

Detecting GPS Outages Nationwide Using the MBS Network

NextNav LLC

NextNav Overview





NextNav is deploying, operating and managing a "terrestrial" constellation" to complement GPS in urban and indoor environments, and offering location as a service



Nationwide spectrum licenses, significant intellectual property portfolio and wide-area architecture provide consistent store level / floor level precision across entire metropolitan areas



Service capability robust enough for Public Safety, Enterprise and 911 applications, but designed to support a wide range of consumer and enterprise location applications

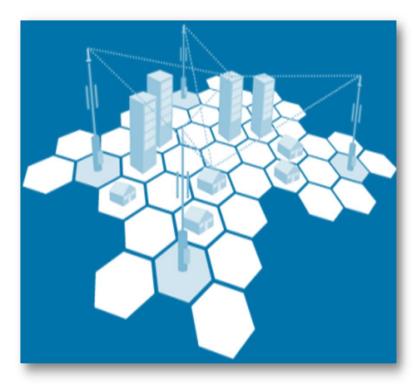


Powering location services for Public Safety/911 with potential to enable a myriad of commercial applications

Metropolitan Beacon System



("MBS")



- Overlay network dedicated to PNT (X,Y & Z axis, time), with unique, proven floor-level vertical and horizontal accuracy
- Serves Indoor and Urban areas complementary to GPS
- Wide-area coverage with unlimited capacity can cover an entire metro with fraction of a typical cellular build
- Long-range, low-cost broadcast beacons placed on cell towers and rooftops not building specific
 - Similar to GPS serves all applications
- Deployed and managed to deliver 'Mission Critical' location with multi-layer reliability and immune to GPS disruptions
 - Network & Beacon redundancy
 - Battery backup to ensure continuity during power outage
 - Encrypted Signal
 - GPS free operation
- Designed to be integrated into Mass Market Devices
- Proven "best in class" in various CTIA/ATIS, FCC-sponsored trials

MBS is essentially a network of low-cost terrestrial "satellites" broadcasting from roof-tops and towers

Motivation



- Effects of GPS Outage Local and Wide Area Outage is starting to be recognized as a problem
 - Could have serious impact on Critical Infrastructure
- Several Industry and Government Efforts to detect and mitigate unintentional and intentional GPS Outage/Jamming Scenarios
- GPS Backups/Alternates being investigated by various Government bodies around the world
- Detecting, Reporting, Providing Alternate Sources for Position, Navigation and Timing is essential for continued PNT availability for CI and **Commercial Applications**

NextNav MBS Network



(Features relevant to this presentation)

- Purpose-built Nationwide network for Alternate PNT
- A Network of Beacons in a Market
- Beacons provide PNT coverage for Indoor and Urban Areas
- Each Beacon derives its timing from GPS, backed up by an Atomic Clock
 - Beacons can work independent of GPS (not relevant in this presentation)
- Each Beacon has a high quality GPS antenna, Phase Stable Cable, A high accuracy multi-constellation capable GNSS timing receiver module
- Messages from GPS module are continuously analyzed and processed on the beacon's CPU for any anomalies

Typical MBS Installations









GPS Antennas on a Penthouse on a rooftop

MBS Antenna On a cell tower





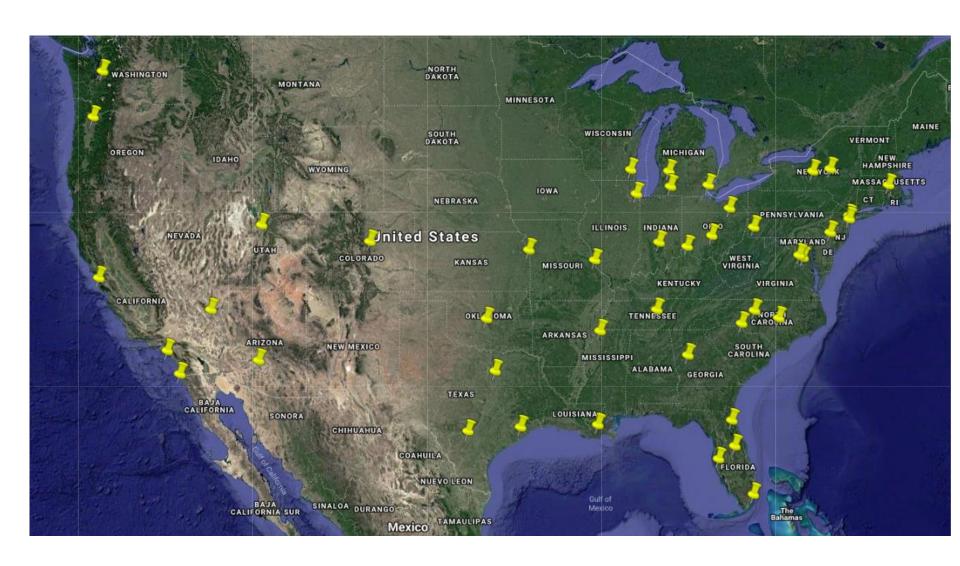


MBS Beacon on a roof top

GPS Antennas near cell towers

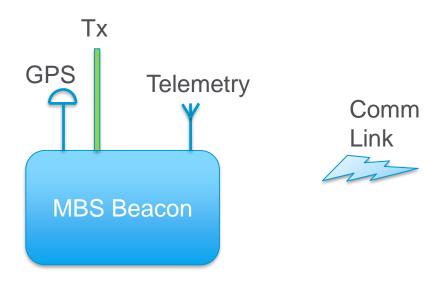
Beacons in the CONUS





GPS Live-Alarming Framework







NOC

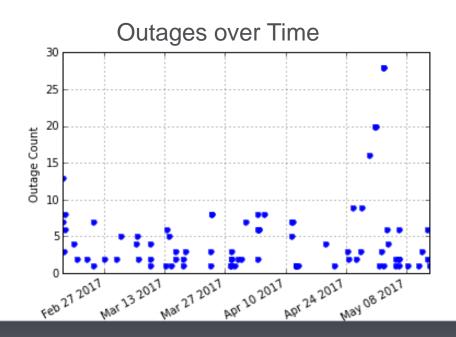
- GPS Alarms are raised under certain GPS Signal conditions, local context and learning:
 - Usually indicates loss of signal
 - Using an atomic clock helps verify the validity of the GPS signal
 - MBS beacons continue to provide synchronized positioning signals

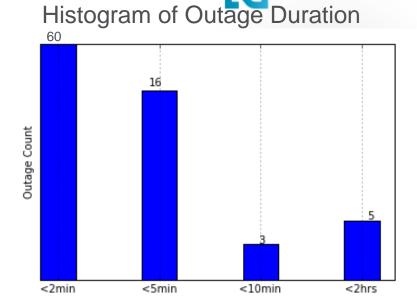


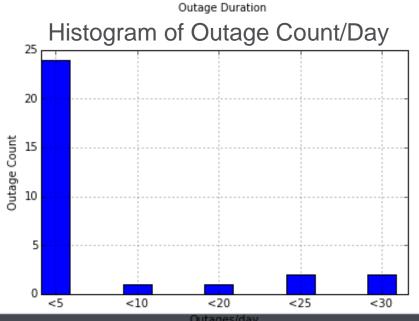
GPS Field Data

Nationwide GPS Outage report

- Nationwide live monitoring
- 90 day period in 2017
- Live Alarm feeds
- 84 events





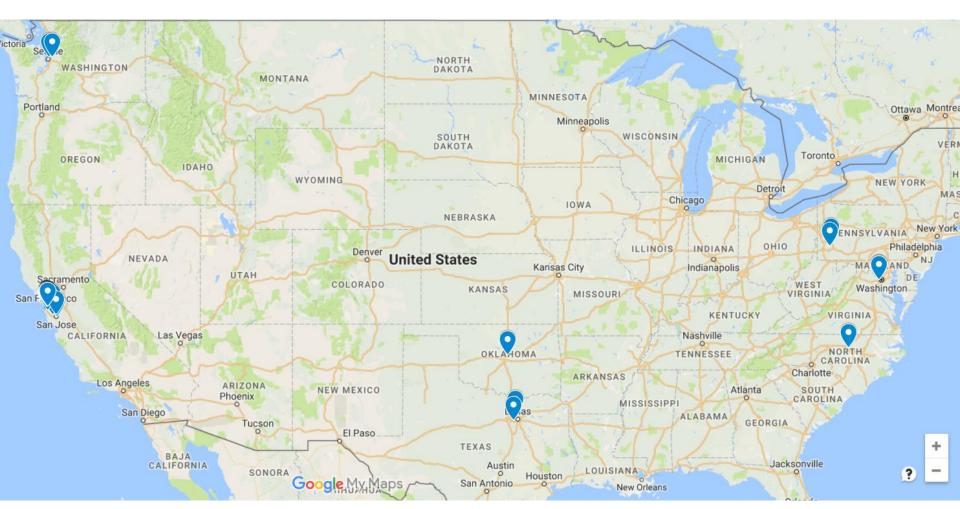


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NEXTNAV

Outage Map





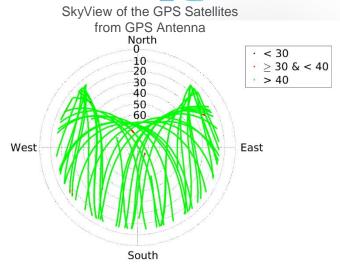
Outage during 90 days

Detailed Analysis

- One of the beacons @ SFO International Airport
- Rooftop of one of the terminals
- No other co-located transmitters on roof top
- ~ 1hr 30min outage!



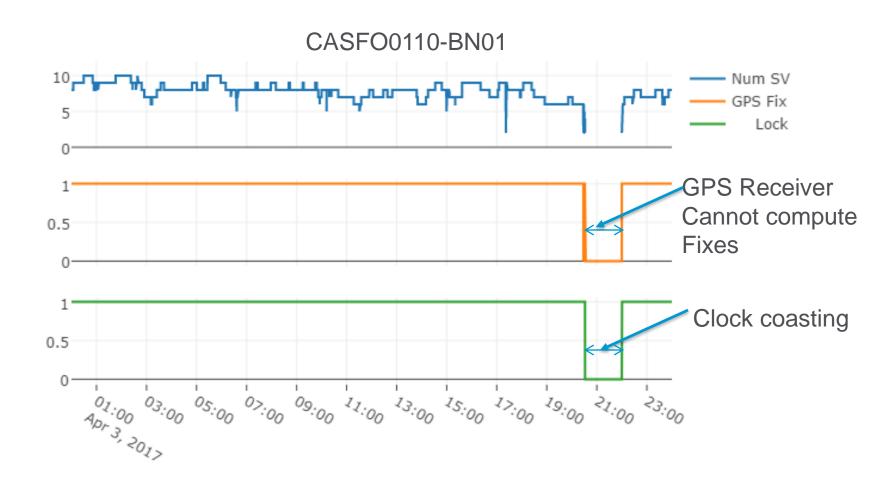






Detailed Analysis





Detailed Analysis



CASFO0110-BN01 (Zoomed view of "Outage" period)



Summary



- GPS Outage Detection is essential for protection of Critical Infrastructure
- MBS Beacons can provide 24x7 live reporting of GPS outages
- With additional sensors (Crowdsourced?), triangulation of potential jamming/spoofing sources may be possible
- Understanding the causes for these outages in a localized environment will be critical from a resiliency point of view