A low-cost solution to GPS vulnerabilities

Given that jamming a satellite is now as easy as a quick Google search, it's surprising that the global maritime sector has not placed greater urgency on finding an independent back-up positioning system.

For years, navigation experts have been warning governments and the maritime industry of the vulnerabilities of GPS. Whether unintentional (solar flares) or intentional (satellite jammers), the loss of GPS navigation with no back up can leave a vessel, quite literally, in an unknown position. Given that jamming a satellite is now as easy as a quick Google search, it's surprising that the global maritime sector has not placed greater urgency on finding an independent back-up positioning system. It is here in North Vancouver that Helmut Lanziner, the founder of ECDIS, has developed a solution.

The issue

Reporting on a panel session at a recent European Navigation Conference (ENC), Peter Gutierrez, with *Inside GNSS News*, provided a succinct summary of the issues with "At ENC 2014: A GNSS wake up call for Europe". (GNSS stands for global navigation satellite system.)

"GPS is in so many onboard systems today, that the people who run ships today aren't even aware of what all can go wrong when GPS drops out." Presenter David Last told attendees. "Satellites can fail. Solar flares can swamp the system. And there is intentional jamming." What's worse, GPS is now widely the only positioning tool on board.

Professor Last made the observation that one person can knock out all L1 to L5 bands, meaning GPS (global positioning system), WAAS (Wide Area Augmentation System primarily used in the aviation industry), Galileo (a global navigation satellite system currently being developed by the European Union), and Navstar (the network of U.S. satellites that provide GPS services).

In the same ENC session, speaker Erik Theunissen, from the Netherlands Defence Academy, compared GNSS with the Internet. "There was once a time when the Internet was young and everybody thought it was great and no one thought anything could go wrong. Then came the first high-profile hacking incidents. Then came deliberate attacks. And despite all our efforts, they have never stopped." Theunissen referenced such examples as the Newark airport case and the recent jamming of South Korean maritime navigation systems by North Korea.

While some experts in Europe are advocating for an international eLoran system — low-frequency, LOng-RAnge Navigation independent from GNSS — with Loran-C abandoned in North America, new infrastructure and significant resources would be required to make this a viable option and is impossible without government participation which appears slow in coming.

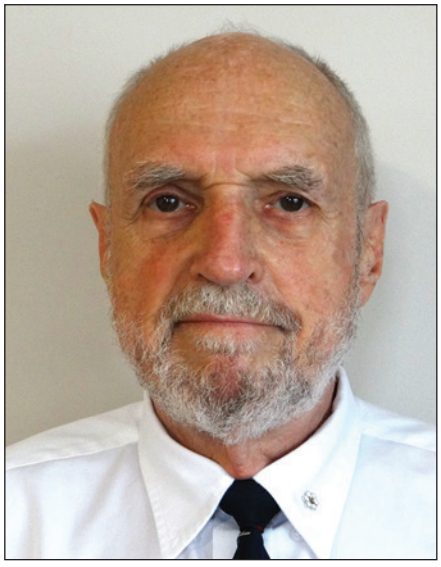
Bottom-line: there is currently no realistic back up for GPS and governments are slow to address the problem of GPS vulnerability. As far back as 1998, the *White House Weekly* reported on the U.S. President's "Commission on Critical Infrastructure Protection" described GPS navigation as the greatest single risk to America in the modern electronic era. And yet solutions continue to evade regulation, leaving ship operators and owners to fend for themselves to ensure the safety of crew, cargo and ship.

So what to do?

Enter — or rather, re-enter — Helmut Lanziner. Internationally recognized as the father of what is now known as ECDIS (Electronic Chart Display and Information System), Lanziner and Harvey Russell, President of Russell Technologies have developed Automatic Radar Positioning (ARP) or 'RadarFix', a system that provides 100 per cent redundancy in the event of failure of, or interference with GPS.

The Canadian solution

Few in the local shipping sector realize that ECDIS — likely the single largest advance in marine navigation since radar — was invented by North Vancouver local Helmut Lanziner, a pioneer in the field of positioning systems and electronic charting. Lanziner has received the Order of Canada, Transport Canada's 2005 Marine Safety Award, and the Queen Elizabeth II Diamond Jubilee Medal in recognition of his ground-breaking work. He was also a part of the Canadian delegation to the International Maritime Organization to deal with electronic chart-related issues.



Helmut Lanziner — internationally recognized as the father of ECDIS — provides a Canadian solution to GPS vulnerabilities.

For over 40 years, Lanziner has been at the forefront of positioning and navigation technology — he began working on positioning systems as early as the 1970s and supplied the first self-contained operational electronic chart system (PNS, or Precise Navigation Systems) for six offshore supply vessels and dedicated icebreakers in the Canadian Arctic. He went on to develop PINS, or Precise Integrated Navigation Systems, and then further developed PINS to include radar information and other sensor integration in ECPINS, or Electronic Chart Precise Integrated Navigation System.

Lanziner also developed radar image overlay to identify uncharted hazards relative to a ship's own position. In 1989, while at Offshore Systems Ltd. — the company he founded (noting he has since moved on) — Lanziner undertook the first trials of RadarFix, a patented radar positioning technology. Originally developed for stand-alone operation in confined waters, ARP has evolved to become an interface to existing shipboard radars and

provides a completely independent, low-cost back up to GPS/GNSS. It requires no additional navigation equipment or infrastructure external to the vessel.

RadarFix can serve as a totally independent, low-cost, and robust backup to GPS/GNSS without the need for any additional navigation equipment or infrastructure external to the ship.

The evolution of RadarFix

Prior to GPS, international efforts focused on coming up with a practical and economic solution for precise, highly reliable, land-based positioning. In order to reduce the complexity and cost of these types of installations, Lanziner undertook development work on a system called RadarFix. The plan was to adapt standard marine radar to become a highly-accurate automatic positioning system by accurately determining range and bearing to distinct shore-based radar targets, and determining position by solving for geometry.

With the integration of a personal computer and software to standard marine radar, RadarFix could extract measurements from existing radar targets of different shapes in a sophisticated manner to yield accurate range and bearing information. Effectively, it can subject the geometric shape resulting from the combination of measured targets to a pattern-matching process with a previously established database. Detailed parameters about the size and shape of these targets are entered into this database, together with precisely surveyed co-ordinates. This allows the radar to work not only with isolated point sources, but to use information from larger structures, such as faces and corners of buildings, edges of docks, and line-ends evident on jetties. The resulting position accuracies are two to five metres (95 per cent).

Fast forward to present day and the current iteration of RadarFix has some major differences in functionality and performance compared to previous versions. One of the most time-consuming and complex aspects previously was setting up a RadarFix network. This included surveying the reflector/target sites and providing a detailed description of potential targets. Establishing survey control was costly, which normally resulted in the use of fewer targets than necessary for optimum results.

With GPS/GNSS and accurate heading information available today, this is no longer the case. As an integrated input to RadarFix, these sensors provide a constant position and bearing reference for the acquisition of any number of targets. While target position determination used to be a one-time opportunity (i.e., all measurements were made during the setup), it is now an ongoing process. The system can continuously check, verify, update and refine target positions. It will allow for the addition of new targets on an ongoing basis, as well as further refinement of target shapes and positions through many hundred, or even thousands of radar observations from different perspectives, with the benefit of a continuous accurate position and heading reference of own-ship.

In addition, given the processing speed of today's computers, the number of targets that RadarFix can now process simultaneously has increased by orders of magnitude to enhance position accuracy and reliability.

Today's RadarFix can be used with existing targets. Many of the original RadarFix installations had specially designed radar reflectors to discriminate against background clutter. Experiments and trials in some operational areas revealed that by utilizing existing targets, it is possible to achieve the same level of accuracy and reliability as that accomplished using built-for-purpose reflectors. The result is that special reflectors are not always necessary and that the standard marine radar, as installed on the vessel, will deliver reliable positioning performance.

Peace of mind

RadarFix can serve as a totally independent, low-cost, and robust backup to GPS/GNSS without the need for any additional navigation equipment or infrastructure external to the ship. One of the main weaknesses of GPS is in the low energy of its signals and the relative ease in which jamming devices can be effective. With radar signals being more difficult to jam, RadarFix is well-suited to serve as a back-up. And since RadarFix works with existing radar installations on ships, all that is needed is a sensor interface between the radar and a computer, together with RadarFix software. In addition, shore-based infrastructure that RadarFix needs to perform in most operational areas consists of existing radar targets and inexpensive reflectors that can be added to augment the system in difficult operating areas.

No less than seven international conferences were held in the last year to address the issue of GPS vulnerability with a number of experts predicting that it's only a matter of time before a major incident occurs. And while governments around the world continue to ignore the reality of GPS vulnerabilities, at least one solution is being developed that can provide peace of mind for ship owners and operators. Russell Technologies is in the process of translating the old RadarFix software onto new platforms with current software technology. A demo system is expected to be up and running in Vancouver by the beginning of 2015.

For more information about RadarFix, contact Helmut at: HLanziner@russelltechnologies.ca or visit www.russelltechnologies.ca. BCSN