eLORAN: Global, Resilient & Co-Primary PNT to Protect Against GPS/GNSS Disruptions

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The Right Team - Purpose Built for eLORAN

Experts in PNT, able to delivery the right capabilities, globally
GPS/GNSS Vulnerability

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GPS/GNSS: Susceptible to many forms of Disruption

Weak GPS/GNSS signals make it vulnerable to:

- Interference
  - intentional (jamming)
  - unintentional

- Spoofing (fake GPS signals)
  - covert (Iran high jacking navy ships)
  - deception (tricking tracking devices)

- GPS Satellite Transmit Errors
  - Erroneous update data
  - Corrupted software
  - Failed updates (Jan 26, 2016)

- Multipath
  - Signal splitting reflection

- Cyber-Attacks
  - Non-Signal Issues

- Atmosphere
  - Storms/weather
  - Scintillation
  - Solar flairs/activity

PNT Resiliency and GPS/GNSS Independence is an international security protection priority
GPS/GNSS Jammers/Spoofers: Affordable, effective, proliferating
GPS/GNSS Disruption & Spoofing is a Global Problem
Sample of Global Independent Reports: GPS/GNSS is critical and vulnerable; eLoran is an ideal solution for a backup
eLORAN: Resilient PNT
Signals in Space and User Equipment
Enhanced Long Range Navigation (eLORAN) is a proven, land-based signal transmitted from 19 towers for national coverage. Invented in WWII and used through the 2010. **eLORAN is virtually immune to the weaknesses of GPS: “No common failure modes with GPS/GNSS or space systems”**

eLORAN attributes: range of 1,200 miles, can penetrate into buildings, tunnels, and is **3-5 million times stronger than GPS** making it nearly jam proof, while providing the same capabilities as GPS – **and eLORAN can work where GPS can’t**

The LORAN-C system has been sitting idle since 2010. It can be resurrected, modernized, and go operational as eLORAN quickly to reduce our risk threat. The 19 existing towers provide full PNT coverage for the United States to backup GPS and **act as a Co-Primary and interoperable PNT system to GPS/GNSS, given greater combined capabilities and accuracy then either alone**
eLoran: Low Frequency, High Power, Ground Based

- Now operating, UK Anthorn site transmitting
- *Unmanned / autonomous operations (low cost)*
- <99.999% availability. Air, land & sea, wearable PNT
- Terrestrial, Independent but interoperable with GPS/GNSS or any other PNT system
- Range of 1,200-miles per tower reduces required infrastructure 1 for timing, 3 for position & navigation
- Spectrum (100 kHz) internationally protected, free worldwide
- Up to 1MW transmits power, signal nearly impossible to disrupt
- Useable anywhere *indoors & underground, underwater (2m)*
- User antenna *integrated with receiver*, no need for roof or external installation – fully integrated user equipment
eLORAN: 19 USG Towers/Stations for National Coverage
LDC – LORAN Data Channel – “9th Pulse” – One Way Data

• The LDC is a channel within the high power eLORAN signal capable of 1-way data communications

• Multiple data channels per eLORAN station available
  • LDC range extends to 1,200 miles; LDC strength virtually 100% at 1,200 miles
  • Additional stations = additional 9th pulses = more data

• LDC uses include:
  • Encrypted, mission specific data messaging/SW updates
  • Authentication of eLORAN broadcasts (anti spoofing)
  • Secure, un-jammable command and control
  • Penetrates all structures, weather, underground, etc.

• Alternate LDC techniques can provide extended range and/or higher data rates (> 1000 bits/second)
  • Potential expansion of bandwidth by 8x
eLoran User CONOPS
PNT and Beyond
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Unmanned/Autonomous Systems, Navigation & Control w/LDC

- Assured navigation of all UAS (Air, land, sea, subsurface)
- Near Immune to jamming and spoofing
- Small, lightweight, inexpensive user equipment: receive & antenna integrated
  - 1 watt receiver, 2-3 watts antenna
- User equipment SWaP requirements ideal for small craft
- Command capability: go to location, return to home, control a swarm
- Activate a system: turn on/command a camera, avoid, destruct
- Truth detection of GPS errors
  - When eLORAN and GPS diverge
Former LORAN-C Sites: Easily Reconstituted to eLoran
The eLORAN Team
Partnered for Success
Contact Information

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Hellen Systems: Joint Venture Team

• Hellen Systems
  • Core background in private equity partnerships, government contracting, capital market structure, financial modeling & operations/legal
  • Broad experience company acquisition and build (100+ companies, total enterprise value of $1.5b)
  • Leading core team development, commercial market strategy development, primary capital raise and lobbying/advocacy efforts

• Macquarie Capital USA
  • US infrastructure focused private equity firm based in New York City
  • $395 billion assets under management, $17b in annual revenues
  • Extensive background in infrastructure related public private partnerships
    • Kentucky Wired: $1.8b fiber optic deployment PPP, service fee & hook up revenue model for 20 year period, Boston Skyway: $780m transportation project, Goethals Bridge: $11b, Freeport Energy (LNG) $15b in financing for large plant
Leaders in eLORAN and PNT: Harris Corporation & Microsemi

**Harris Corporation:** $17b in annual revenues
- Primary business areas: Network deployment, tactical radios, space based systems (GPS), radar & avionics, and engineering services and design
- Focus areas include complex, nation-wide network system design, deployment and operations, ground based system operations and
  - FAA ADS-B Program: $2.2b, 20 year, GPS positioning & ground based aircraft surveillance system operationalized through an integrated network of 650 ground stations – Won in 2007, PPP with the FAA & $100m company investment

**Microsemi Corporation:** $2b in annual revenues (wholly owned subsidiary of Microchip Corporation - $7b annual revenue)
- The industry leaders in time, frequency, and synchronization solutions for the US government, commercial, and national critical infrastructure operators
  - Sole provider of time and frequency equipment for LORAN-C since 2000, with key advancements in eLORAN technology & receivers
  - Led 2014 research contract for on-air eLORAN development w/USG
Leaders in eLoran & PNT: Booz Allen & Continental Electronics

• Booz Allen Hamilton: $6b in annual revenues
  • Primary business areas: Industry leaders in data analytics, engineering, cybersecurity, market development, strategic thought leadership and consulting
  • Broad experience in PNT and future architecture solutioning and implementation for critical infrastructure sectors for DOD/Civil & commercial
  • Deep knowledge in developing and testing eLoran receivers and building use cases for broader applications

• Continental Electronics Corporation (CEC): Founded in 1946, US base manufacturer of low frequency, high power transmitters
  • Primary business areas: US leading manufacture of radio frequency (RF) transmission equipment
    • Specializing in the design, development and manufacture of high power transmitter systems for global military, scientific, industrial and broadcast applications.
    • Well known worldwide legacy of eLoran transmission systems, providing these to the USG and other nations for decades.
    • Have deployed and supported these systems globally for over 70 years
Leaders in United Kingdom PNT: Chronos & NLA International

• Chronos Technology Ltd
  • Delivering global synchronisation and timing solutions to telecoms, energy, fintech, broadcast, enterprise IT & defence markets for over 30 years; optimising timing in communications networks and enabling our customers to deliver seamless services
  • Working closely with our global customer base, our team of technical experts provides complete solutions from knowledge, network design, solution specification, system integration, installation & commissioning and 24/7/365 hardware and helpdesk support
  • Experts in GNSS vulnerability mitigation including jamming & spoofing detection & eLoran deployment for timing

• NLA International: Blue Economy Solutions
  • Is a Blue Economy solutions company applying innovative technologies and processes to enable prosperous and sustainable growth in marine, maritime and coastal/littoral domains.
  • Delivering strategy, research, marketing and consultancy services to governments, NGOs and commercial clients.
  • Led the development and publication of the MarRiNav Report, focused on a resilient PNT strategy for the United Kingdom