

# Robust Low-Frequency Spread-Spectrum Navigation System

UT-B IDs 200501614, 200501627



## Technology Summary

The Triply Redundant Integrated Navigation and Asset Visibility System (TRI-NAV) developed by researchers at ORNL expands the ability of GPS navigation systems to reliably function under a variety of adverse conditions, as well as detect multipath, jamming, or spoofing-induced errors. TRI-NAV synergistically combines the use of GPS with a ground-based radio-frequency (RF) scheme known as TPS (the Theater Position System) and a low cost, mid-level performance inertial navigation system (INS) for accurate navigation indoors, underground, and in those circumstances where neither GPS nor TPS signals are available.

A major operational liability for deploying U.S. military and law enforcement personnel is the nearly exclusive dependence on conventional GPS for accurate position information in the field. Since GPS signals are comparatively weak and subject to degradation from multipath and RF interference, GPS can be unreliable in adverse reception environments such as thick foliage, rough terrain, and urban areas; it is also susceptible to deception by an adversary. Inertial navigation systems have been proposed as backup systems to GPS reception but they are generally not suitable for field use due to cost, size, and power requirements.

By improving radiolocation performance and reliability where GPS reception is impaired or unavailable, TRI-NAV has the potential to become a useful extension to GPS-only navigation. The use of programmable software defined radio-based designs permits the rapid, adaptable returning of hardware to a wide range of operational frequencies to accommodate operational needs. The integration of modern GPS, TPS, and cost-effective INS modules, coupled with a new paradigm in low-power, high-stability timebase technology, can provide the U.S. military, emergency, and law enforcement personnel with a new level of dynamic location system accuracy, reliability, and availability, especially in adverse reception environments.

## Advantages

- Allows for accurate, reliable tracking and navigation in buildings, heavy foliage, urban terrain, caves, and underground with less interference than is currently available using GPS
- Provides additional level of safety for military and law-enforcement personnel

## Potential Applications

- Military, emergency, and law-enforcement safety applications
- Radio-frequency communications, wireless security, and intermodal logistics

## Patents

Stephen F. Smith and James A. Moore. *Robust Low-Frequency Spread-Spectrum Navigation System*, U.S. Patent No. US 7,876, 267B2, issued January 25, 2011.

Stephen F. Smith and James A. Moore. *Robust Low-Frequency Spread-Spectrum Navigation System*, U.S. Patent No. US 7,859, 464B2, issued December 28, 2010.

Stephen F. Smith and James A. Moore. *Robust Low-Frequency Spread-Spectrum Navigation System*, U.S. Patent No. US 7,626, 544B2, issued December 1, 2009.

Stephen F. Smith and James A. Moore. *Triply Redundant Integrated Navigation and Asset Visibility System*, U.S. Application No. 11/583,373, filed October 17, 2006.

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