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Supplementing GNSS with Low Earth Orbit Satellites for Resilient Timing & Synchronization

Rick Knea Manager Business Development

What are the PNT threats & GNSS vulnerabilities?

Why we need alternatives to supplement or supplant GNSS

PNT cyberthreats

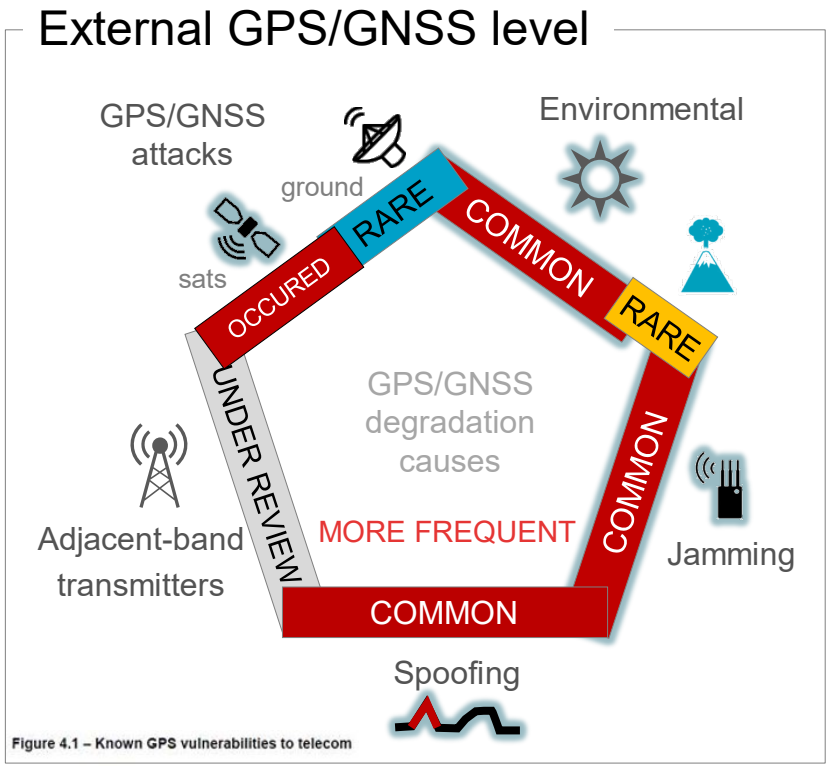


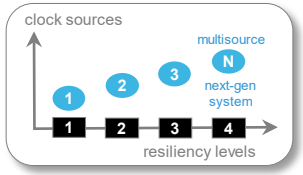
Figure 4.1 – Known GPS vulnerabilities to telecom

The US Government mandate: What is *resilient* PNT?

Driven by US Federal Executive Order 13905 and UK & Euro Commissions

- **PNT** stands for **P**ositioning, **N**avigation & **T**iming. **T** enables **P** & **N**
- **Protect** government/industry critical infrastructure against PNT disruptions from GPS/GNSS jamming/spoofing & network timing cyberattacks
- **Cybersecurity and Infrastructure Security Agency (CISA)**
  - Federal Positioning, Navigation, and Timing Services Acquisitions Guidance (Feb 2024)
  - Streamline and support the implementation of PNT
- **Deploy** resilient, assured & self-survivable PNT systems with defense-in-depth capability
- **Target** critical infrastructure under national security threats

Telecommunications | Data Centers | Power grids | Finance | E911/Public Safety | Transportation | Broadcast



- **Use** published resilient PNT guidelines & standard in progress
  - DHS Resilient PNT Conformance Framework
  - NIST Cybersecurity Framework for PNT Profile
  - IEEE P1952 Resilient PNT for User Equipment Standard working group

NIST NISTIR 8323

IEEE SA P1952 PNT

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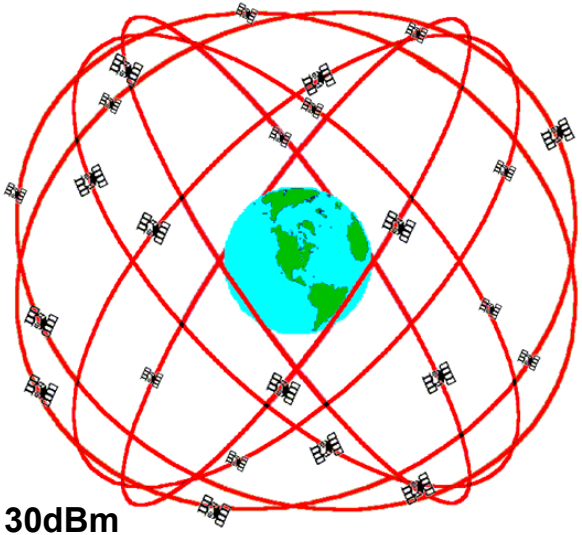
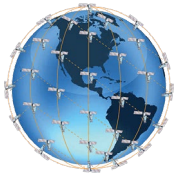
GPS Constellation vs Iridium (LEO) Constellation



Receive Signal -130dBm

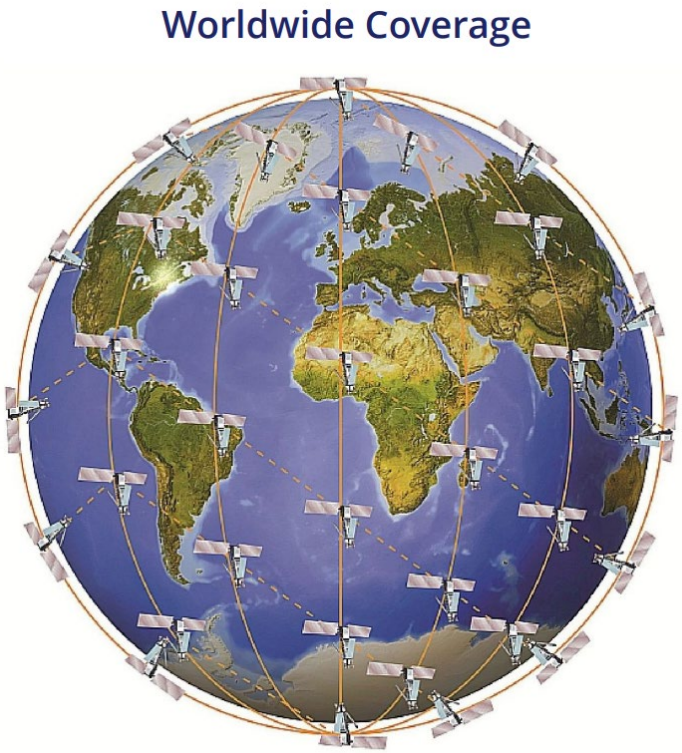
GPS Nominal Constellation
24+ Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,180 km Altitude (12,550miles)
55 Degree Inclinations
Orbital speed 14,000 km/hr (9k mph)
Orbital period 12 hours (2x/day)
Different satellite in each plane every 3 hrs



Receive Signal -100dBm

Iridium Nominal Constellation
66 Satellites in 6 Orbital Planes
11 Satellites in each Plane
781 km Altitude (485 miles), Polar orbits (86.4 degrees)
Orbital speed 27,000 km/hr (17k mph)
Orbital period 100 minutes (14x/day)
Different satellite in each plane every 9 min

Polar Orbits



Iridium Nominal Constellation

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781 km Altitude, Polar orbits (86.4 degrees)

Orbital speed 27,000 km/hr (17k mph)

Orbital period 100 minutes (14x/day)

Different satellite in each plane every 9 min

What is Satellite Time & Location (STL)?

STL *Satellite Time and Location*

STL is an alternative to GPS for a Position-Navigation-Timing (PNT) service provided by Iridium Satelles

- Provides precision timing independent of GPS
- Provides location information independent of GPS
- Can augment GPS measurements when not enough GPS satellites are in view or are obstructed or denied

Powerful Time & Location Signal from Low Earth Orbit ("LEO") Satellites

STL signals are 1,000 times (30 dB) stronger than GPS

- Unlike GPS, multiple satellite lock is not required for good STL performance
- An STL receiver can typically process at least one burst every 2 seconds from each LEO satellite in view

- The average number of received **bursts per minute** are more important than the number of satellites locked

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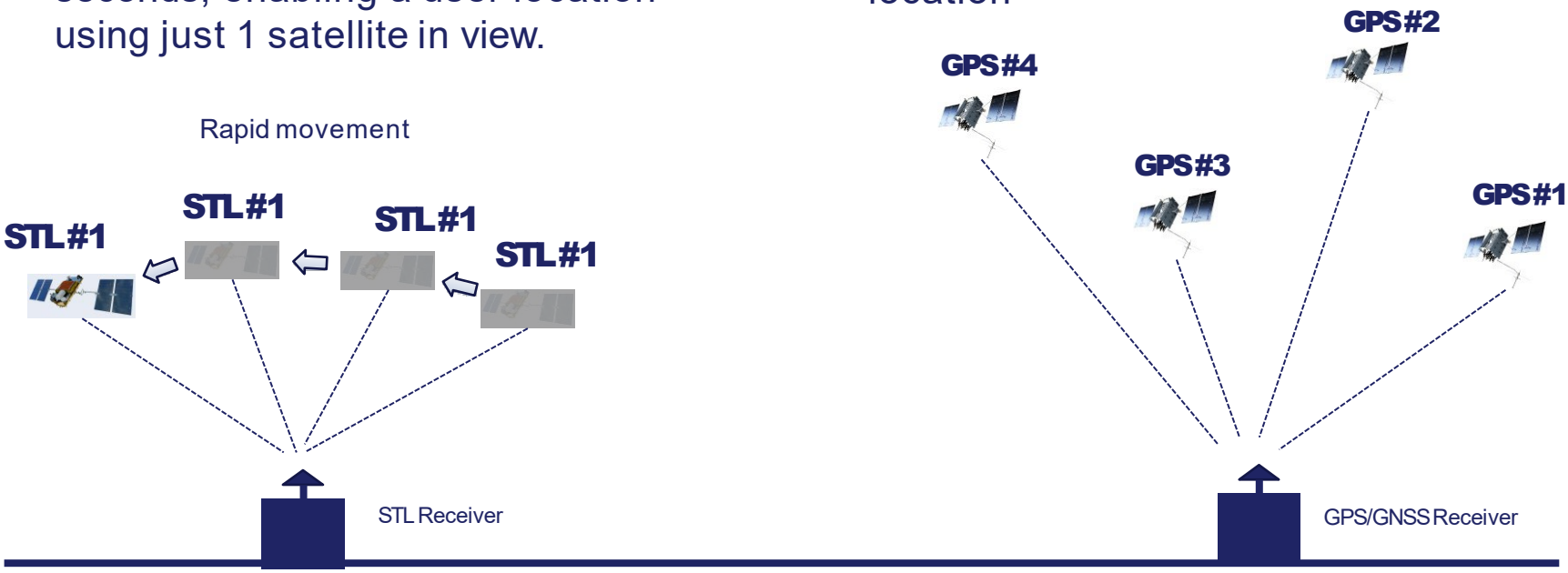
Satellites Needed for STL vs GPS/GNSS

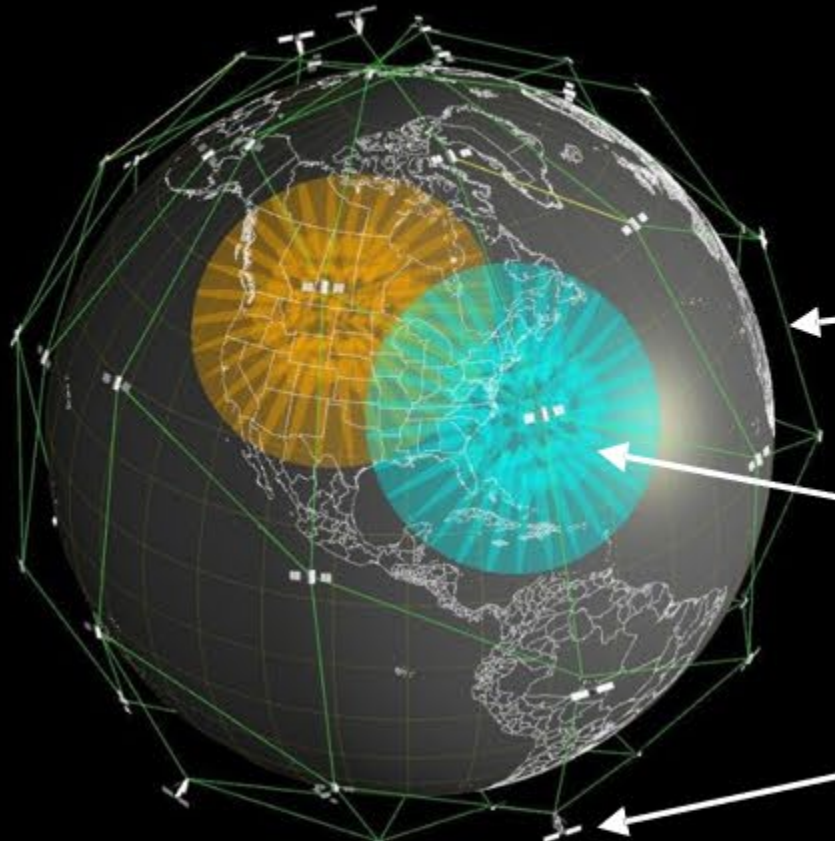
Iridium (LEO) Satellites circle the Earth every **100 minutes**. They move so fast their ranging angle can change up to 1 degree every 4 seconds, enabling a user location using just 1 satellite in view.

GPS/GNSS (MEO) Satellites circle the Earth every **12 hours**. They move so slowly that at least 4 satellites must be used to determine a user's location



Secure Signal — Impervious to Cyber Attacks

STL



STL is secure because the signal is **unpredictable in advance** — yet it is **easy to validate when received** and allows us to **prove a user's location**.

Here's how it works:

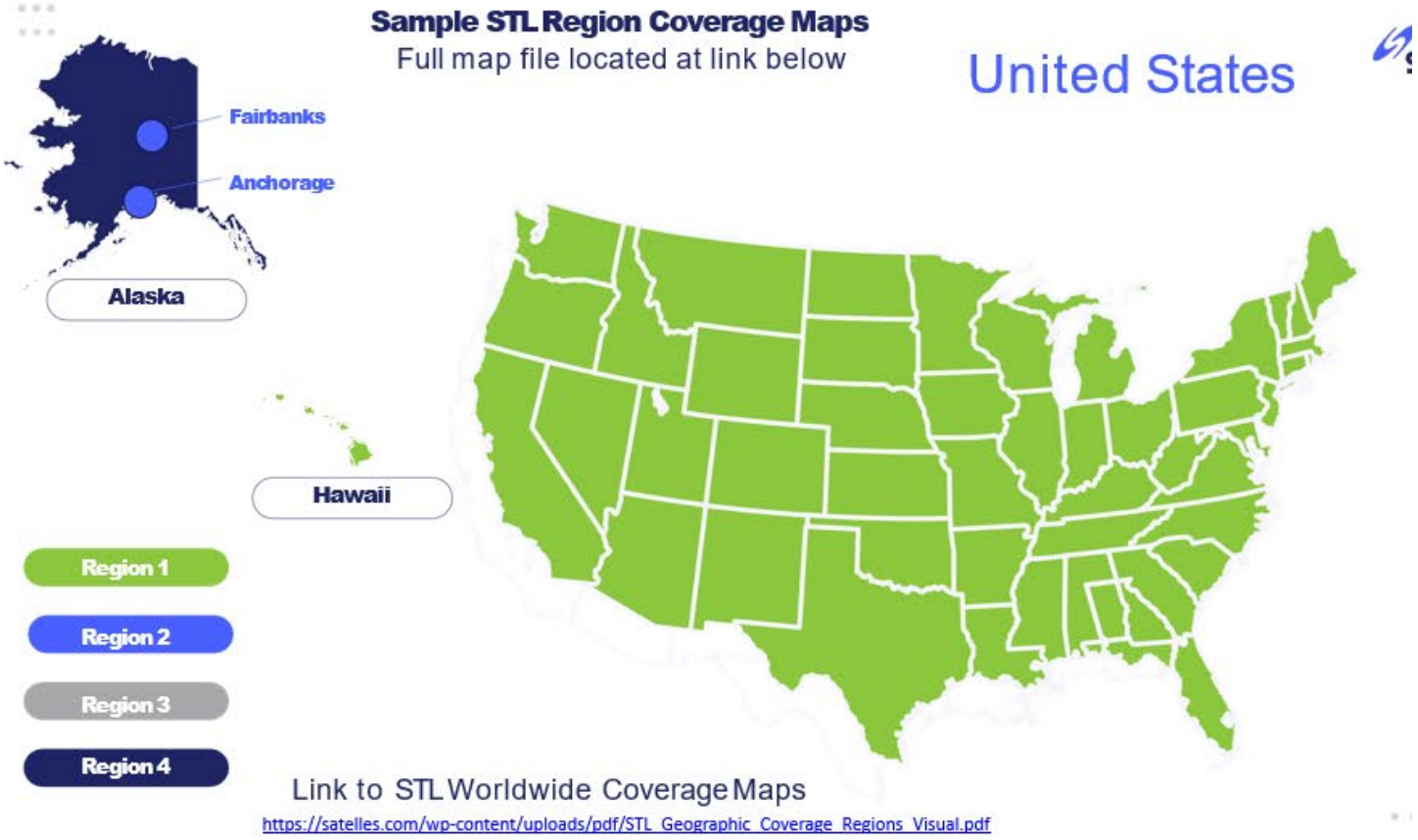
Cross-links provide continuous orbit and time information on the entire constellation even when most are not in view of ground systems.

Overlapping **spot beams** provide location-specific keys that change every second to support location-based authentication (48 spot beams per satellite × 66 satellites = 3,168 spot beams globally).

Not only do the location keys change every second, but also the **satellites change positions** frequently to activate different spot beams (horizon-to-horizon transit time is just under nine minutes).

Sample STL Region Coverage Maps

Full map file located at link below

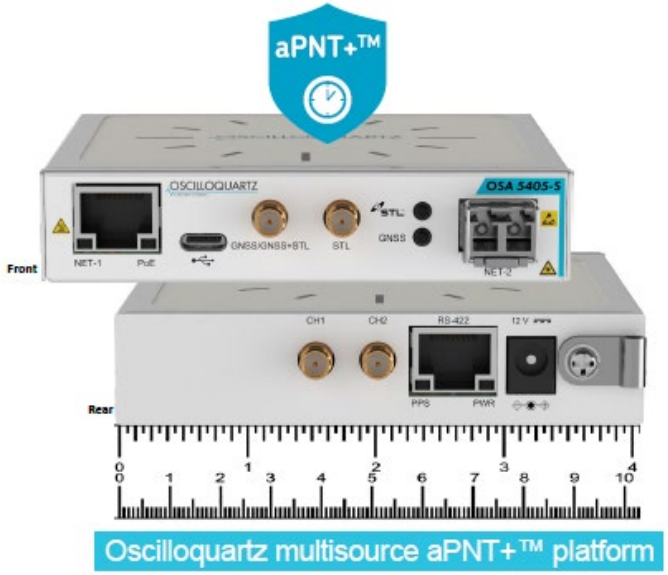


Link to STL Worldwide Coverage Maps

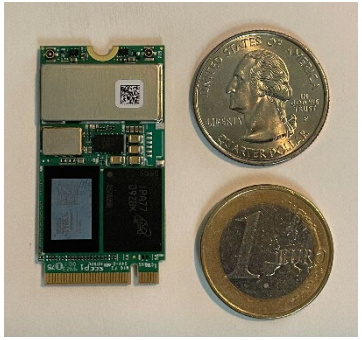
https://satelles.com/wp-content/uploads/pdf/STL_Geographic_Coverage_Regions_Visual.pdf

STL Receiver – Adtran OSA-5405-S

- STL/GNSS Receiver with OCXO and PTP GM function
- STL can be used alone or as a backup for GNSS
- STL signal monitoring via USB-C console port
- First small form-factor STL/GNSS timing solution



STL Inside



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Connections

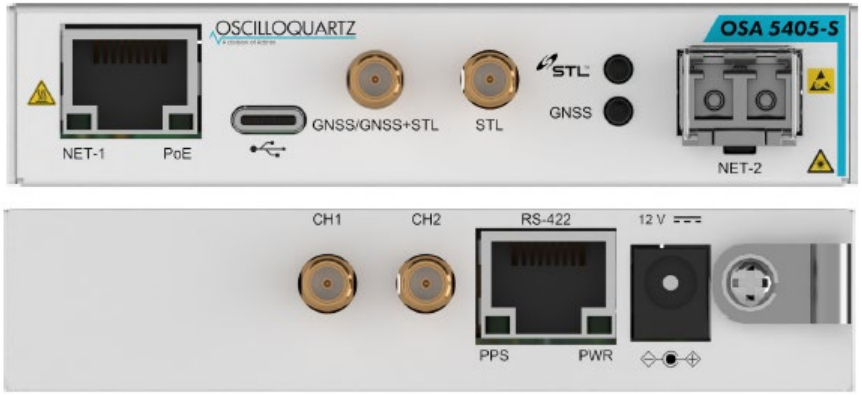
GNSS/GNSS+STL – input from **GNSS + STL antenna** (outdoor)

STL – input from **STL antenna** (indoor or outdoor)

USB-C console port

CH1 – 1PPS output for test

CH2 – External 10MHz clock input (optional)



Antenna options (resiliency)

Outdoor

OSA 1047020174-01
Active GNSS L1 + STL antenna

Outdoor

Tallysman HC860
Active GNSS L1/L2 + STL antenna

Indoor

Tallysman HC610
Active STL only antenna

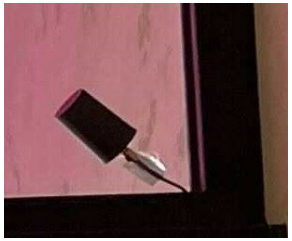
Equipment

STL Antennas

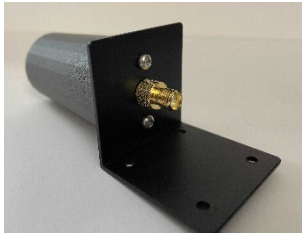
Tallysman HC610
(STL only – best for indoor)
Pole mount
using 1” PVC pipe
Tape connectors and tape antenna to pole to waterproof
(preferred method for outdoor)

HC860 (GNSS/Iridium)
is best for outdoor
use 1.25” PVC pipe

Window mounts
(low E-glass or window film may reduce signal)



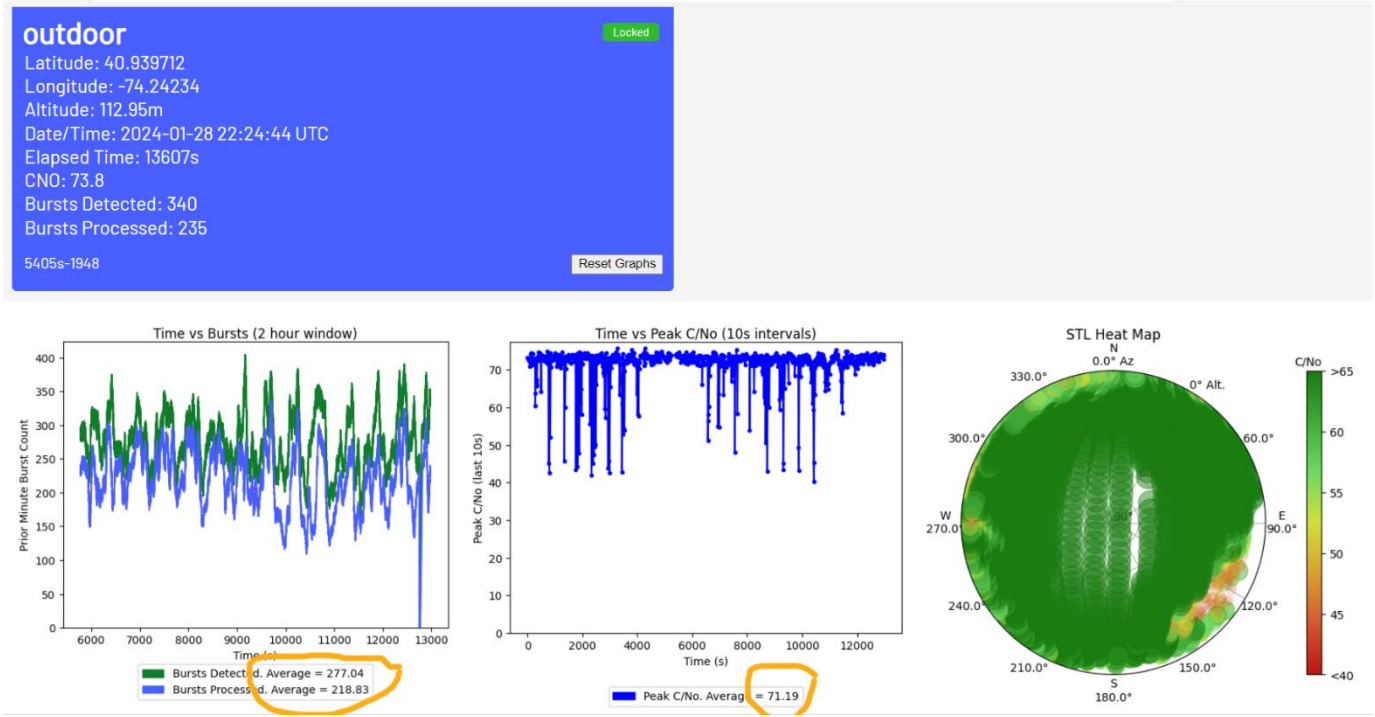
Bracket Mount
Bracket comes with adhesive tape for wall or glass mounting
(screw, glue, or tie-wrap)



While STL is 30 db stronger than GPS, concrete and steel are still difficult to penetrate

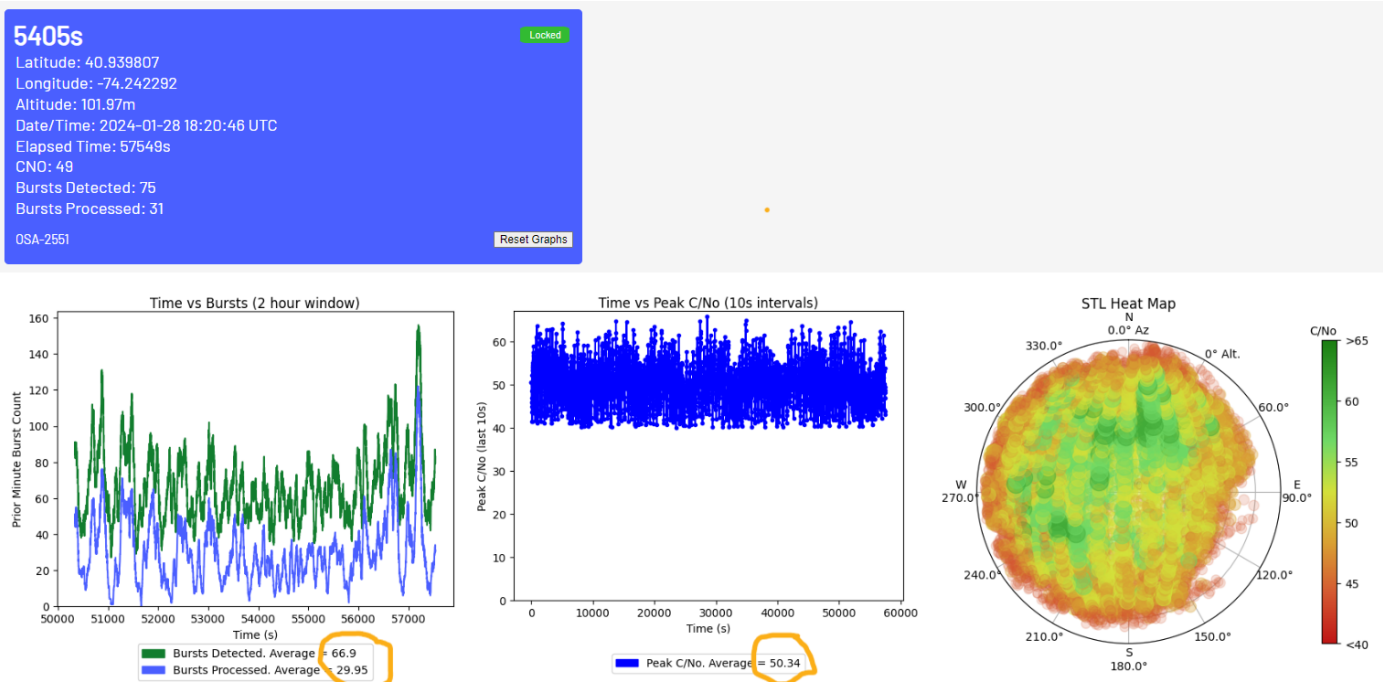
Deep indoor locations may require cable runs to reach areas with better reception

STL GUI – Burst Performance Analysis - Outdoor



These plots show typical STL signal reception from an outdoor antenna when averaged over 3 hours

STL GUI – Burst Performance Analysis - Indoor



These plots show typical STL signal reception from an indoor antenna when averaged over 16 hours

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Thank You

THIS IS NOT THE END…..ITS JUST THE BEGINNING!

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