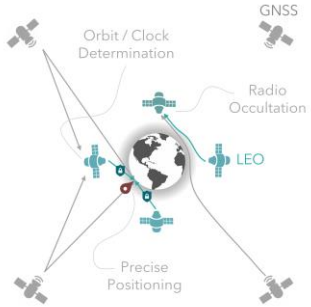
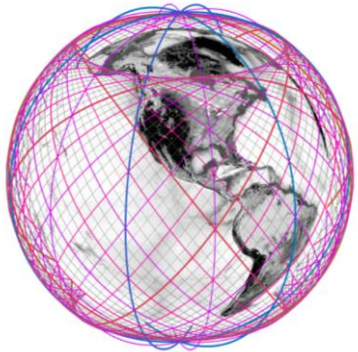
PNT Needs and Motivations



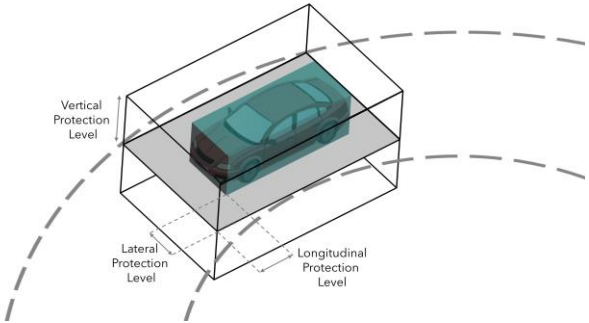
LEO PNT Sat Nav Approach



Xona PULSAR & Partner Ecosystem



PNT Needs and Motivations



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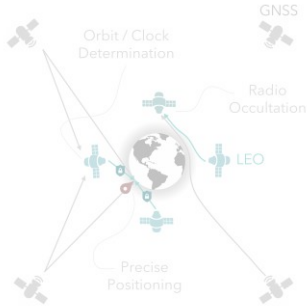
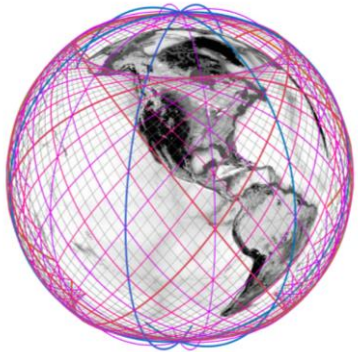


Xona PULSAR & Partner Ecosystem

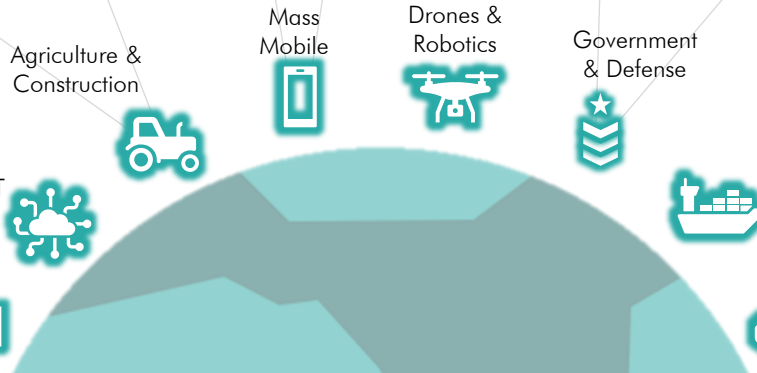


PROBLEM:
Technology is demanding more accurate & reliable location.

GNSS drop-outs around trees plague precision agriculture.

66% of apps rely on GNSS data that is inaccurate, unreliable, or not available.

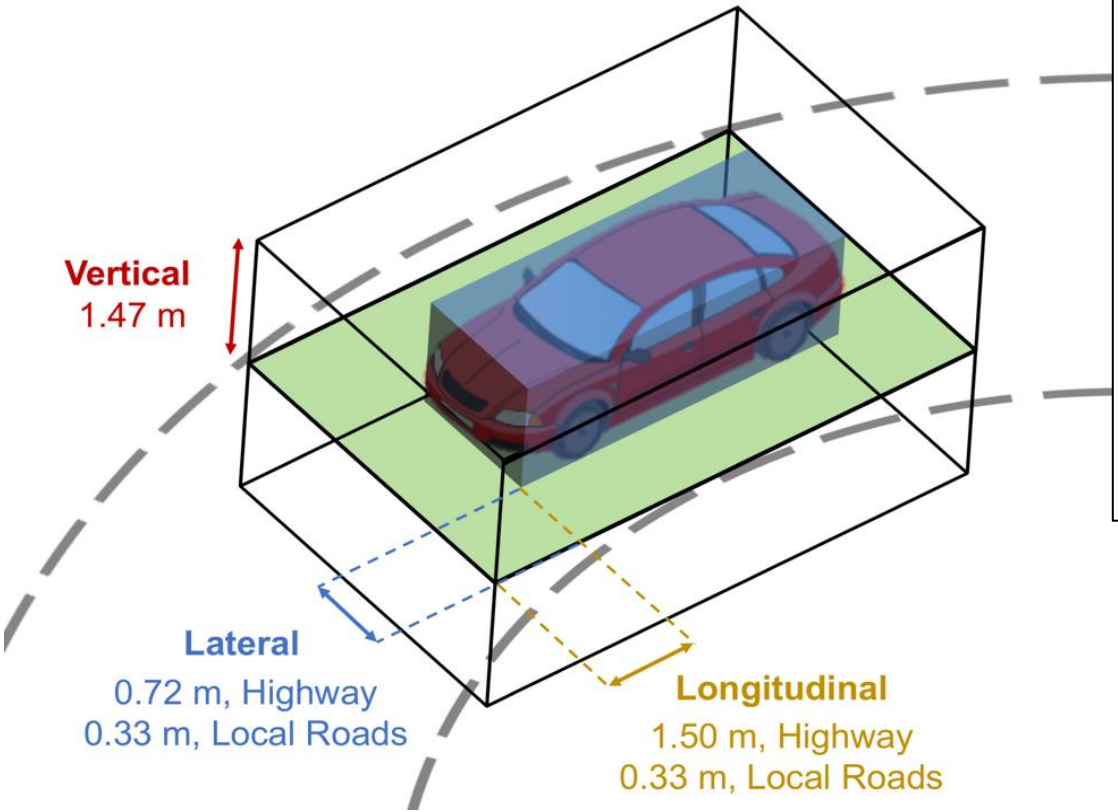
Lack of alternatives to GNSS make it a major target in conflict.

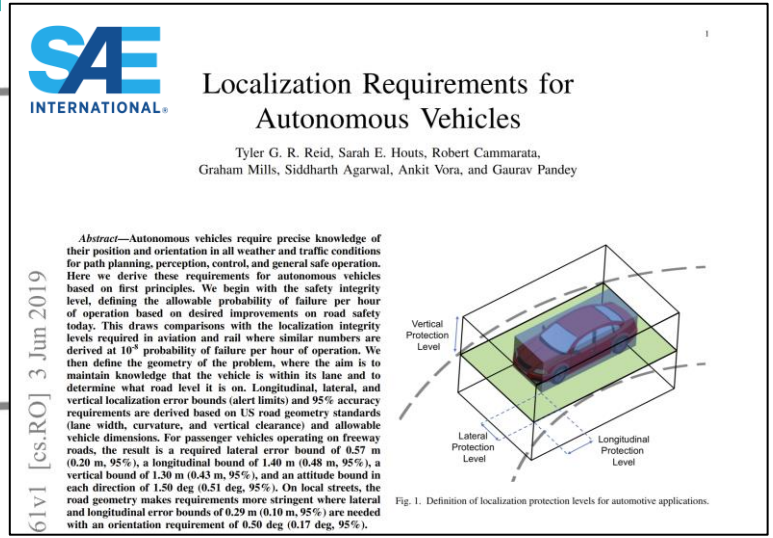


GNSS is integrated into every aspect of the connected world, but so are its vulnerabilities.

Being an established government system, GNSS has inertia that prevents it from keeping pace with commercial demands, leaving a growing demand gap for better performance.

New Drivers in Navigation Requirements





SAE INTERNATIONAL

Localization Requirements for Autonomous Vehicles

Tyler G. R. Reid, Sarah E. Houts, Robert Cammarata,
Graham Mills, Siddharth Agarwal, Ankit Vora, and Gaurav Pandey

Abstract—Autonomous vehicles require precise knowledge of their position and orientation in all weather and traffic conditions for path planning, perception, control, and general safe operation. Here we derive these requirements for autonomous vehicles based on first principles. We begin with the safety integrity level, defining the allowable probability of failure per hour of operation based on desired improvements on road safety today. This draws comparisons with the localization integrity levels required in aviation and rail where similar numbers are derived at 10^{-8} probability of failure per hour of operation. We then define the geometry of the problem, where the aim is to maintain knowledge that the vehicle is within its lane and to determine what road level it is on. Longitudinal, lateral, and vertical localization error bounds (alert limits) and 95% accuracy requirements are derived based on US road geometry standards (lane width, curvature, and vertical clearance) and allowable vehicle dimensions. For passenger vehicles operating on freeway roads, the result is a required lateral error bound of 0.57 m (0.20 m, 95%), a longitudinal bound of 1.40 m (0.48 m, 95%), a vertical bound of 1.30 m (0.43 m, 95%), and an attitude bound in each direction of 1.50 deg (0.51 deg, 95%). On local streets, the road geometry makes requirements more stringent where lateral and longitudinal error bounds of 0.29 m (0.10 m, 95%) are needed with an orientation requirement of 0.50 deg (0.17 deg, 95%).

Fig. 1. Definition of localization protection levels for automotive applications.

Affordable L4 vehicles must have navigation systems that use reliable low-cost PNT sensors, operate in all weather conditions, across rural and urban environments.

But isn’t GNSS free?

The signal is, the capability is not.

Entry

$1+

+ $0/yr

1-10m accuracy

Basic

$10+

+ $0-100/yr

Semi-reliable 0.5-3m accuracy

Advanced

$1,000++

+ $0-2000/yr

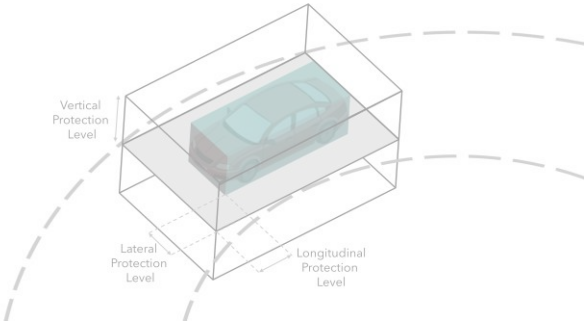
Semi-reliable 2cm-1m accuracy

Customers spend an estimated $20B/yr on GNSS user equipment and are desperate for better performance and to integrate modern technologies such as AI and autonomy.

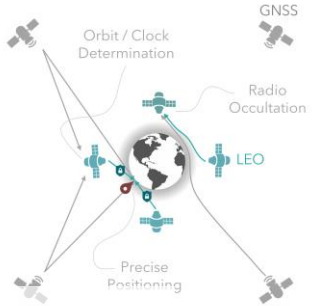
Performance is limited by the capability of the GNSS satellites, and users are paying for workarounds.

OUTLINE

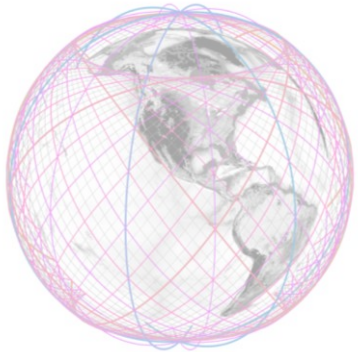
PNT Needs and Motivations



LEO PNT Sat Nav Approach



Xona PULSAR & Partner Ecosystem



Why LEO PNT?

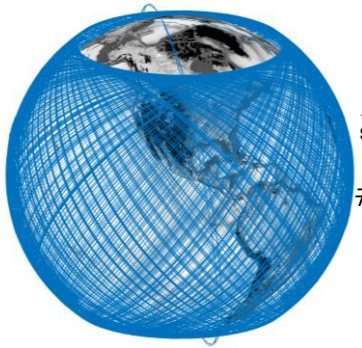
PNT applications are seeking improved accuracy, resiliency, and/or security

Technology advancements and the New space ecosystem enable high performance from LEO with lowered costs

LEO Mega-Constellations

(*Planned)

Broadband



STARLINK

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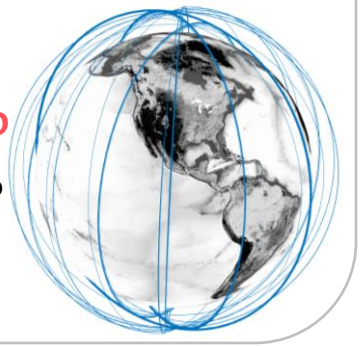
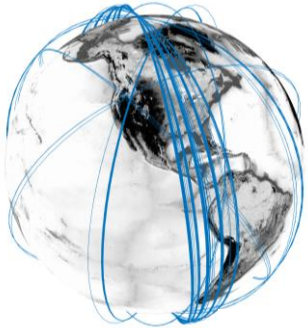
OneWeb

#Sats = 636



Remote Sensing



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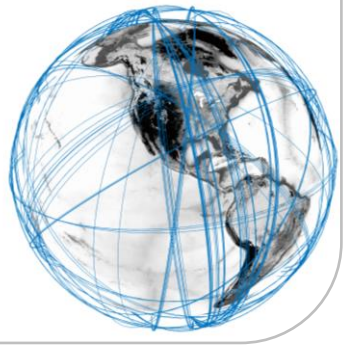
spire

#Sats = 81



Position, Navigation, & Time

xona

258

GEELY 240

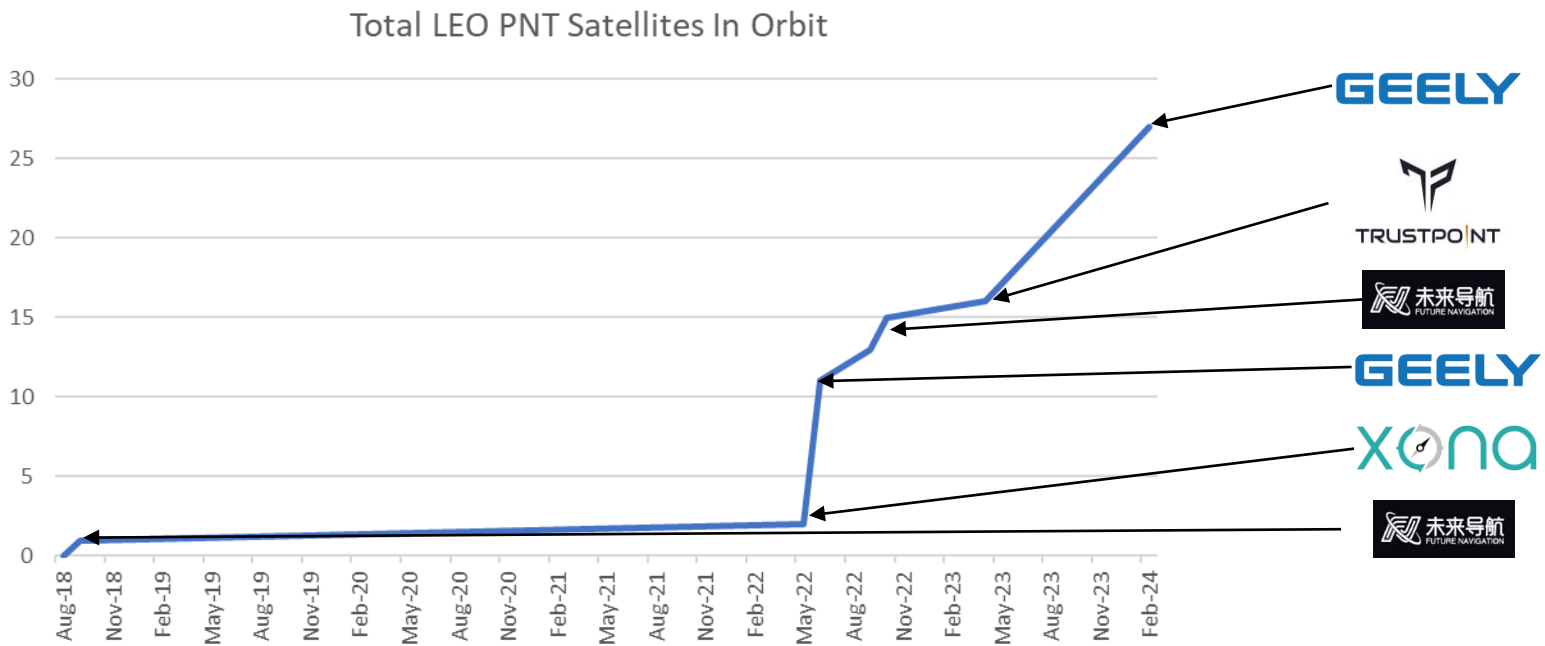
TRUSTPOINT 288

未来导航 FUTURE NAVIGATION 160

JAXA 480

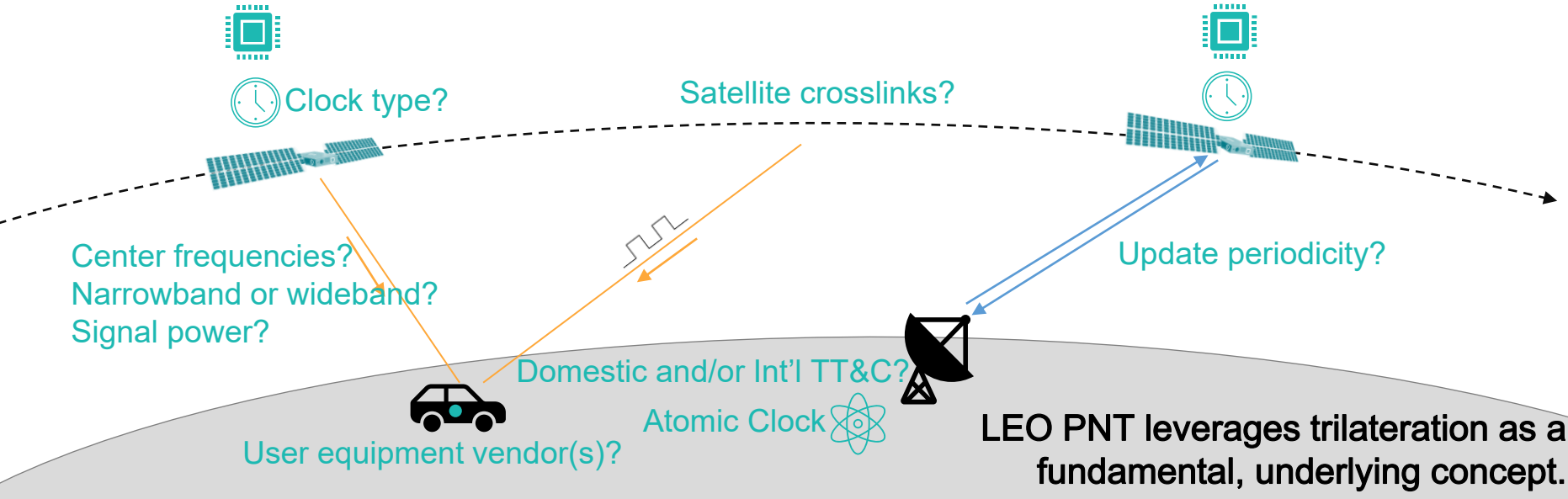
esa TBD

Recent LEO PNT Satellite Launches



Sat Nav Considerations Today

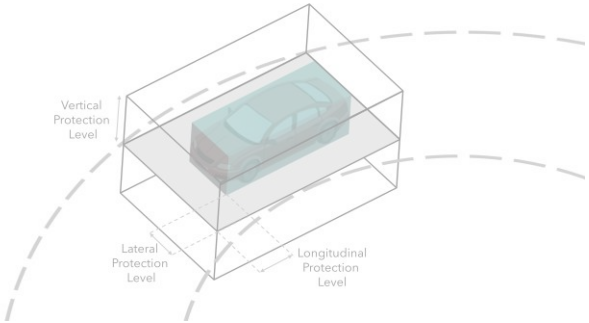
Moving to MEO to LEO…



LEO PNT leverages trilateration as a fundamental, underlying concept.

OUTLINE

PNT Needs and Motivations



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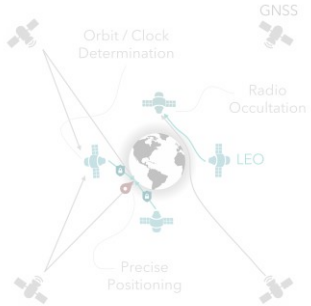

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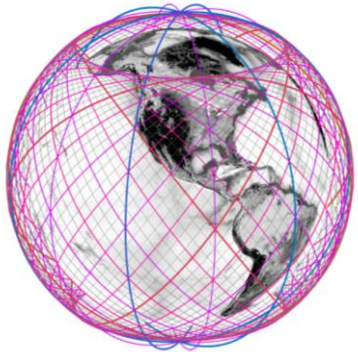


THE XONA TEAM

Founded in 2019 by PhD's from Stanford's GNSS Laboratory and aerospace professionals.

Brian Manning
CEO

Tyler Reid
CTO

Bryan Chan
Business

Jerami Martin
Satellites

Adrien Perkins
Engineering

Andrew Neish
Signals

Kaz Gunning
Algorithms

Paul Tarantino
Testing

Headquarters in Burlingame, California.
Offices in Montreal, Canada and London, UK.

NEXT GENERATION SATELLITE NAVIGATION

Xona's PULSAR PNT service incorporates the best of modern GNSS tech and overlays additional performance.

Government level **security**

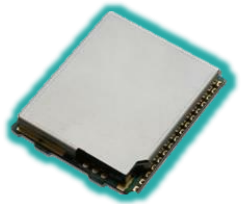
5 cm-level **accuracy** in seconds

Civil aviation level **integrity**

Enhancements for legacy GNSS signals

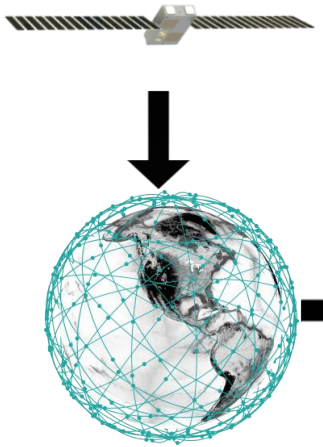
LEO satellites provide 170x higher **power**

Must be easy to integrate (firmware-upgradeable) into GNSS user equipment.

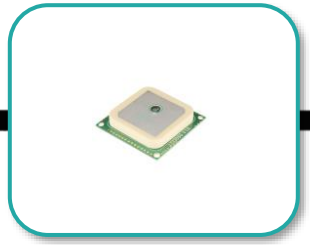


Navigation & Timing as a Service

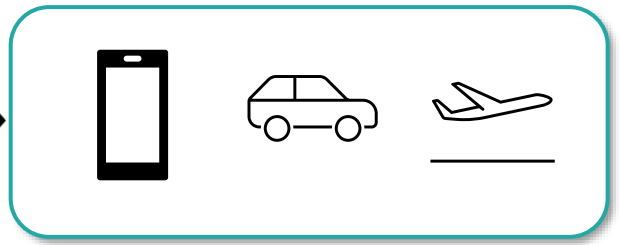
Xona is developing the infrastructure…



…working to partner with Tier 1's and receiver manufacturers to integrate Xona functionality…

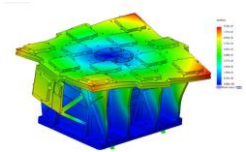


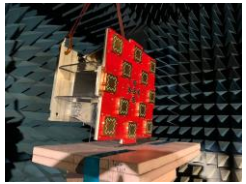
…to provide PNT as a service to end users.

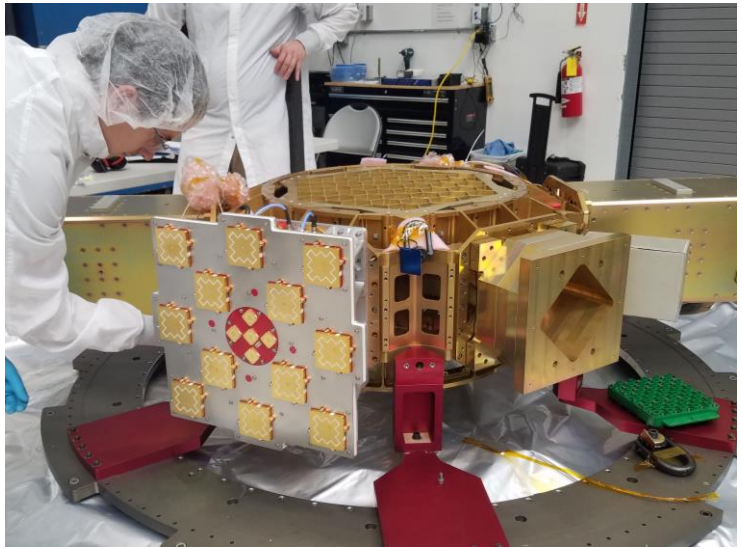


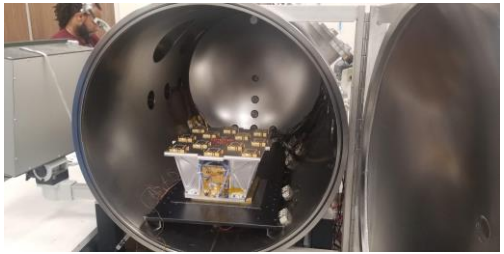
TECHNOLOGY PROVEN IN SPACE

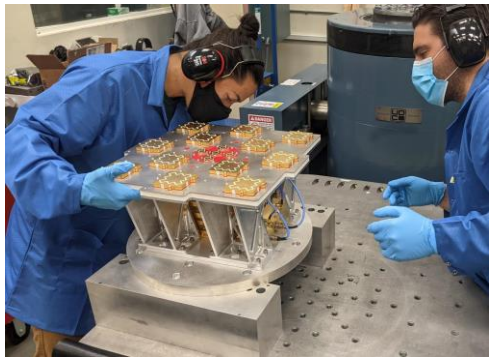
Launched May 25, 2022
First ever commercially funded satellite navigation mission











THE PULSAR ECOSYSTEM

Xona has partnered with GNSS industry giants to integrate PULSAR into receivers for virtually any user application.

PULSAR licenses are activated by the customer, or come pre-installed with the receiver.

Receivers

Simulators

Xona Production Satellite

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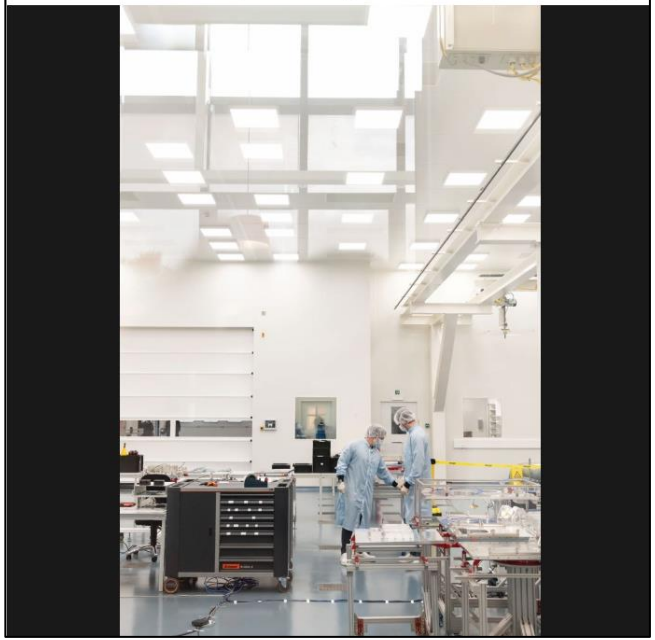
Aerospacelab to build Xona Space's first navigation satellite https://lnkd.in/eq4x3_JJ



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Strategic Partnership Between Aerospacelab and Xona Space Systems Targets Breakthroughs in PNT Satellite Navigation Technology

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Commercial

Aerospacelab to build Xona Space's first navigation satellite

The Belgian manufacturer will produce Xona's satellite in the United States

Sandra Erwin March 19, 2024

Conclusion

- Commercial and government LEO PNT developments are accelerating quickly.
- LEO PNT has the opportunity to provide enhanced resilience, accuracy, and security.
- Technology development is driven by commercial and government needs.