Topic: N14A-T009

Toyon Research Corporation

Demonstration of a Local Carrier-Based Precision Approach and Landing System (LC-PALS)
Toyon's Adaptive eLORAN-aided Positioning and Timing (ADEPT) system provides all-weather GPS-denied navigation capabilities with centimeter-level accuracy for local carrier-landing applications and meter-level accuracy for global missions. Local, high-precision performance is enabled by novel transmitters with LPI/LPD waveforms, while a software-defined radio receiver provides global GPS-like navigation capabilities. The ADEPT technology leverages Toyon's advanced positioning, navigation and timing (PNT) solutions for cost, size, weight and power (C-SWAP) constrained platforms, which include manned and unmanned vehicles. The technology provides both local precision and global accuracy for virtually every platform that requires precise PNT performance under GPS-denied and anti-access/area denial (A2/AD) conditions. Technology feasibility was demonstrated through extensive analysis and simulation, while a real-time demonstration of the transmitter and receiver hardware in a relevant environment is currently underway.

Technology Category Alignment:

RF Components for sensing, transmission and communication
Autonomy
Advanced Electronic Protection Techniques and Technology
Radio Frequency (RF) (non-EW)
Guidance, Navigation & Control (GN&C) and Data Links

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Department of the Navy SBIR/STTR Transition Program

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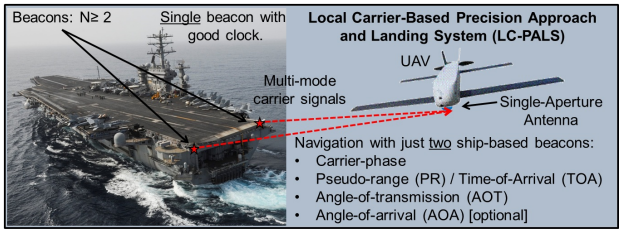
WHO

SYSCOM: NAVAIR

Sponsoring Program: PEO (U&W), PEO (A), AIR 1.0, PEO (T),

Transition Target: PMA-213, Landing Systems

TPOC:
(301)342-2193



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Other transition opportunities: All Navy, Marine Corps, Army, and Air Force systems that require precision local navigation and global absolute navigation under GPS-denied conditions will benefit from this technology. The technology can be miniaturized for use with most any platform capable of supporting a cellphone-like device.

Notes: Toyon's Adaptive eLORAN-aided Positioning and Timing (ADEPT) system comprises navigation beacons with a low-probability of intercept/detection (LPI/LPD) waveform and a software-defined radio (SDR) receiver that provides centimeter-level local positioning precision and meter-level global accuracy under GPS-denied and GPS-challenged environments. Unlike GPS pseudolites, which require four emitters, only two ADEPT beacons are required for precision (centimeter-level) navigation and none for global absolute navigation with meter-level accuracy. The SDR receiver can be miniaturized to be no larger than a cell phone and can provide global navigation without GPS. The beacons can also be miniaturized for tactical use or permanently installed wherever local precision navigation is required such as at airports or on aircraft carriers. The system also includes a military GPS receiver for when GPS is available.

WHAT

Operational Need and Improvement: There is a need for an all-weather GPS-denied navigation system that provides centimeter-level navigation performance during carrier landings as well as meter-level global accuracy. The system augments the Joint Precision Approach and Landing System (JPALS), which depends upon the availability of GPS, as well as optical-based landing systems that cannot operate in all-weather conditions, including fog, rain, hail, and sandstorms. Like GPS pseudolites, the system significantly improves the signal-to-interference-plus-noise ratio (SINR) under GPS jamming conditions, but unlike GPS pseudolites, which require four emitters for 3-D navigation and time, only two beacons are required.

Specifications Required: Aircraft carrier landing systems require a vertical landing precision of 10-cm, while most targeting systems require better than 10-m global accuracy. Moreover, these specifications need to be met under all-weather conditions and under intentional and unintentional interference.

Technology Developed: The Local Carrier-based Precision Approach and Landing System (LC-PALS) makes use of Toyon's ADEPT technology to augment JPALS under GPS-denied conditions to provide JPALS-like performance in all-weather conditions. The system uses frequency-hopping pseudolite-like transmitters/beacons placed around the aircraft carrier for precise landing. Unlike GPS pseudolites, which require four pseudolites for a position fix, LC-PALS only requires a minimum of two transmitters. When aircraft are out-of-range of the carrier and transmitters, the radio-frequency (RF) based GPS-denied navigation system uses signals-of-opportunity (SoOp) and partial GPS/GNSS for navigation using direction-finding (DF), angle-of-transmission (AOT), and time-of-arrival (TOA) measurements. Frequency-hopping enables LPI/LPD.

Warfighter Value: Robust and accurate Positioning, Navigation, and Timing (PNT) are vital to accomplish the warfighter's mission. The receiver and transmitter components of the LC-PALS system are each Navigation Warfare (NAVWAR)-compliant products that address current technology gaps under GPS-denied conditions while providing global GPS-like performance and local JPALS-like precision for aircraft carrier landings.

WHEN

Contract Number: N68335-16-C-0104 **Ending on:** December 18, 2017

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Electronics Fabrication and Testing	Low	Functional Prototype Hardware	TRL 4	September 2017
Airborne Demonstration	High	Local Navigation Performance	TRL 5	December 2017
Real-Time Airborne Demonstration	Med	Real-Time Local Navigation Performance	TRL 6	June 2018
Demonstration in Relevant Environment	Med	Local and Global Navigation Performance	TRL 7	December 2018
Operational Hardware	High	Performance on Relevant Platform	TRL 8	September 2021

HOW

Projected Business Model: Upon successful completion of the live system demonstration, Toyon seeks a Phase III program to miniaturize the hardware and conduct demonstrations on a relevant platform and under relevant operational conditions. Toyon's RF Products Team, which is AS9100 certified, will lead the Engineering and Manufacturing Design (EMD) effort to ensure that the system meets all relevant quality standards for military operation. While Toyon is capable of low-volume manufacturing, we will license the technology to prime contractors such as Raytheon, Northrop Grumman Corporation, L3 Electronics, and Spectracom for high-volume manufacturing. Moreover, the beacons and receiver technology are each unique products that have independent applications. Each will be separately marketed to appropriate prime contractors.

Company Objectives: It is Toyon's intent to use the Phase II effort to demonstrate the feasibility and performance of the ADEPT technology. This in turn will lead to greater interest by various Program Managers (PMs) and prime contractors. Hence, Toyon's short-term objective in participating in STP is to attract interested government PMs, as well as interested prime contractors. Toyon's long-term objective is to attract Phase III funding to carry-out the hardware miniaturization and the development of operational hardware. Once the hardware has been developed and demonstrated, we will license the technology to prime contractors.

Potential Commercial Applications: All military and commercial navigation and timing systems that require the ability to operate under GPS-denied or GPS-challenged environments are potential users of Toyon's ADEPT technology. This includes commercial aircraft operators and civilian airports. Homeland Security applications include the protection of our critical infrastructure from the effects of GPS interference, including the national power grid.

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