

ASSURING PNT: TRUST THE BLUE DOT



AC²ES, embedded in the DDUx tactical computer, works in parallel with the Army's efforts to move beyond standard GPS by adding A-PNT technologies to currently fielded hardware.

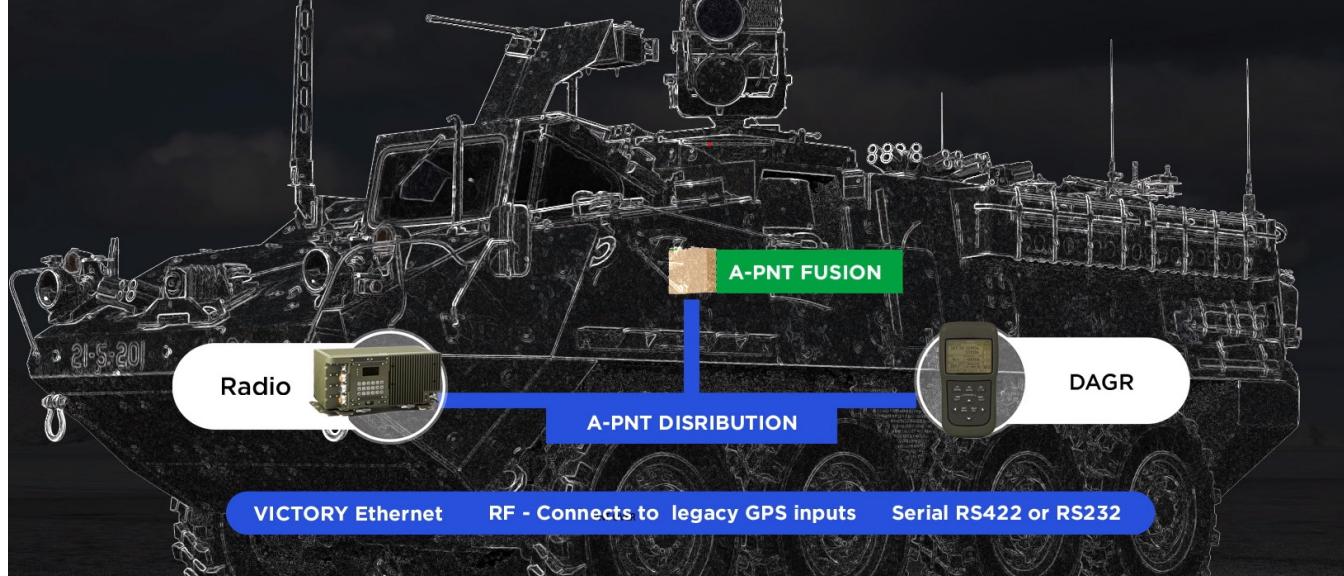
Every Army and Marine Corps system that uses positioning, location, or synchronized timing requires Assured PNT. With the Army's A-PNT program of record currently targeted at only a fraction of their tactical vehicles, an affordable interim solution is needed to face this constant and near-term threat.

SITREP

When it comes to interference against military assets, much of the attention falls on cyberattacks and electronic warfare against networks and communications. Less well known but equally damaging are attacks against the US Global Positioning System (GPS) and European Global Navigation Satellite System (GNSS) that prevent US and friendly forces from using accurate Positioning, Navigation, and Timing (PNT) data to conduct missions.

Without those systems functioning properly — even in disconnected, intermittent, and limited (DIL) environments — troops and vehicles are blind to their own location on the battlefield and to the location of friendly forces.

Attacks against PNT have been ongoing for more than a decade — and it's becoming more



The AC²ES fusion engine evaluates and combines PNT inputs from system components in order to provide a reliable navigation solution during real-world jamming and/or spoofing attacks.

common as we've moved into a near-peer competition with our biggest adversaries. In recent years, PNT was compromised in the 2008 Russian attack on Georgia and again in 2014 when Russia annexed Crimea. Breaking Defense has reported that Russia often spoofs global positioning signals to mask the movements of President Vladimir Putin.

Spoofing and jamming are two of the multitude of ways that PNT can be compromised. Of the two, spoofing is the more worrisome. When GPS is jammed, the signal is lost but the user knows it and can take caution. (For readability, references to GPS include GNSS.)

More dangerous to the warfighter is spoofing. With spoofing, the adversary feeds you an incorrect signal, so you believe you're at one location when actually you're somewhere far different. It affects logistics and the security of supply lines, it affects the ability to properly target, and it can lead to fratricide.

To address the potential loss of PNT, the Army has developed a couple of different options for what is known as Assured Positioning, Navigation, and Timing (A-PNT), with the Army's platform A-PNT program of record called the Mounted Assured Position Navigation and Timing System (MAPS).

MAPS works, does the job, and is being fielded now. However, it is only for key leader and key capabilities vehicles that number in the thousands. There are 90,000 plus mission command-equipped tactical vehicles in the fleets of the U.S. Army and Marine Corps, however, the

limited MAPS fielding means that only a small fraction of Soldiers and Marines will receive A-PNT capability.

MAPS is also a single-purpose solution that requires the placement of a standalone box and installation kit inside of already SWaP-constrained military platforms.

To address those issues, Leonardo DRS has developed an interim A-PNT solution that is both affordable and scalable, called AC²ES (A-PNT Converged Computer-Embedded and Scalable). Specifically designed for tier-two and tier-three vehicles that will likely never get MAPS, AC²ES is an affordable solution that lets the Army and Marine Corps accelerate the capability fielding of A-PNT. Ready now to begin installation in every mounted mission command-equipped vehicle, AC²ES doesn't require any additional space-claim to provide essential and Assured PNT to every tactical vehicle.

An A-PNT system that complements the Program of Record

Adversaries want to take away our ability to leverage PNT data to know where we are on the battlefield and our ability to synchronize forces using modern systems such as Blue Force Tracking capabilities of Mounted Mission Command. Because of that, the Army named the development of A-PNT solutions as one of its critical modernization objectives.

The Army is addressing A-PNT not only through the MAPS program of record under the Program

Executive Office for Intelligence Electronic Warfare & Sensors, but also through a Cross-Functional Team (CFT) formed under Army Futures Command to address key capability gaps and modernization challenges. Named the A-PNT/Space CFT, it is charged with accelerating the delivery of A-PNT and also tactical space and navigation warfare capabilities and is on par with other CFTs like the Future Vertical Lift CFT and Network CFT.

“All international forces have become network enabled and GPS dependent, so along with the benefit of using GPS, for management of forces and employing the timing inherent with GPS to synchronize defense systems, comes the significant potential downside risk that an increasing number of potential adversaries can take those away from you,” said Bill Guyan, senior vice president and general manager of Leonardo DRS Land Electronics, the division that produces tactical computers and displays for the Army and Marine Corps and that has fielded more than 300,000 Battle Management Systems (BMS) to US and international forces. This mission command capability is arguably best known for the Blue Dot displayed on a screen that shows position information.

“Just as there are many systems that enable GPS and networks, now there are new systems that can deny those and create an environment that jams or spoofs GPS signals. Systems that are dependent upon position data, or the timing that comes from a GPS satellite network, can now be fooled or disabled by an adversary.”

Critical to every battle management system is knowledge of position location, which has always been provided by GPS. Early on in the fielding of BMS in the US, Leonardo DRS started delivering GPS systems with an embedded SAASM (Selective Availability Anti-spoofing Module). This was an effort to try to get ahead of the threat, which was presented by potential adversaries that could jam

or otherwise spoof the GPS signal.

Now that peer adversaries have even greater capabilities, the Army has recognized that APNT is a critical capability not only for BMS on tactical vehicles but for all systems used for targeting, command and control, and operation of ground and air autonomous systems.

As mentioned, MAPS is the program of record tied to that effort. Currently, however, that program is only scoped to provide up to 25,000 systems through 2026 to the key leader/capability vehicles in the Army fleet, which is far short of all the mounted mission command-equipped vehicles and systems that the military possesses.

“Tier two and three systems aren’t currently provided for under the Army’s program of record,” said Guyan. “What we’re trying to do is offer the Army and Marines a capability that can be ready now, delivered sooner, and be more cost effective

to provide scalable capability to systems not designated for MAPS as a complement to the existing program record for APNT.

“We’re not a competitor to the current Army’s plans or program of record. What we are is a complement to those—something that would allow for the ability to

pull capability to the left in an affordable way – an innovative potential enhancement to the Army’s current plans for A-PNT.”

AC²ES works in parallel with the Army’s efforts to move beyond standard GPS, by adding new technologies to currently fielded platform computers called the Data Distribution Unit Expandable (DDUx), which is also the commercial baseline computer hardware for the U.S. Army Mounted Family of Computer Systems or MFoCS program of record. This includes Military GPS User Equipment (MGUE) to replace the SAASM GPS; the insertion of a more accurate, internal atomic clock; introduction of an internal inertial measurement unit (IMU); a unique system for vision navigation



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from Leidos (discussed later in this Pathfinder); and the insertion of a fusion engine to pull in data and analyze and verify the accuracy of all these new technologies being installed inside of the DDUx. The fusion engine evaluates and combines PNT inputs from these system components to provide a reliable navigation solution during real-world jamming and/or spoofing attacks. The customizable graphical user interface (GUI) is displayed on the BMS rugged touchscreen displays.

“As you can see, we are adding a plethora of A-PNT related technologies into the existing DDUx already resident in 160,000 tactical vehicles,” said Bob Pyne, Director of Business Development for Leonardo DRS Land Electronics. “Regarding the MGUE, both the Army and Air Force have publicly stated that the upgrade to MGUE is 3X more accurate and 8X less susceptible to jamming than the SAASM GPS.

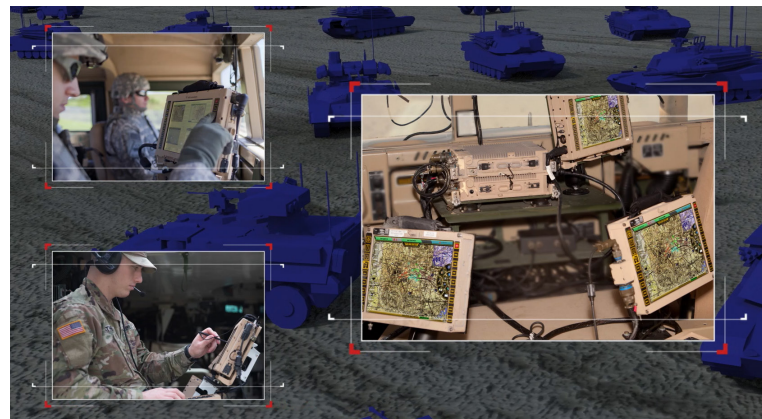
“That single upgrade alone is going to move warfighters closer toward having Assured PNT. And with the addition of the other A-PNT enabling enhancements, you can quickly move up the performance curve to introduce what Leonardo DRS is best known for, which is a very affordable solution.”

The component parts that make AC²ES embedded and scalable

The US and its allies are aware of the capability that our adversaries have in targeting PNT, and they regularly demonstrate a willingness to use it in places like Ukraine. It only makes sense, given our dependency on the capabilities that GPS provides, to level the playing field in an area where the US has historically had a great advantage.

As discussed earlier, most of the mission command systems are delivered today with an anti-spoofing GPS (SAASM) module. There’s also a next generation of GPS in the pipeline called M-Code (military code) GPS that is a more secure GPS that could eventually be an easy drop-in addition to the DDUx system to provide for a more resilient jam- and spoof-resistant capability.

However, M-Code is “years away from being widely fielded across DOD...due to the complexity of the technology” and the need to integrate it into hundreds of different weapon systems, including some with “complex and unique integration needs



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or configurations,” according to the Government Accountability Office’s 2021 report on GPS modernization called DOD Continuing to Develop New Jam Resistant Capability, But Widespread Use Remains Years Away.

In the meantime, there are a whole series of additional capabilities that are resident in the A-PNT toolbox and available now.

“That’s what we have done with AC²ES, which is a Swiss Army knife of capabilities that will allow a customer to match their risk and affordability profile with a capability set that matches their needs,” said Guyan. “In order to be able to fight the way we train, and to depend upon the systems that we rely on now, A-PNT at different levels of capability has to be fielded across the force to give the enemy reason to be concerned about the effectiveness of their jamming efforts. That may cause them to change the way they fight and also give our soldiers increased assurance and confidence that their systems will work even in non-permissive environments.”

Let’s see how AC²ES does that by breaking down the component parts of the acronym that together will provide A-PNT. The “converged computer” aspect gives warfighters the capability to conduct computing at the tactical edge in DIL environments through the DDUx computer. It does this by “embedding” new A-PNT hardware and software into the system that is already in the Army’s inventory in great quantities.

Specifically, AC²ES can be embedded in the DDUx Processor Unit. Convergence with the DDUx allows

for ease of use, as A-PNT is embedded into the BMS. The vehicle operator can use the BMS' GUI to view and manage GPS and A-PNT functions on a single screen. In addition, A-PNT distribution to other PNT consumers on the vehicle is supported.

From a size, weight, and power (SWaP) perspective, AC²ES does not add any new boxes, wiring, harnessing, or installation kits to the vehicle.

It is also “scalable” because users can choose from a list of A-PNT related hardware and software that they can add to the DDUx depending on the level of PNT performance they need and can afford. For example, if a vehicle is not involved in targeting, then AC²ES can be configured to provide a lower level but more affordable A-PNT capability.

“One of the key take-aways is that AC²ES and the converged computer are integrated into an already existing platform electronics housing; this is the only solution for A-PNT on the vehicle that is not adding a new “box,” said Todd Hicks, VP and Chief Technology & Innovation Officer for Land Electronics at Leonardo DRS. “A new box needs a new mounting bracket, a new place to put it, and new wiring harnesses. The difference between leveraging an existing box versus installing a new one is a key driver in lowering cost and getting A-PNT to warfighters quicker and more easily.

“We also provide a scalable, tailorable menu of capability options. Different Army vehicles have different risks and performance needs along with different budgets. Given that, the AC²ES solution is flexible and configurable to meet the varying requirements.

AC²ES includes vision navigation developed under DARPA

AC²ES includes another element that no other

A-PNT solution, including MAPS, employs—vision navigation. Developed by Leidos and integrated in AC²ES by Leonardo DRS, this vision navigation capability is an option for customers that creates a significant new advantage by using the infrared (IR) cameras that already exist on the vehicle along with a satellite imagery database that is stored on hard drives in the DDUx computer, and then matches what the IR camera is seeing to location information within the database.

“This pulls you to an absolute zero when the IMU and other components begin to drift,” explained Kevin Betts, director of Position, Navigation, and Timing for Leidos.

The Leidos vision navigation software got its start from several, different DARPA programs in the 2010-2013 timeframe. The largest of those

programs was All Source Positioning and Navigation (ASPN), which aimed to develop low-cost but still robust navigation solutions without inertial drift for any operational platform regardless of whether GPS signals were accessible.

“All inertial systems drift; the level of that drift is just a function of how expensive the unit is,” explained

Betts, noting that even very costly systems with high-end gyroscopes and accelerometers still drift at about 0.8 miles an hour if they're not aided. For tactical units used to five meters of GPS accuracy, the drift rate can quickly place them into unknown and dangerous territory if they're not aided with other sensors.

For the most part, those other sensors are the intelligence, surveillance, and reconnaissance (ISR) sensors such as camera feeds for situational awareness and targeting that are already on tactical vehicles. Live images from those cameras and other RF signals are blended with the inertial system and maps of the surrounding environment to provide position accuracy when standard GPS is unavailable.



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“If you could just take something like Google street-car images that we all have in Google maps, which are beautiful, crisp, textured street-level images of your environment, then it’s not hard to match a live image to great maps like that,” said Betts. “The challenge for a military mission is we need 3D map information from all around the world. An adversary is not going to let you drive a car with multiple, stereo cameras and a LIDAR drive down their streets and precisely build maps of their areas before you go in. So what we use for map matching in AC²ES is satellite-derived 3D models.”

“They don’t look like Google Street View, but they do give you a nice, basic geometric shape of the environment. We take that live image and coarse 3D model of the world and apply deep-learning algorithms to do the image processing to match the live image to the 3D environment and get an absolute position fix out.”

The vision solution is RF independent and doesn’t require any satellite signals. Even in a completely jammed and contested environment where warfighters are overwhelmed with RF interference, it still gives them a way to get absolute position information and get away from the paradigm of drifting INSes at different rates.

All the computing necessary to accomplish vision navigation is done onboard the vehicle through the DDUx hard drive that stores the map information and the DDUx processor that derives positioning from the input data. No network connection is needed.

Conclusion

Leonardo DRS’ AC²ES was not designed to provide a different or better A-PNT capability than MAPS. Rather, the AC²ES capability is complementary to the capability that the Army already has in the pipeline under the MAPS program.

“It doesn’t replace MAPS, it doesn’t challenge MAPS,” noted Guyan. “But as a complement to MAPS, it can address the need to field additional systems more quickly and affordably. One of the things that is important about our offering—in addition to the ability to leverage existing footprint and already paid-for Army investment—is that we

offer a scalable capability that’s not one size fits all.”

“A-PNT capability is not inexpensive. But the need is wide because every single vehicle and every single system in the Army that uses either position, location, or synchronized timing requires Assured Positioning, Navigation, and Timing. This is a big burden for the Army.”

With AC²ES, the Army can tailor the capability that they need fielded based upon the threat, risk, and budget that’s available. Some systems may have a full suite of capabilities, some may have a lesser capability. But all of those capabilities can be housed inside of the same tactical computer that the company already fields to all Army vehicles and Marine Corps platforms.

AC²ES can also help the Army drive toward what it’s doing with its Modular Open Systems Approach (MOSA) and C5ISR/EW Modular Open Suite of Standards (CMOSS).

“The Army’s vision for some time now has been for open architecture and the ability to leverage investment for continued upgrade of capabilities and obsolescence management, and we’ve always designed our computers with expandability and upgradability” said Guyan.

In the near term and mid-term, AC²ES can help the Army to pull capability left. In the longer term, future CMOSS-compliant chassis will house a number of interoperable cards and the Army’s vision is that there will be A-PNT cards provided by various vendors. They’ll plug and play inside of the CMOSS chassis to provide A-PNT capability.

“For a long time, though, there will be a mix of legacy platforms and CMOSS-chassis-equipped platforms,” said Guyan. “The threat of compromised Positioning, Navigation and Timing (PNT) to Army and Marine Corps mission-critical systems is significant; it’s a near-term - already-present threat. It’s our position that our forces require near term and mid-term capability that can be widely fielded affordably, and we think AC²ES can offer that. In the longer term, the fleet will be transitioning to CMOSS, but that transition could take decades. Until then, the threat is real and present, as demonstrated every day in the Ukraine-Russia conflict.” //