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DEPARTMENTS

LETTERS
to the Editor

Still Not a Thing

I always enjoy reading your comments. However, I have some comments on your last article ["Thinking Aloud," MayJune, *Inside GNSS*]

1. MOPS stands for Minimum Operational Performance Standards, not specifications.
2. ICAO does not produce MOPS; RTCA does.
3. MOPS are not mandatory until ordered by FAA or another nation.

Most airlines that travel over oceans or other areas where there are no ground communications are equipped with ACARS and can communicate with the ground through satellite. The cost of transmissions is too expensive to transmit location info all the time. A line-of-sight link is used domestically that can transmit location info (this operation is called ADS (automatic dependent surveillance). Several years ago the USAF had a program for a radar in space that could monitor all aircraft in a given coverage area. I think this may have been cancelled when the threat changed from aircraft to missiles. Plus we have other ground radars (satellite also for missiles) that can detect aircraft and missiles earlier before they reach the US. Bottom line is that the cost of aircraft equipage is not the main problem but the cost of transmission via satellite is. Domestic location is not a problem using secondary radar, Mode S and other links that aircraft have today.

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Response to Secretary of Defense

"I hate GPS. . . . 20 years from now we won't be buying GPS satellites." Ashton Carter in June 2014 podcast [See article on page 14.]

Who would have the audacity to contradict the SecDef? Well, there's always me.

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track signals independently to provide precise code and carrier phase reference measurements as well as signal-quality measurements and other integrity monitoring metrics.

Housed in a 19-inch rack-mount enclosure with AC power supply and integral cooling fans, the G-III reference receiver platform has been customized to meet the needs of individual satellite networks. In addition to the QZSS G-III product, NovAtel supplies U.S. Wide Area Augmentation System (WAAS) G-III reference receivers to the Federal Aviation Administration and IRNSS G-III reference receivers for the ground control segment of the Indian Regional Navigation Satellite System (IRNSS).

In 2013, NEC Corporation received the contract to build the QZSS ground control system. IG

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Ashton Carter's administrative authority has far-reaching consequences. "Techies" have very different kinds of influence, coming from very different experiences. If administrators and techies reach opposite conclusions, administrators often hold sway — whether right or not — with major ramifications. Example: Loss of Loran could have been permanent. Thank God we dodged that bullet.

So, as a techie, I'm light years away from the power that comes with being Secretary of Defense. He is equally distant from techie-based experience. If Mr. Carter had criticized how we use satnav data, I could have agreed with him. When he blasts a GPS system "that doesn't work in certain circumstances" and cites a need for cooperation between technology companies and DoD to mitigate technology-based risks, he's banging the same drums I've hammered for decades, most recently at the last National Space-Based Positioning, Navigation, and Timing (PNT) Advisory Board meeting <http://www.gps.gov/governance/advisory/meetings/2015-06/farrell.pdf>.

Discussion from here can aim at two objectives. The first, in uncompromising disagreement with Mr. Carter, will be followed by addressing his legitimate concerns just noted.

In regard to his advocacy of inertial MEMS-based PNT that "will never need a satellite" I must assert: That's unrealistic. My thousands of hours spent with real-world GPS and inertial measurement unit (IMU) data were preceded by thousands more, analyzing inertial plus myriad other navigation sensors.

My first integrated nav book (1976) included two chapters dealing with inertial instruments. Much concern with IMU performance is focused on drift. There were literally dozens more sources of accelerometer and gyro errors documented in the 1950s. Incredibly, nav analyses today give scant attention to them. Most are sensitive to motion, both translation and rotation, with coefficients that defy precise calibration due to aging, thermal effects, and their sheer plurality. Many degrade with vibrations — and a zero average vibratory excursion will emphatically NOT produce zero average error. Others, in marked contrast to gradual drifts, introduce consequential errors abruptly. IMUs will require updates for the foreseeable future.

Returning to Mr. Carter's words that GPS "doesn't work in certain circumstances," I'll cite a glaringly obvious reason for that. By imposing excessive requirements riveted into operational specifications, our industry inhibits satnav's intrinsic versatility. Unless we have a full fix plus more for RAIM, on a silver platter every time, we declare "loss-of-GPS" — and that's only the beginning.

Pinpoint positioning is obsessively pursued, even when there's an often overriding importance for velocity. A vital measure of that, 1-second change in carrier phase, is discarded from virtually all operational systems (if they use phase at all). A vast majority still use loose GNSS/IMU coupling and "velocity observables" derived from position history.

Most GNSS receivers exclude individual satellite measurements from the output interface (thereby wantonly squandering partial fix information; ancient mariners would have laughed us to scorn). Not only tight but ultratight coupling should now be ROUTINELY used for its well-known improvement of signal-to-noise ratio (typically over 20 dB), but hooks for aiding-signal insertion don't exist. After decades of unheeded advocacy, lost opportunities for both the FAA's NextGen and DoD are now surfacing.

All the needed measures are compatible with efforts elsewhere for protection against jamming and spoofing. In closing I'll revisit Mr. Carter's desire for industry's cooperation with DoD. Here's a GIANT step in that direction: Have manufacturers make the individual satellite measurements available for processing in user equipment, which most GPS receivers don't do. Without such data, user equipment is unable to perform receiver autonomous integrity monitoring or tight integration or high-accuracy mixing with other sensors — because averaging coordinates can't deliver good performance — or differential operation or anything that makes use of partial data. Furthermore, receivers should allow not only reading individual satellite measurement data but also writing aiding signals to tracking loops. No need for proprietary software then — so, more than a half-century late, DoD could finally stop repeating full price payments every time there's any modification.

OK, an acknowledgement is owed — a mountain of good work has been done on satellite navigation. But with current conditions this is no time to bask in glory. Clearly it's time to adopt overdue fixes.

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