Expert Advice — Why We Need eLoran

Mar 1, 2007
By: Len Jacobson
GPS World

I have spent 40 years on GPS and its predecessors (for example, 621B), so the reader might find it strange that I'm writing about Loran. I care very deeply that GPS become the world standard for navigation and fit seamlessly with other GNSS whenever they reach their full potential. Yet I've been disturbed for many years now about the slow pace in starting the development of GPS III because of the likely decay in GPS capability as the constellation ages, if no replacement satellites are available.

By now, most users are aware of GPS operational limitations in environments where it originally wasn't intended to operate and under benign or malignant interference. GPS III, with its added power and new L1C signal, should improve accuracy, greatly reduce vulnerability, and foster international interoperability. But GPS III is a decade away. We have to do something now in addition to getting GPS development started, and that is to consider eLoran as a practical solution. In talking to Loran experts, I uncovered quite a bit of information that I was not aware of. The results of that investigation make it clear that this is a reasonable approach to lower overall risk for GPS users.

As readers of this magazine know well, GPS is everywhere. It truly has permeated our society and influenced our lives, our commerce, and our safety. Consider, most new cars include a navigation system option — this would not be available without GNSS. (Except where I refer specifically to GPS, I use GNSS to mean GPS now, plus Galileo and others when available.) Commercial airliners often provide a little map display for passengers to track their flight's progress; it provides them (and also the pilot) the plane's position as determined by GNSS. Digital cell phones and ATMs, as well as the Internet, work because these secure local and wide-area networks use accurate time or precise frequency or both from GNSS. In such ways and others, GNSS has become an essential utility, and this will very likely increase in the near future.

Vulnerability. What does this have to do with eLoran? GNSS is vulnerable to disruption, and it doesn't work everywhere. This is demonstrated when entering a tunnel or parking garage or even traveling down a narrow city street: the navigation system generally alerts to "loss of satellite reception." Some interruptions of cell-phone operations or losses of other services for no apparent reason have been the result of GNSS interference. There have been examples of improperly tuned electronic devices reradiating noise in the GNSS bands, effectively jamming GNSS reception in entire harbors, near airports, or throughout large portions of cities. It is often difficult to find the source of such interference, and until it is eliminated, GNSS reception — and applications needing GNSS positioning or timing information — are unreliable.

Enhanced Loran, or eLoran, is independent of GNSS but fully compatible in its positioning and timing information, and its failure modes are very different. eLoran is based on the existing low frequency Loran-C infrastructures that exist today in the United States, Europe, and Far East, and in fact throughout much of the northern hemisphere. It is an internationally recognized positioning and timing service, the latest evolution of the low frequency long-range navigation (Loran-C) radionavigation system. But, to borrow a phrase from a carmaker's ad campaign, *it is not your father's Loran-C*, which dates from 1958, operated in virtually the same fashion until the middle 1990s, and suffered from inaccuracies due to users' inability or unwillingness to apply manual corrections for ground-wave signal propagation. Such corrections are now built into eLoran, seamlessly providing the accuracy and integrity needed for harbor entrance and approach in maritime navigation, for enroute, terminal, and non-precision approach in aviation navigation, and for stratum-1 or better time accuracy and frequency stability.

Seamless Backup. It is virtually impossible to prevent interference to GNSS. We can certainly try, but there may be a better way, and that is where eLoran comes in. In the event of loss of GNSS, for any reason, eLoran can be the seamless backup for critical applications. eLoran operates on a 100 kHz (low frequency) carrier at very high power levels. It is virtually impossible to jam and at that frequency propagates indoors far better than GNSS signals. Those attributes make it attractive as a backup and extension of GNSS for most applications. Moreover, the new technologies incorporated in eLoran make it ideal in this role.

eLoran is entirely new — at the transmitters, in its operating concepts and capabilities, and in its user equipment. The transmitters are all solid-state, "soft fail" devices that continue to operate for months or years without being turned off for maintenance, and even then, most repairs are made while the signals remain on air. They are driven by new frequency standards, three state-of-the-art Cesium beam standards operated as an ensemble at each transmitter, and the ensemble is steered to universal coordinated time (UTC, or in other words, steered to GPS time) as maintained by the U.S. Naval Observatory. Finally, the entire transmitter and timing system operates on an uninterruptible power supply, which ensures that even with loss of commercial power, there will be no momentary interruption of signals while the generators come on line.

Perhaps the most exciting changes from Loran-C to eLoran are the new operating concepts. All transmitters are timed directly to UTC, so that a user may use all eLoran signals in view, rather than only those in a Loran-C chain, and may combine them with GNSS signals for robust position and time solutions. Each transmitter includes a messaging channel; this is an in-band signaling channel that allows the eLoran signal to also carry information to improve the user's solution. Very much like GPS and the Wide-Area Augmentation System, this messaging channel provides transmitter identification, time of transmission, differential corrections, and authentication and integrity signals.

eLoran includes two types of corrections for the additional secondary phase factor (ASF) delays experienced by eLoran ground wave signals — differential monitor sites for temporal correctors and in-receiver survey databases for spatial correctors.

Born Digital. Finally, eLoran user equipment takes full advantage of all the advances made in digital signal processing. By the late 1980s, when Loran-C user equipment was still analog, most companies shifted to GPS user equipment, and the latter was "born digital," took advantage of robust digital signal processing techniques, and even pushed the state-of-the-art. There is today a nascent eLoran user equipment industry, which has applied these same digital techniques to processing of eLoran signals and has working prototype combined GPS and eLoran receivers. Limited production quantities could be available within a year or so, and prices are predicted to drop dramatically for full production.

In these equipments, the eLoran operation is set up to seamlessly extend positioning and timing performance into GNSS denied areas, during periods of interference, and for some applications indoors. Having such a seamless back up will also serve to deter those who would attempt to harm us by denying GNSS use through jamming — their efforts would have no effect on the critical applications, so why bother?

Why do we need eLoran? To extend and defend the global positioning and timing grid based on GPS today and in the future based on GNSS.

Len Jacobson is president of Global Systems and Marketing Inc., a consulting company, and a member of GPS World's Editorial Advisory Board. His new book, *GNSS Markets and Applications*, will be

available in June.