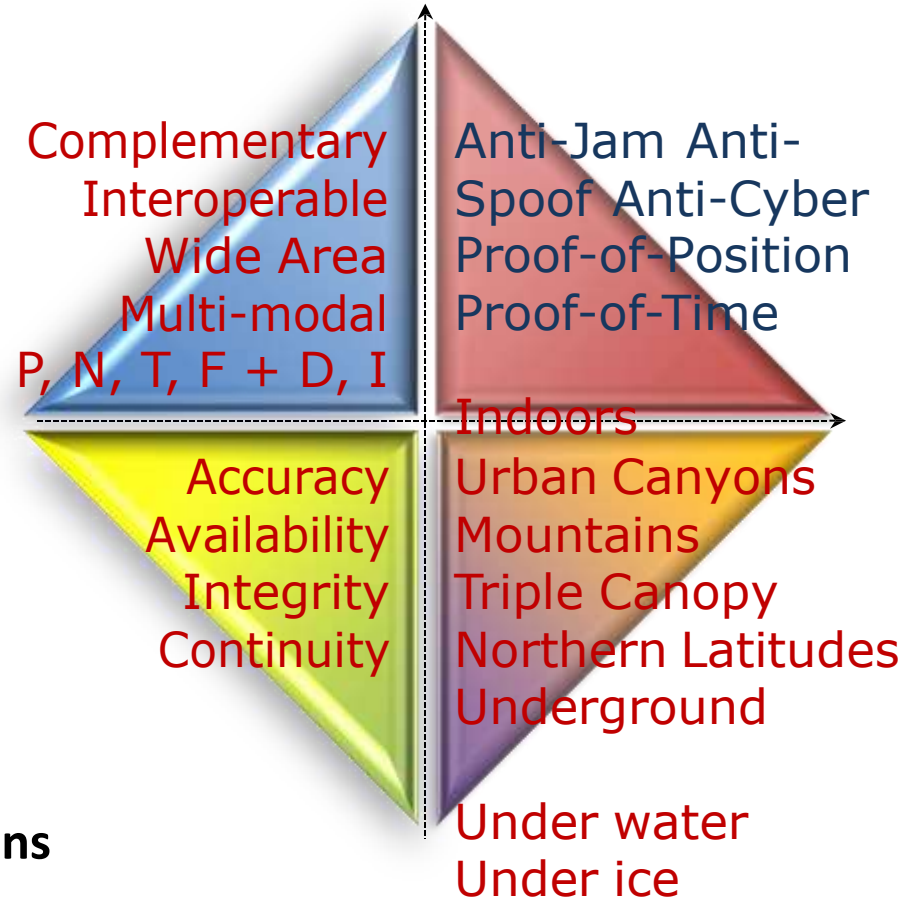
Enhanced Loran

Tested & Approved

- Government(s)
- Academia
- Industry
- Users

Technology Available Today

- Transmitters
- Transmit Antennae
- Receivers
- Receive Antennae
- Command, Control, Communications



Uses for eLoran

- Wide-area or localized **timing** source
- Stratum-1E **frequency** source
- **Critical Infrastructure / Key Resource protection**
- High-profile events (Olympics)
- Interference-enabled **crime fighting** (car theft, illegal border crossings, "toll" cheating, tracking felons)
- Heading / Pointing / Azimuth (Compass)
- Automatic Vehicle Location (AVL) services
- High-Value Asset Tracking
- Submarine communications and navigation
- GNSS/RNSS **Interference Detection and Mitigation**
- UAV / UAS / RPA solutions
- Irregular Warfare / Counterinsurgency (**COIN**) Operations
- Geo-encryption, -location, -fencing
- Third-Party **Data** Client
- **Military operations** (triple canopy, active jamming, mountainous regions)
- First responders (firefighters, EMT, police)
- Anti-cyber "data throughput" protection

Standard versus Enhanced Loran

Salient Differences

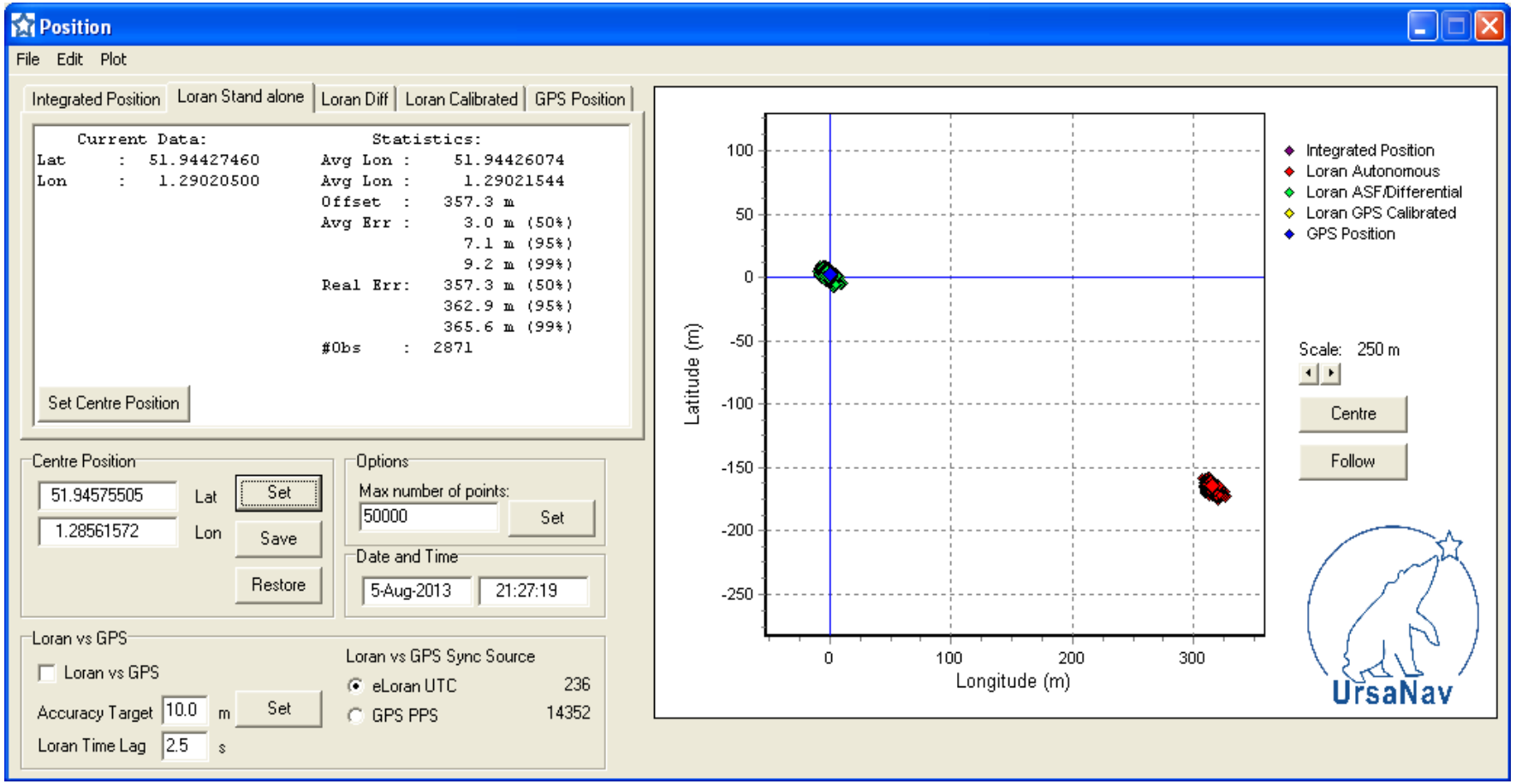
- Each transmitting site synchronized to UTC using "ensembling" of technologies and methods
  - Three Primary Reference Standards
  - GNSS, when available; not directly coupled
  - TWSTT
  - TWLFTT (completely "sky-free")
- Differential corrections
- All-in-View signals
- Data Messaging Channel(s)
  - 9th / 10th Pulse, Eurofix, other
  - Additional integrity
  - Differential corrections (dLoran or dGPS)
  - Other communications / navigation messages

Evolution

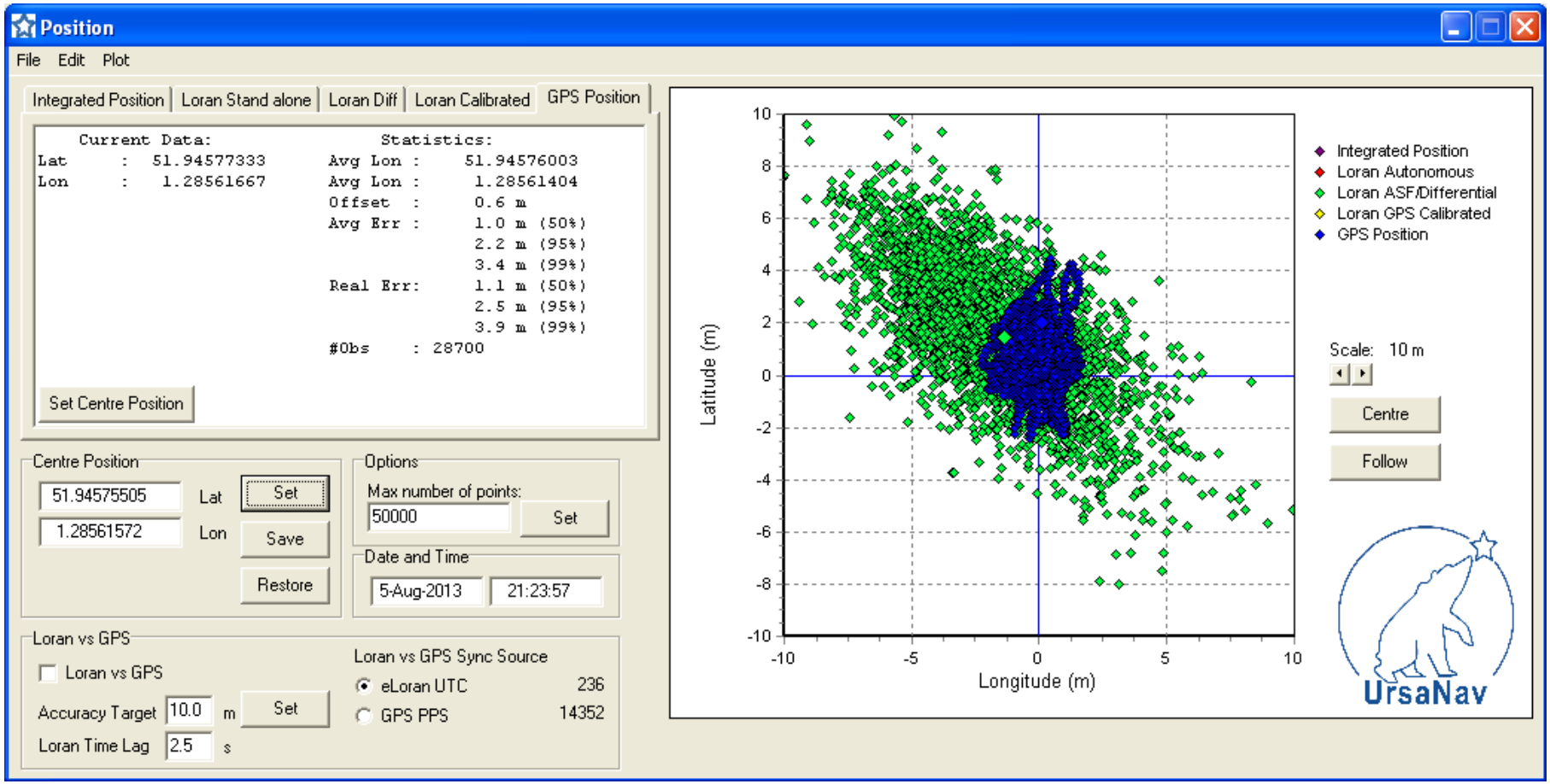
Supported Application	USCG Loran-C	Modernised Loran-C	Prototype eLoran	eLoran
Resilient PNT				✓
Maritime: Ocean		✓	✓	✓
Maritime: Coastal & Harbour			✓	✓
Aviation: Non-Precision Approach				✓
Stratum 1 Frequency	✓	✓	✓	✓
UTC			✓	✓
Precise Timing				✓
Land Mobile			✓	✓
Interference Detection & Mitigation			✓	✓

Source: Professor David Last

Standard Loran (Loran-C)

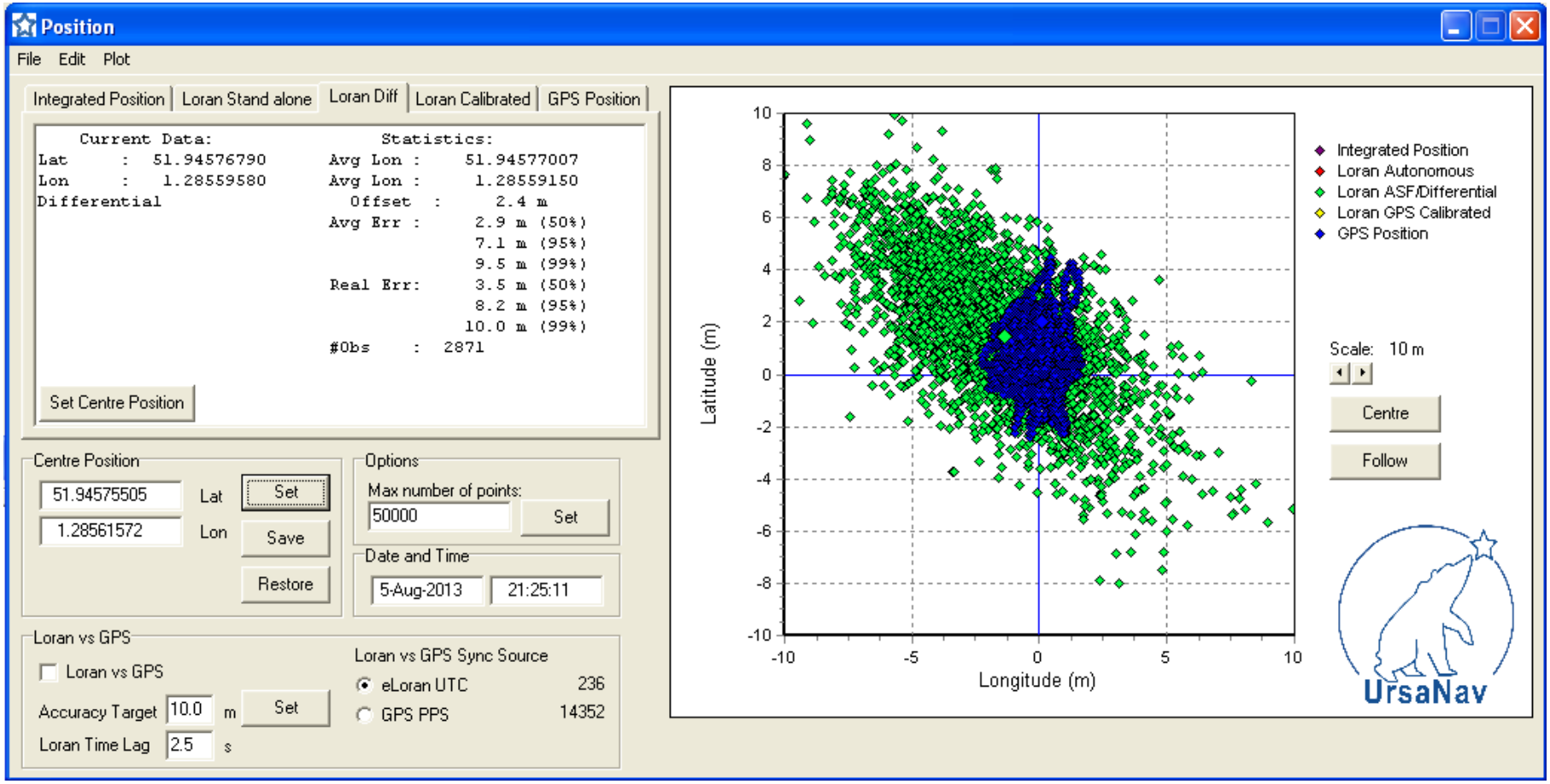


Stand alone Loran-C. Offset 357.3 m. Error of 7.1 m (95%) from surveyed position.



GPS. Offset 0.6 m (2 feet). Error 2.2m (95%) from surveyed position.

Enhanced Loran (eLoran)



Differential eLoran. Offset 2.4 m (< 8 feet). Error 7.1 m (95%) from surveyed position.

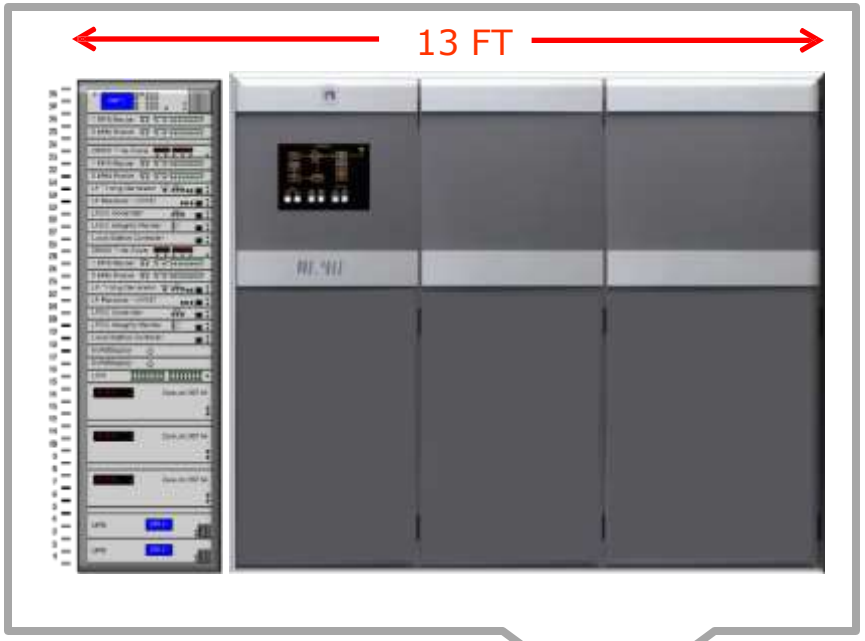
Note: 2.4 m equates to less than eight nanoseconds.

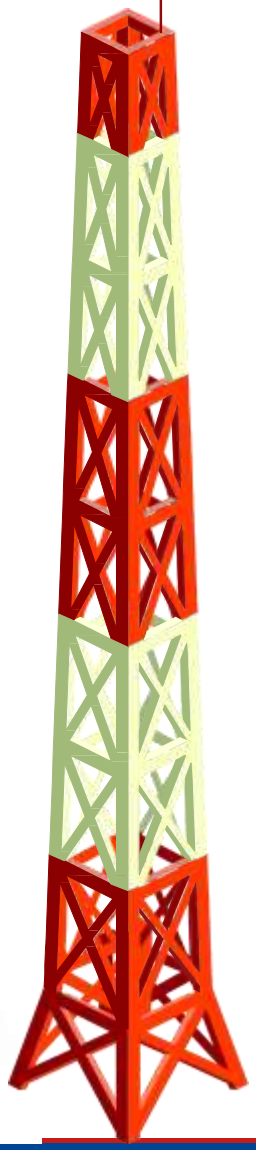
Technology

System Technology Solutions

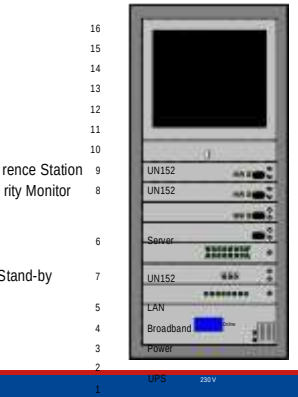
Timing & Control
- Remote Time Scale
  - Global or Sovereign UTC
  - Active Sky or Sky Free
- Local Time Scale
  - Triple PRS Ensemble

Transmitters
- State-of-the-Art
- Self Healing; Hot Swappable
- > 75% efficient
- Zero Maintenance
- Future proof

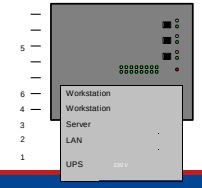




Control & Monitor Site



Differential eLoran Site



User Technology Solutions

"Software Defined" Receivers

- Multi-mode
- E- or H-Field Antennas

Availability

- Timing and Frequency
- Maritime
- Differential (ΔLoran) Reference Sites
- Scientific, Research
- Land Mobile
- OEM Module

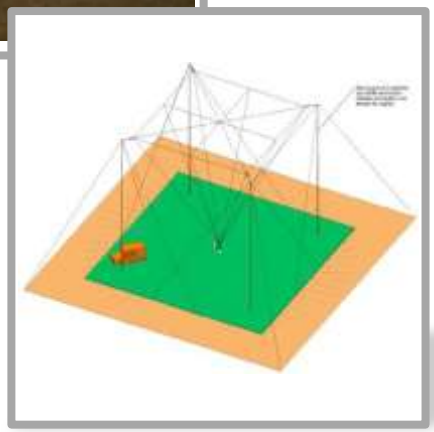
"Triple-T" Solutions

"Triple-T"

- Temporary
- Tactical
- Transportable

Field Tested

- 4-6 hours setup
- ~ 140 mile range
- 70' x 70' x 70' Inverted Pyramid
- "Box" truck mimics CONEX
- Successfully deployed three times



History of eLoran in the U.S.

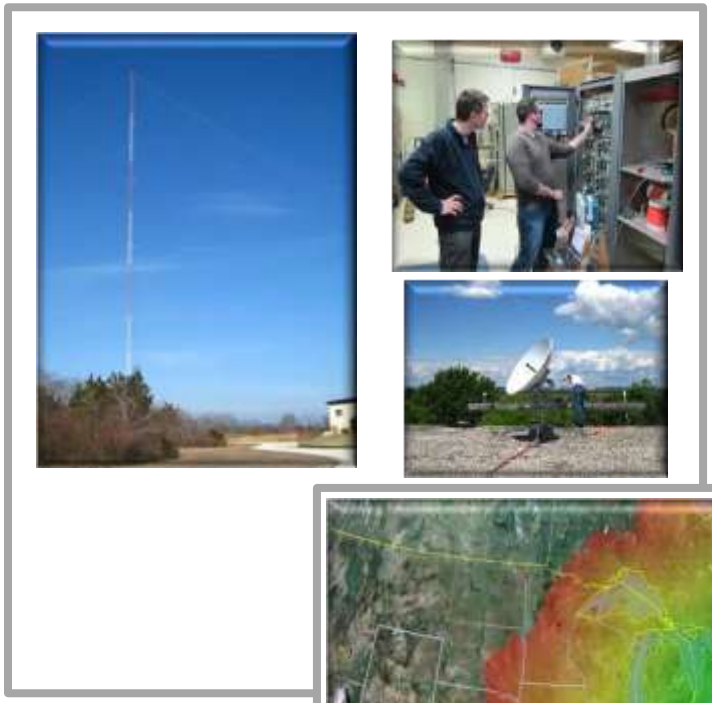
How did we get where we are at today?

- During the period from **1997 through 2006**, $160M invested to modernize and upgrade Loran-C to eLoran. Modernization and upgrade was never completed.
- In March **2007**, the DOT POS/NAV Executive Committee and DHS Geospatial/PNT Executive Committee accepted the findings of the Institute for Defense Analysis' Independent Assessment Team, and agreed to pursue the designation of Enhanced Loran, or eLoran, as a national PNT backup for the U.S. homeland.
- In February **2008**, DHS adopted eLoran as the national backup to GPS.
- In March 2008, as a result of NSPD 39, the National Executive Committee for Space-Based PNT tasked DOT and DHS with completing an action plan that included identifying an executive agent, developing a transition plan to address funding and operations, and requested approval by DOT and DHS Secretaries resulting in a final decision. DOD had not approved eLoran as a backup for military applications.
- DHS identified NPPD as the executive agent to carry eLoran forward.
- In February and August of **2010**, Loran-C was terminated in the U.S. while leaving the fate of eLoran uncertain.

The CRADA

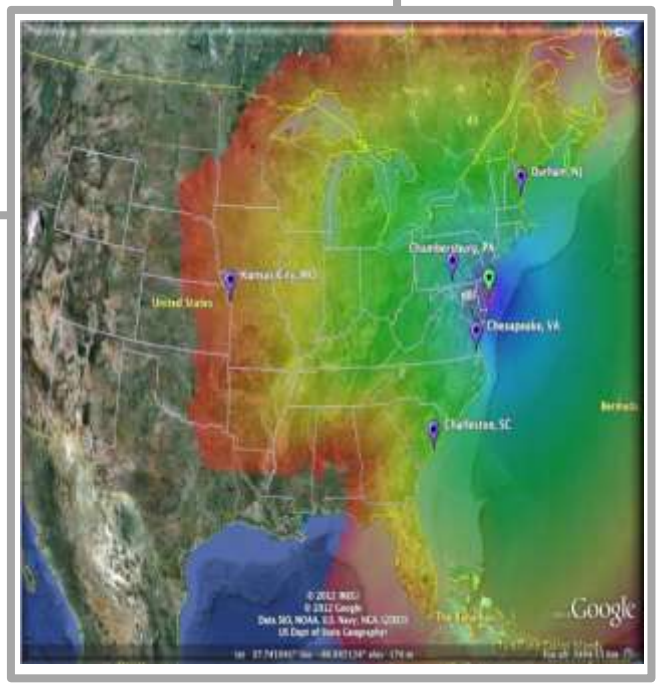
Cooperative R&D Agreement

- Effective February 13, 2012
- Not a contract
- No exchange of funding
- Typically 3-4 years
- USCG cancelling March 31, 2014 because of "lack of funding"



Cooperative

- Promotes R&D
- Government facilities
- Technology Transfer
- Public benefit
- Marketable product(s)

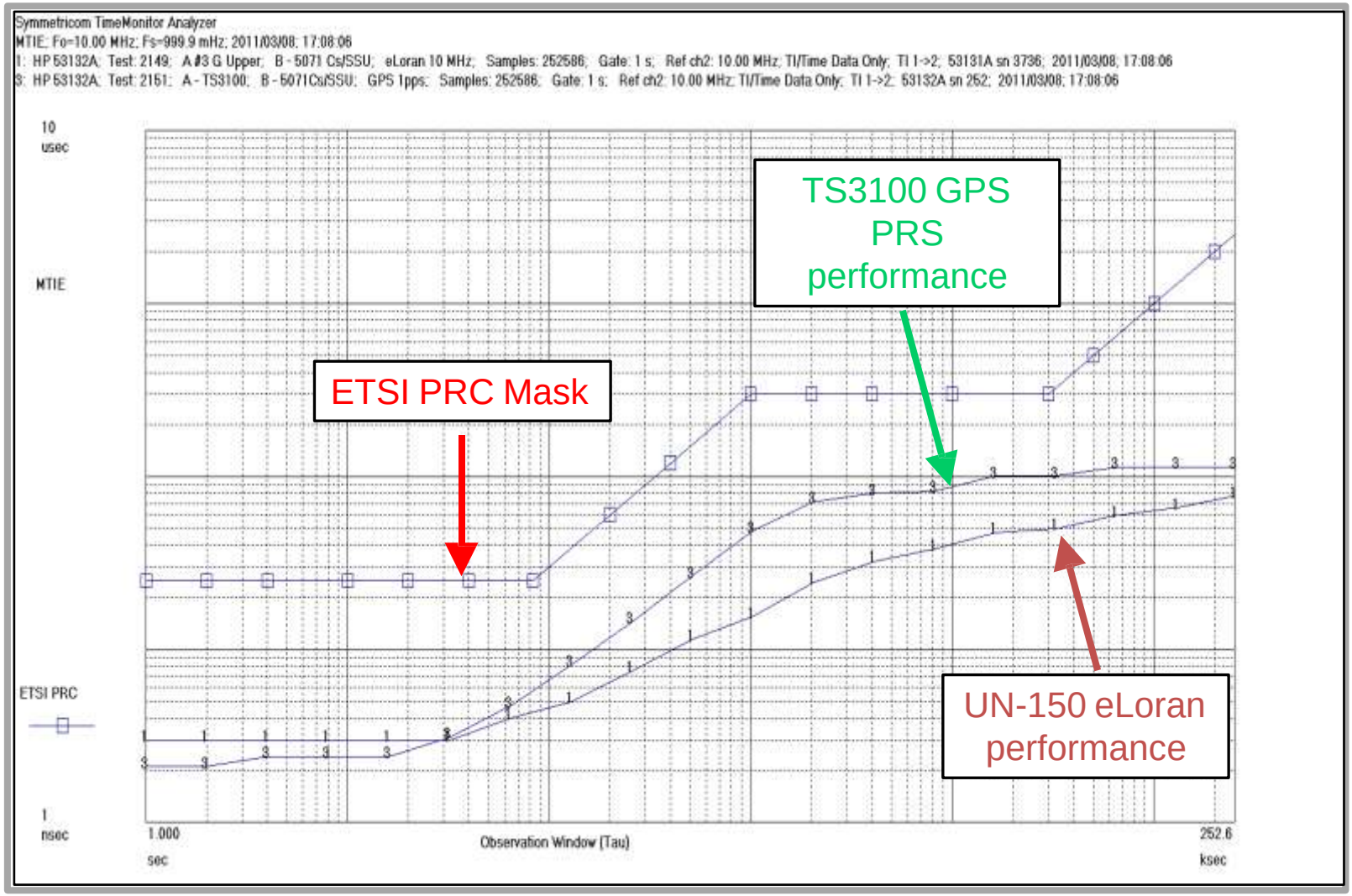


R&D

- Wide area time transfer
- Indoor T, F, & D recovery
- Improved alignment to UTC
- Performance as input to CI / KR
- Advanced waveforms & signals
- Advanced modulation techniques

CRADA "Case Studies"

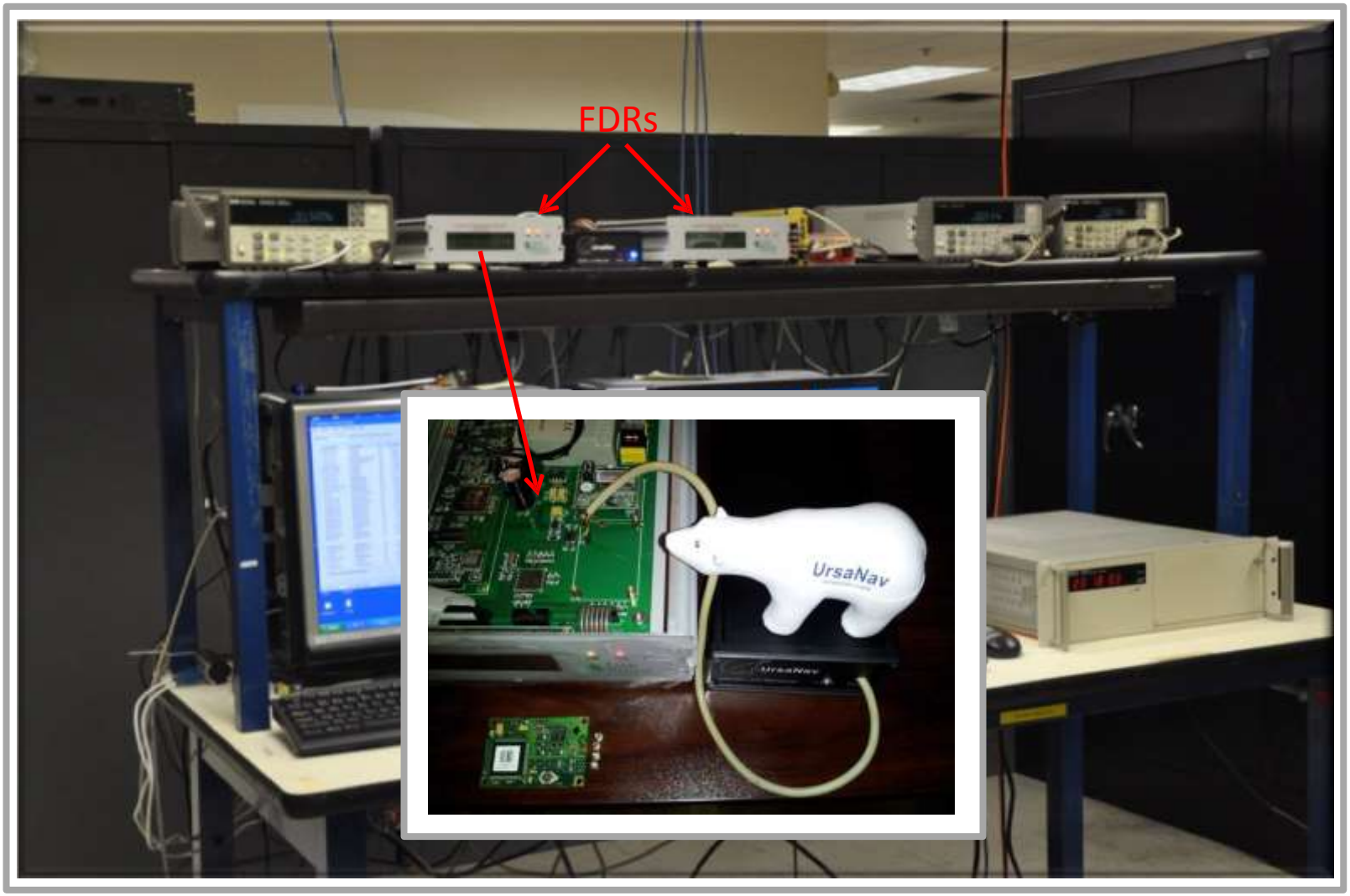
eLoran Timing Receiver MTIE Performance



Testing by Chronos Technology Ltd.

Additional Testing by National Physical Laboratory

Example: Electrical Power Grid



Example: Electrical Power Grid

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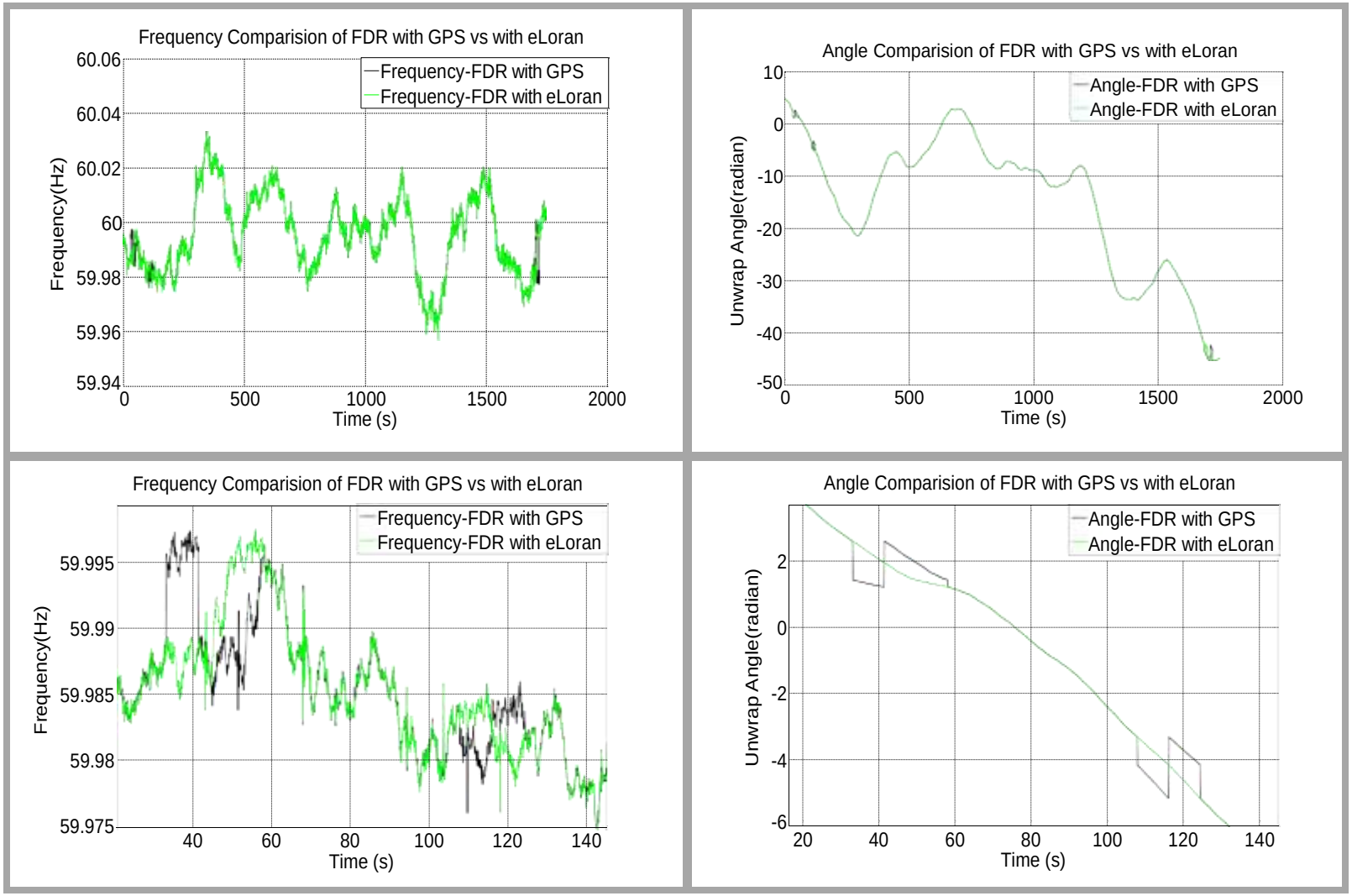

"That is great, now we can see the data from unit 905 and 913. Could you tell me which unit is using eLoran now?"

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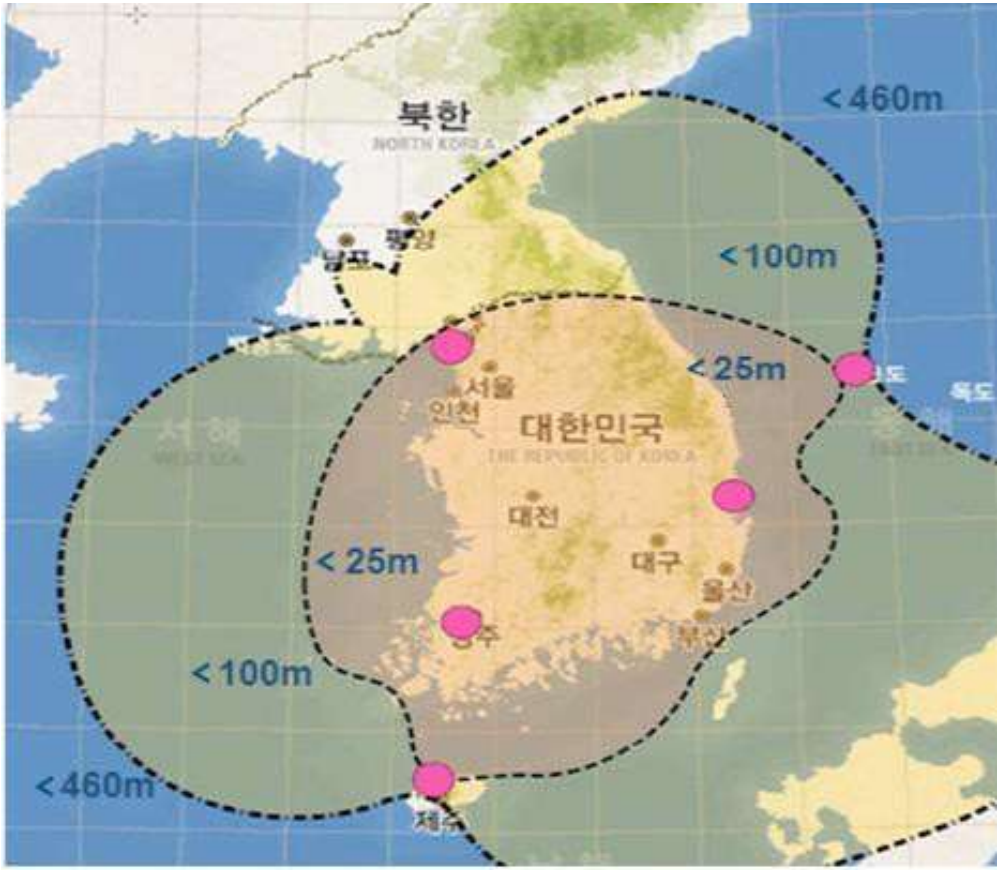
Global eLoran Initiatives

GLA dLoran System (United Kingdom)

- Contract awarded 2013 for 7 differential Loran sites
- General Lighthouse Authorities active in standardization efforts
- System expansion in 2015 to cover south, west & Ireland

Republic of Korea eLoran System



Predicted Accuracy of RoK eLoran System

International Tender in Process

Assignment of dLoran Reference Stations

Summary at This Point

- eLoran is **the answer** to "What is the most effective alternative to GPS Position, Navigation, and Timing (PNT) service over the broadest area at the lowest cost?"
- eLoran is **the result** of $160M in taxpayer investment and is a proven technology.
- Investment and development of eLoran is **shifting from the US** to foreign nations.
- **UrsaNav is committed** to helping realize broad scale international adoption of the technology.
- Today in the US **we are at a crossroads** where one path is to continue haphazard dismantling of real infrastructure protection capabilities and another is crafting a cost beneficial, technically sound, job creating, secure system for the delivery of co-primary PNT information types.

Way forward in the U.S.

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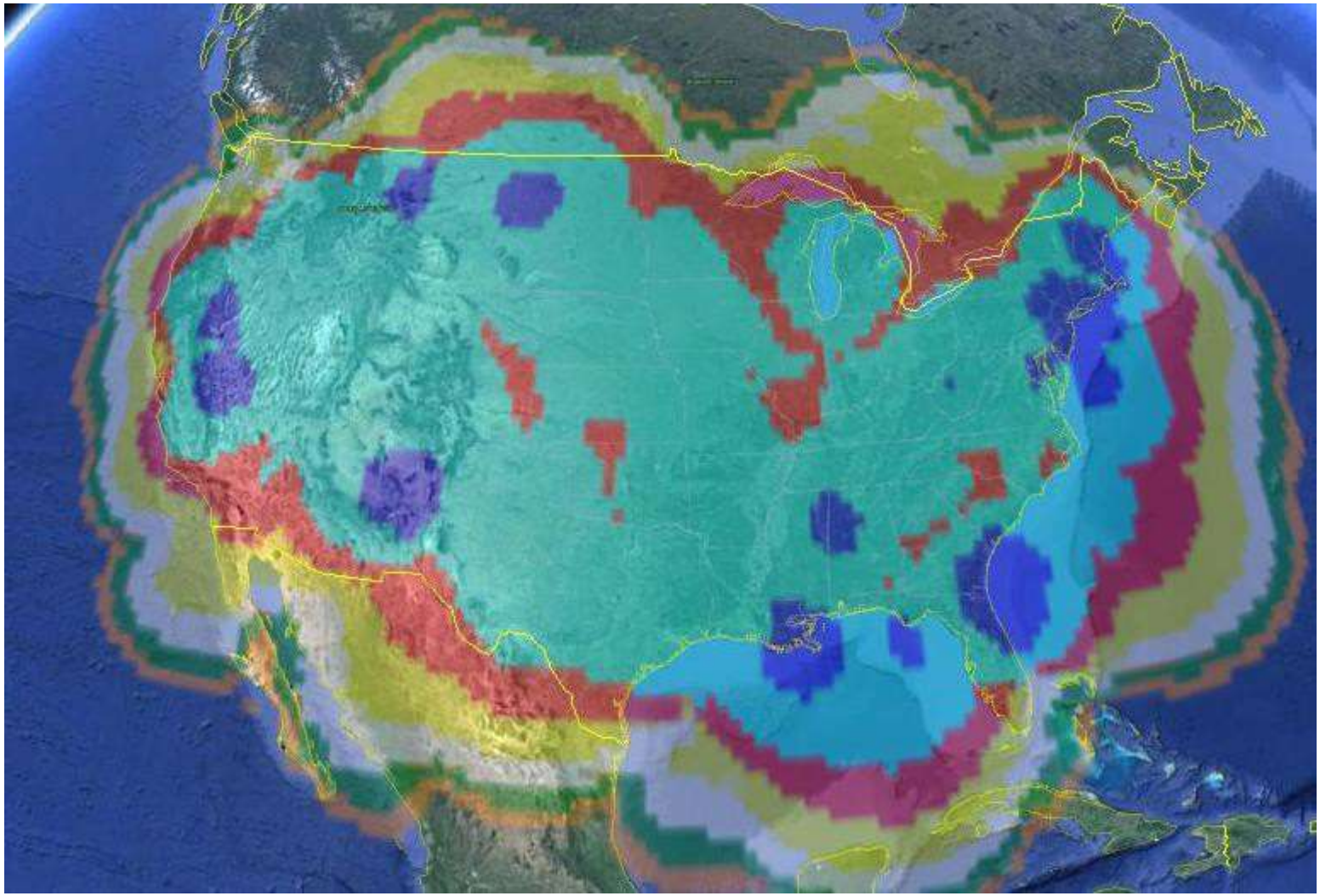
- Do Nothing
- Option 1 – Restart Government Owned/Operated Service
- Option 2 – Public Private Partnership
- Option 3 – Private Commercial Service

- For the Government, shifting from Option 1 to Option 3 results in increasing, decreasing, or equal:

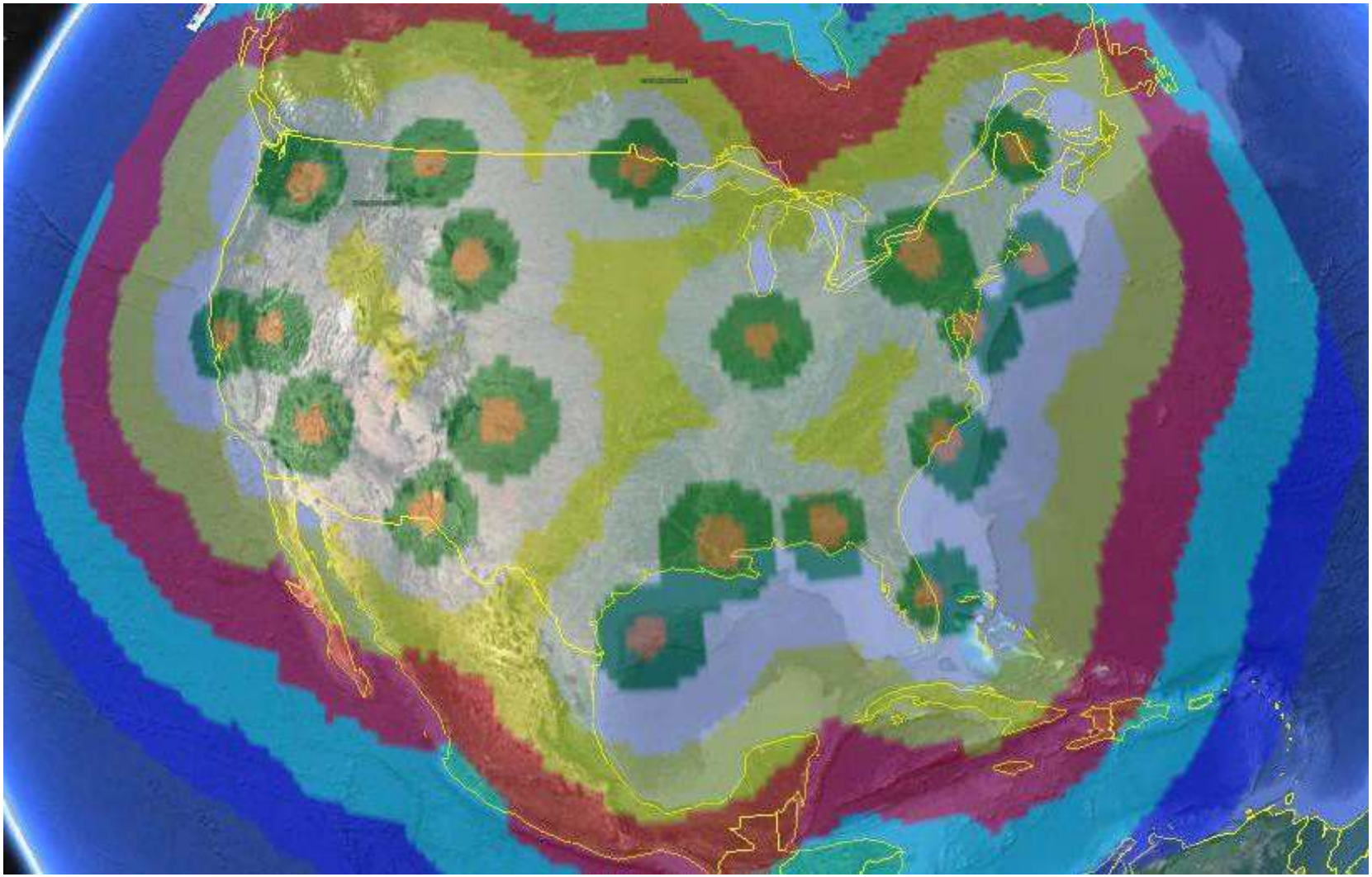
Public Private Partnership

- Possible Approach
  - Government loans existing assets (i.e. land, buildings, antennas, site equipment) under a 20 year lease
  - Industry provides necessary equipment and services to fulfill a service-level agreement
  - Tiered service with mechanism for revenue recovery to reduce or eliminate out-year costs to government
- Phased Approach
  - Initial phase resurrects 2008 era
  - Rapid build out of CONUS high reliability timing network (dual coverage)
  - Position and Navigation capabilities added later
- Benefits
  - Deferral of EC&R costs
  - Fulfills backup PNT capabilities per NSPD-39
  - Advances technology and creates employment

Nineteen Station Position and Navigation



Nineteen Station Timing Coverage



Market Applications

- Time and Frequency
  - Internet synchronization
  - Landline and mobile telephone systems
  - Power grid phase synchronization / Flow control
  - Paging systems
  - Stock trading / ATM transactions
- Maritime
  - eNavigation / Bridge Systems
- Aviation
  - General Aviation / NextGen
- Land-Mobile
  - High-Value Asset Tracking
  - "Farm- / Ranch-to-Fork"
- Location Based
  - First Responder

GPS and eLoran

UrsaNav