

Nationwide Differential GPS (NDGPS) Program Update

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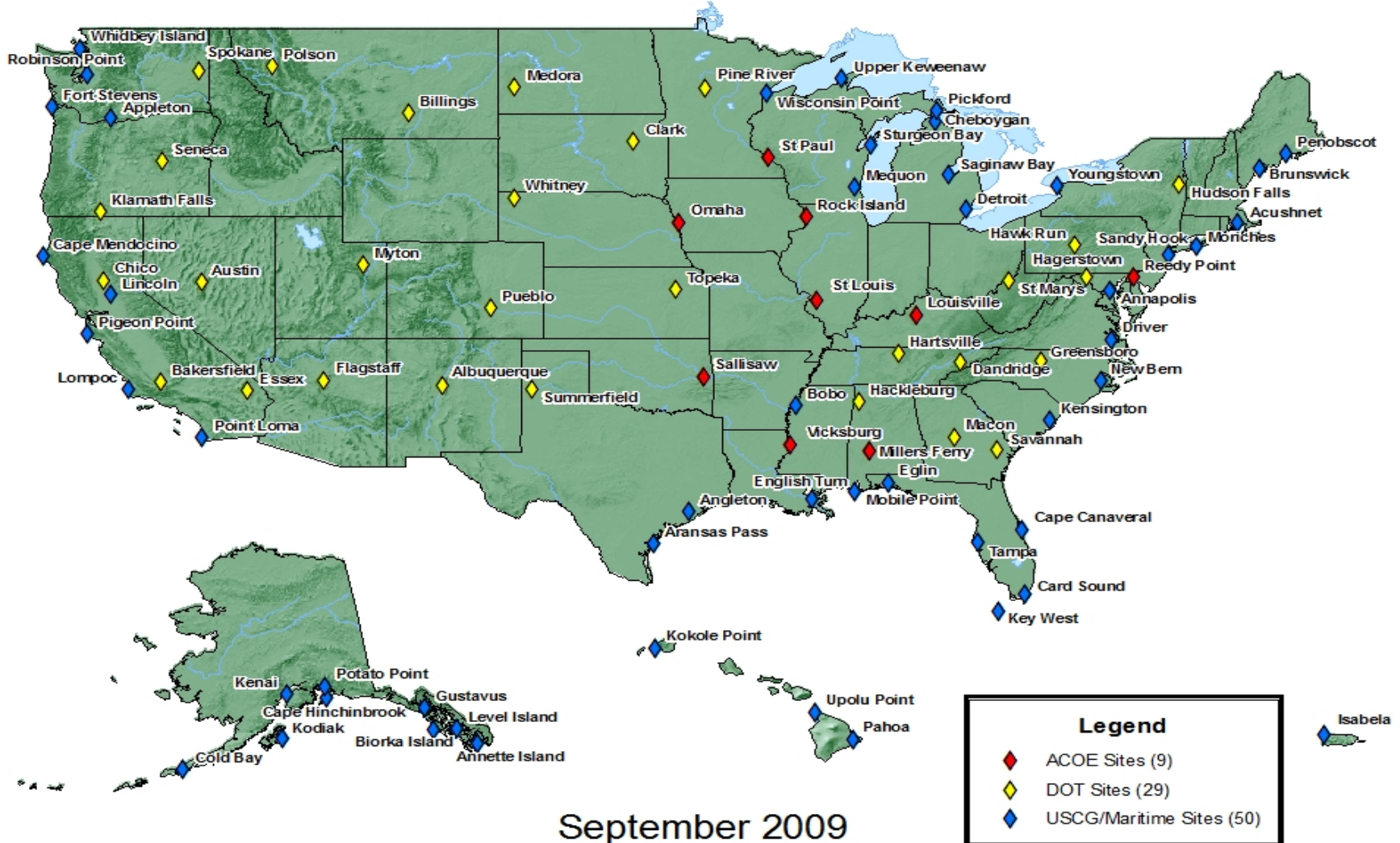
Nationwide Differential GPS

- Expansion of maritime differential GPS (DGPS) network to cover terrestrial United States; managed and operated as one national positioning utility
 - Compliant with RTCM, IALA, IMO, and ITU
 - 50 nations operate compatible systems
 - Observables in NAD 83
- System characteristics
 - Accuracy: 1 to 3 meters typical; better observed
 - Post-processed: 2 to 5 cm
 - Integrity: 2 seconds to alarm at 200 bps
4 seconds to alarm at 100 bps
 - Availability: 99.7% with single coverage
99.9% with dual coverage
- Current coverage
 - Single coverage: 92% of continental U.S.
 - Double coverage: 65% of continental U.S.
- Free of direct user fees to meet the needs of federal agencies, state agencies, industries, universities and the general public



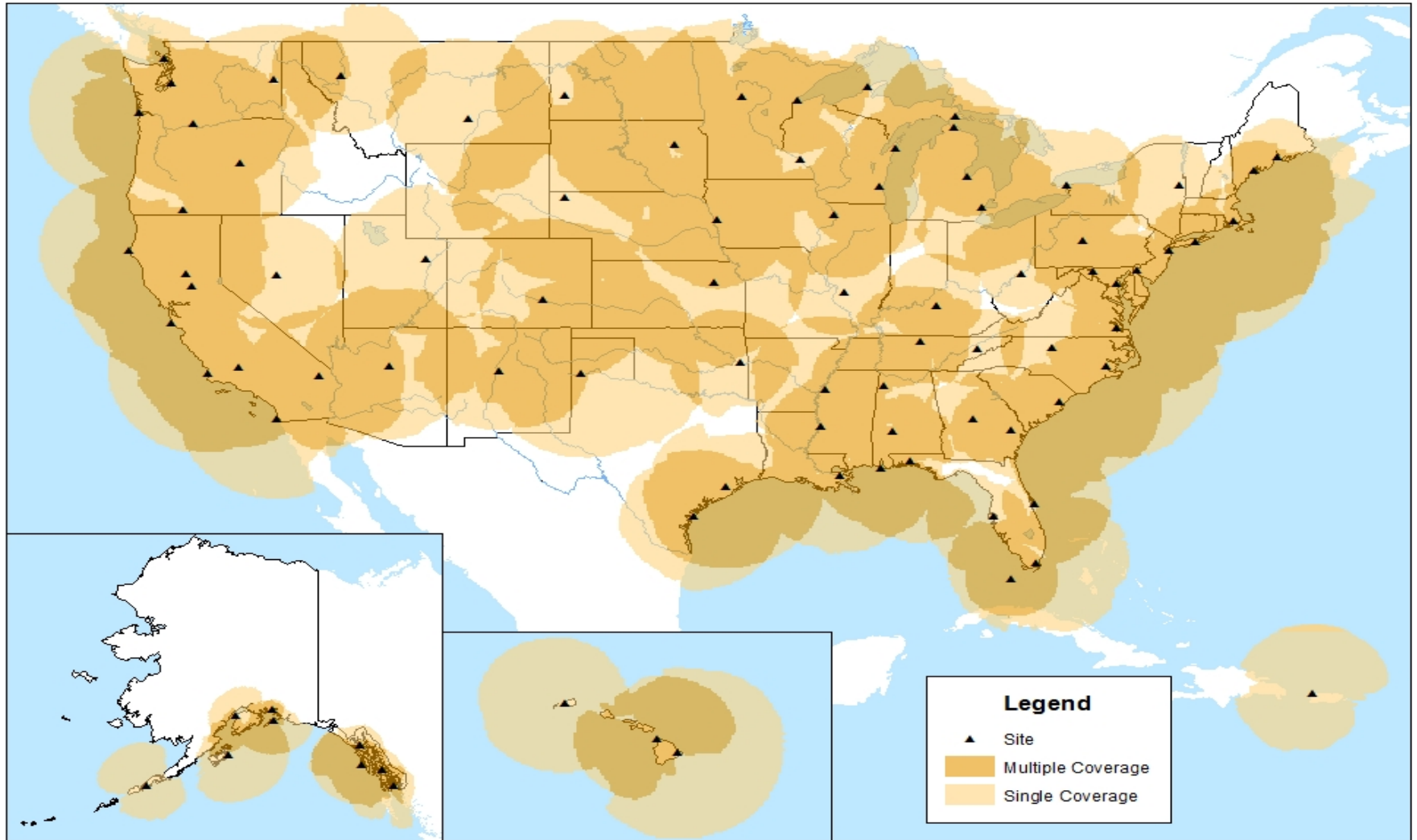
NDGPS Towers

Nationwide DGPS



NDGPS Coverage

Nationwide DGPS



September 2009

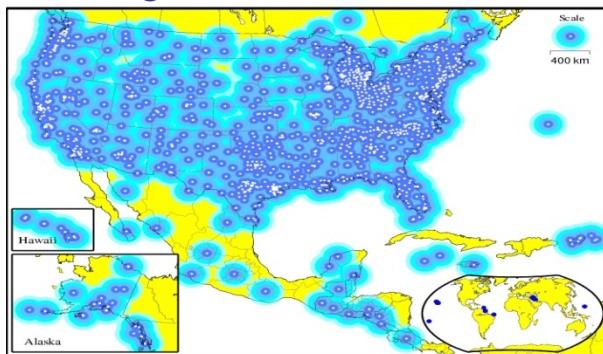
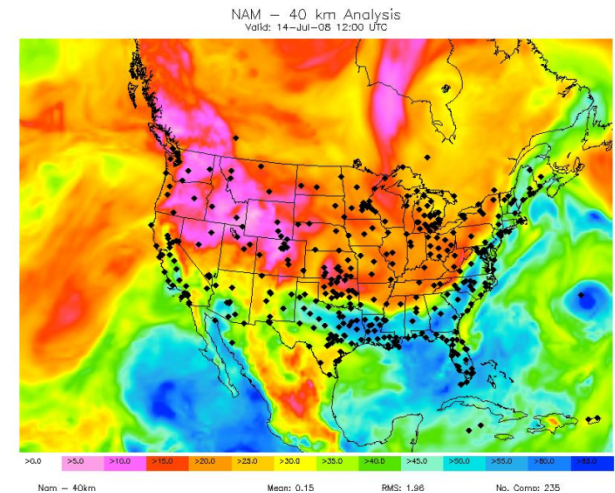
NDGPS Operating Partners

- United States Coast Guard
 - Systems operations and maintenance
 - Aids to Navigation (maritime)
- Army Corps of Engineers
 - Aids to Navigation
 - Dredging and underkeel clearance
 - Underwater survey
- U.S. Department of Transportation
 - Surface transportation applications
 - Safety systems
 - Survey and construction (AMG)
 - Quality assurance
 - Asset management
 - Roadside/ROW management
 - Law enforcement
 - St. Lawrence Seaway (with Canada)



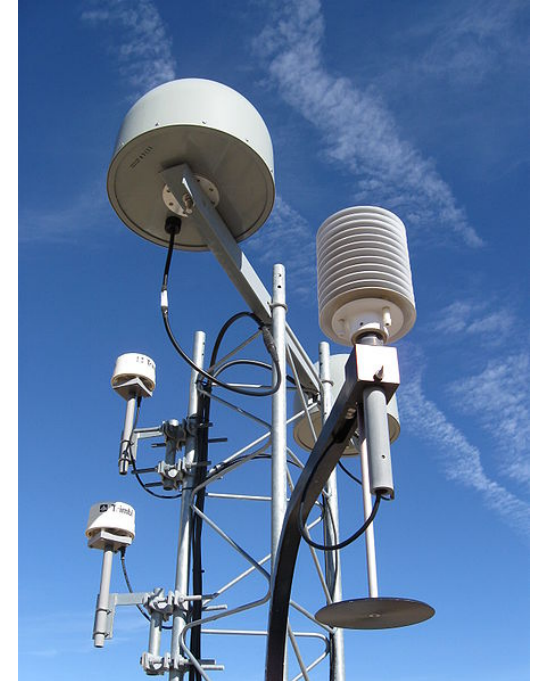
NDGPS Applications Partners

- Department of Commerce
 - Continuously Operating Reference Stations
 - Severe Weather Forecasting – water vapor estimates to national weather models
 - Space Weather Monitoring – free electron mapping
- Federal Resource Agencies (USDA, NPS, USGS)
 - One meter real-time positioning and navigation
 - Fire management and safety
 - Survey and mapping; GIS applications
- State, County and Local Governments, Private and Non-Profit Sectors
 - Lands, parks and environmental resources management
 - Precision agriculture
 - Mining and other resource management

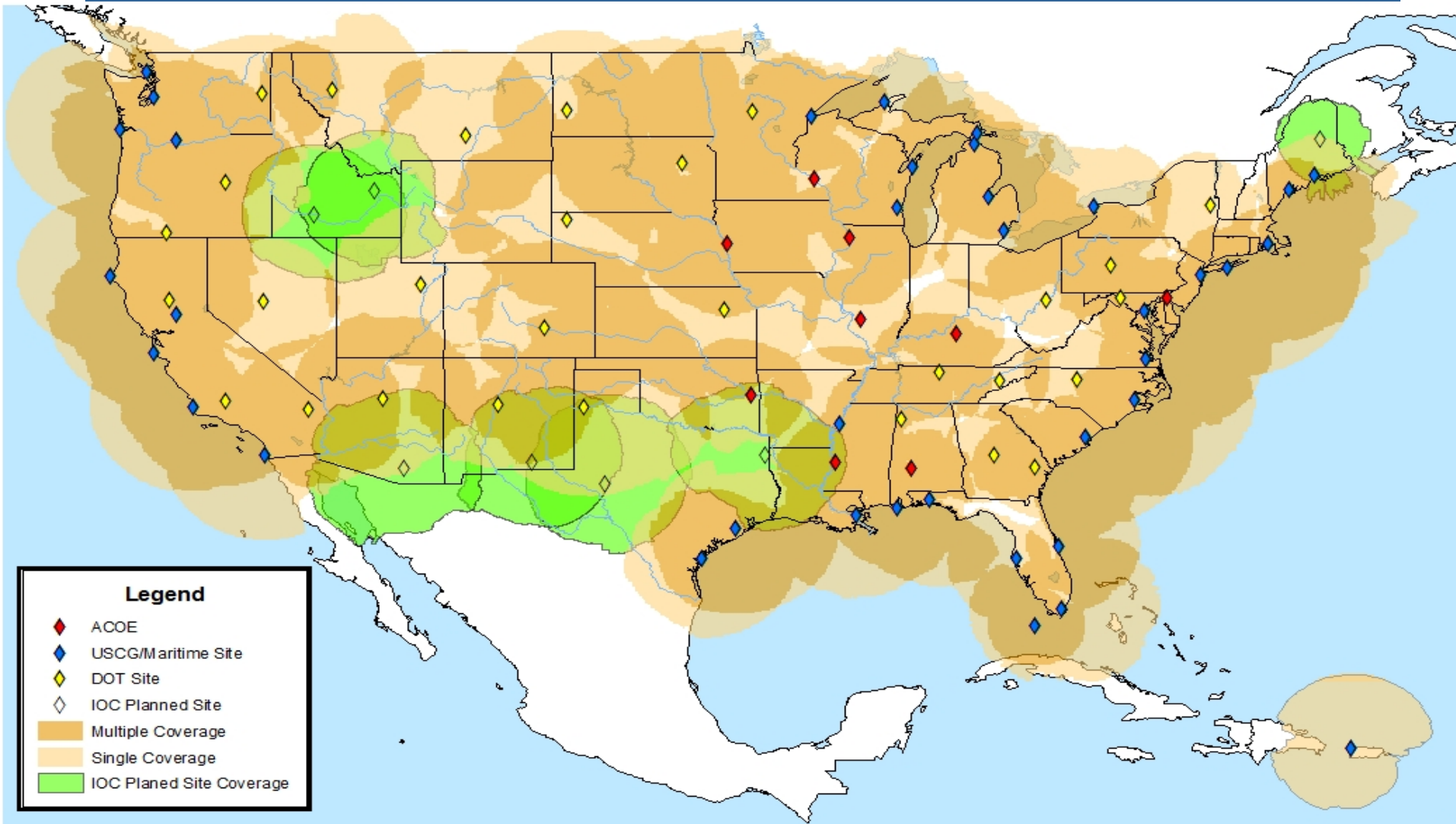


NDGPS Program Progress

- Inland (DOT) Tower Recapitalization
 - Upgrade reference stations/integrity monitors/antenna
 - Install IP-based operations system
 - Upgrade transmitters
 - Depends upon FY11/12 funding
- NOAA/NGS Test-Streaming Observables
 - Improve civil sector real-time user services
 - Provide enabling technology for location-based services
 - Improve reference frames, GIS/survey applications
- GPS Interference and Detection Monitoring
 - Critical infrastructure protection beyond transportation
 - Could support a Nationwide Emergency Communications System
- USDA NDGPS Study
 - Identify potential new services from existing or new NDGPS infrastructure
 - Recently initiated



NDGPS Coverage with IOC Towers



High Accuracy NDGPS Progress

- Goal: sub-decimeter dynamic accuracy for surface transportation active safety applications
 - Expected 2- 15 cm dynamic accuracy
 - 1 sec time to alarm
 - Moving towards prototype sites
- Coast Guard Engineering Change Request documentation complete
 - Test Procedures, Functional Tests for Prototype HA-NDGPS for:
 - Lincoln, CA
 - Pueblo, CO
 - St. Mary's, WV
- Pueblo Site Operational Since June – Coordination with FRA
 - High Accuracy solution compared to first order survey points very good
 - Federal Railroad Administration testing for potential use in Positive Train Control, Track Defect Location and Automated Asset Mapping systems
 - National Park Service using to compare to other PNT sources on Front Range
 - Discussions for autonomous vehicle use in Pikes Peak Challenge
 - More testing required

High Accuracy NDGPS Work in Progress/To Do

- Two Small Business Innovation Research (SBIR) Projects in Progress
 - Ranging
 - Phase I complete; achieved better than 10 meters
 - Results indicate standalone range of <100 miles
 - Phase II in progress: develop hardware and modify broadcast
 - Compression
 - Compress data stream, ionosphere, troposphere, to < 1000 bits per epoch
 - Awardee willing to make algorithm open source
- Still To Do
 - Integrity
 - Algorithms available; need to determine parameters
 - Lots of testing
 - Multi-site integration
 - Used brute force for earlier testing
 - Interpolation between sites is theoretically feasible
 - 3 epoch sub-decimeter solution
 - System testing



What Are We Trying to Get to?

- Intelligent Transportation Systems (ITS) Safety Applications for all Surface Modes of Transportation
 - Leverage technology to make vehicles discoverable to other vehicles, infrastructure, and pedestrians
 - Enable 360° situational awareness to the vehicle and driver
- Intelligent Railroad Systems
 - Assessing HA-NDGPS for meeting requirements
 - Positive Train Control
 - Track Defect Location
 - Automated Asset Mapping/Surveying

