

1. Background

Xona's mission is to provide global navigation services with the accuracy, security, and resilience needed to operate these systems safely in any environment.

To meet the needs of autonomy and other emerging critical Position, Navigation, and Timing (PNT) use cases, Xona is building a space-based navigation service via a New Space approach. Such an approach leverages an ecosystem of lower launch costs, high volume satellite production with Commercial Off The Shelf (COTS) components, and enterprise ground station services. Xona is leveraging these factors to create a Low Earth Orbit (LEO)-based navigation service known as Pulsar. This system will offer three major enhancements over Global Navigation Satellite Systems (GNSS) today: (1) Stronger signals to combat Radio Frequency Interference (RFI); (2) Enhanced precision, bringing sub-decimeter location, globally; (3) Cybersecurity through modern encryption and data authentication as part of the navigation signal design.

Stronger signals result from the physics of moving from Medium Earth Orbit (MEO) to LEO, resulting in 20-25x closer proximity and up to 1000x reduced path loss at zenith [1]. Improved precision is enabled in part through the fast LEO motion across the sky. The significantly faster geometry change compared to legacy GNSS results in convergence times to <10 cm that is measured in minutes or less compared to 30 minutes with GNSS. Last and perhaps most important is security. New LEO signals are not bound by legacy, so there can be inclusion of encryption and authentication as part of the signal design for civil users.

Another significant aspect is that a commercial LEO layer can add capability that can evolve quickly, on a 5-year timescale, to keep up with the pace of commercial demand. This is much more difficult to do this with legacy GNSS services which evolve more on 20-to-30-year timescales because they are already supporting billions of devices and hence have a big inertia to large changes.

2. Mission Overview

Before launching Pulsar, ground-based testing is required to de-risk elements of the system and is showcased in Figure 1. The ground-based testing setup utilizes stationary beacons which transmit a signal over an Industrial, Scientific, and Medical (ISM) band. These beacons will incorporate information broadcasted by existing GNSS constellations and transmit a Xona navigation signal. Testing is planned to occur over a 6 month period beginning August 9, 2021.

The major concept of operations are as follows: (1) Five beacons collect GNSS signals from above to aid in position and clock determination; (2) Navigation messages are generated and transmitted through directional antennas to a moving platform; (3) The platform receives these signals and simultaneously collects position truth data for error analysis. The 5 beacons will be placed 150 feet from each other and have directional antennas that all face in towards a central location. The high-level architecture of the ground-based tests is shown in Figure 1.

There are 4 different types of transmit antennas that can be attached to the beacons (all within ISM bands), but only one set of antennas will be in use at any one time. In other words, only one frequency will be broadcast at any given time.

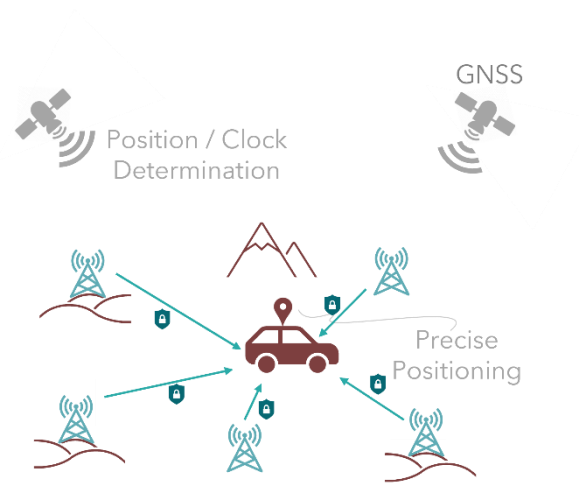


Figure 1: Ground demonstration test architecture. Blue emission lines are from Xona ground transmitters. The brown car represents the central Xona receiver. The transmitters and central receiver all passively receive GNSS signals.

- [1] T. G. R. Reid *et al.*, "Navigation from Low Earth Orbit Part 1: Concept, Current Capability, and Future Promise," in *Position, Navigation, and Timing Technologies in the 21st Century*, Wiley, 2020, pp. 1359–1379.