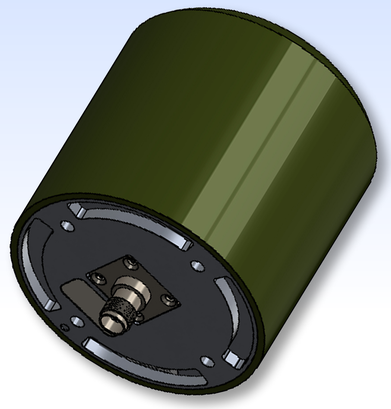
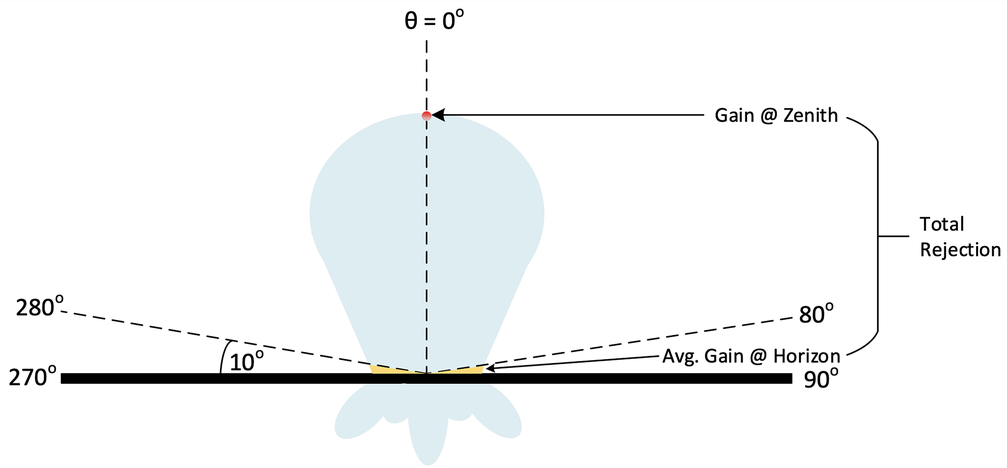
Horizon-Nulling GPS/GNSS Antenna Technology

- GPS/GNSS Reception challenges evolving over time
- Increased issues with reliable satellite tracking in congested RF environments
- Intentional/Unintentional Jamming arriving at low elevation
- Reception optimized near the zenith to spatially filter out unwanted signals
- Innovative design creates directive beams to minimize interference
- Increases reliability and minimizes holdover in contested environments
- Cost-effective and energy-efficient (low power requirements)



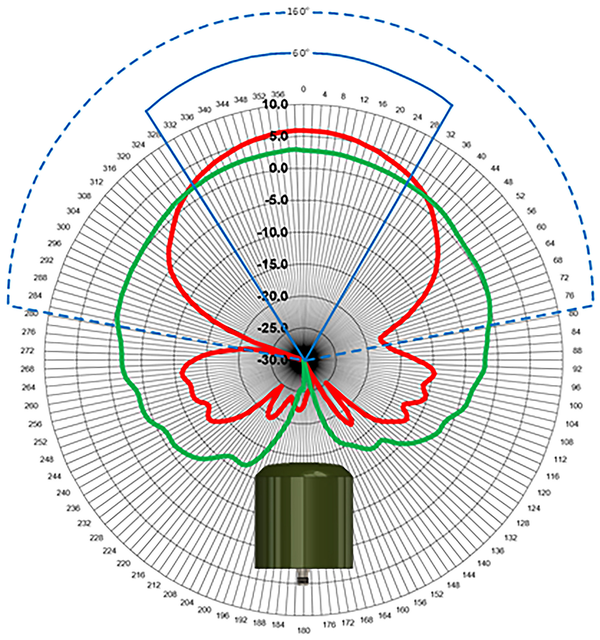


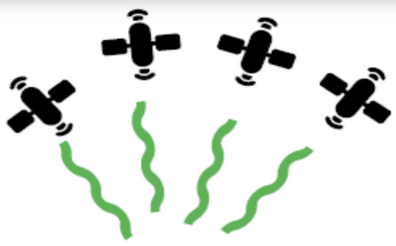
PARAMETER DEFINITIONS

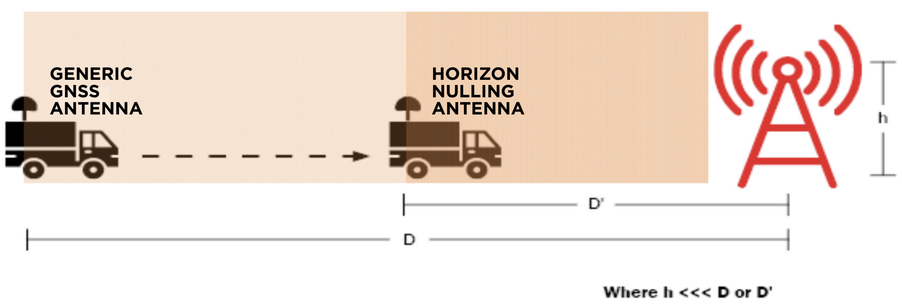
- Gain @ Zenith: Maximum recorded gain (usually close to Theta = 0°)
- Avg. Gain @ Horizon: Average of all readings taken within Theta = 80°–90° & 270°–280° region (10° on either side of the 2D horizon)
- Total Rejection: Difference between Gain @ Zenith and Avg. Gain @ Horizon

Total Rejection parameter used to evaluate the new design as a passive horizon nuller

- Measured 2D pattern data at an independent test facility
- Compared to a nominal GPS/GNSS antenna (green trace)
- Performance of the new design (red trace)
- Improvements evaluated quantitatively by changes in radiation patter metric – HPBW
- HPBW = Half Power Beam Width (angular separation where radiation pattern decreases by 50% from peak value)
- Green trace shows wide coverage of the main lobe extending uniformly across the hemisphere
- Green trace has no discernible null close to the horizon
- Red trace is focused into a 60-degree main lobe perpendicular to the plane of the antenna (beam width reduction)
- Red trace shows a nearly 2X directive gain enhancement at zenith
- Changes made to minimize cost while maintaining same antenna current draw

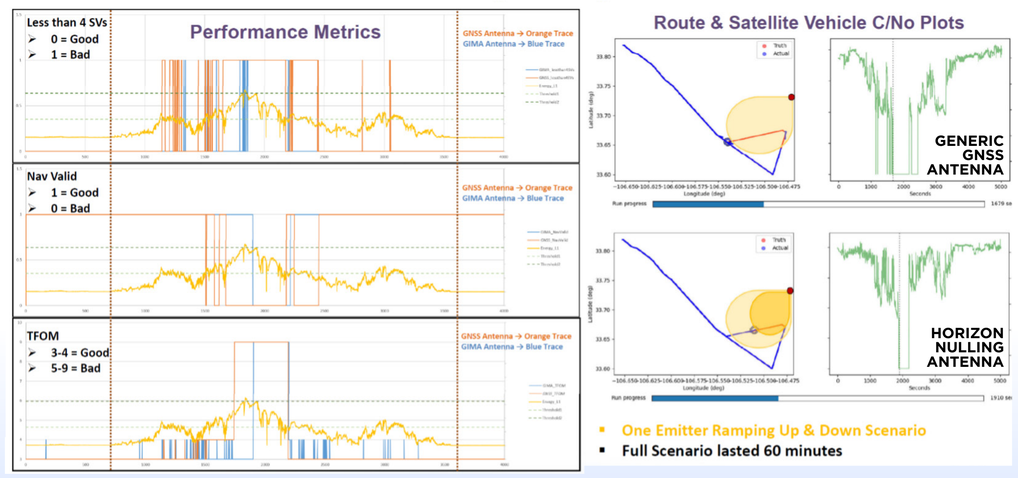






- Illustration left shows horizon nulling antenna tracking SVs significantly better in the presence of jamming originating close to the horizon
- Vehicle outfitted with new design can travel within close proximity of the jamming source (D') compared to the nominal GPS/GNSS antenna (D)

- Performance graphs show comparison of live sky jamming scenario--Horizon nulling antenna vs standard GNSS antenna
  - Blue trace—routes taken by the 2 systems
  - Red trace—actual route taken ('truth')
- Route graph indicates outages of the standard GNSS antenna much further away from the emitter (red dot) than the new GNSS antenna with the Horizon Nulling hardware modification
- Further evidenced by the complete drop in Carrier-to-Noise Ratio of the corresponding connected receiver at two different times of the scenario.



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