THOUGHT PIECE

Booz | Allen | Hamilton®

RESILIENT POSITIONING, NAVIGATION AND TIMING (PNT) REQUIRES NEW THINKING ABOUT SYSTEMS INTEGRATION

Kevin Coggins
Vice President
Coggins_Kevin@bah.com

William Nichols
Principal
Nichols_William@bah.com

RESILIENT POSITIONING, NAVIGATION AND TIMING (PNT) REQUIRES NEW THINKING ABOUT SYSTEMS INTEGRATION

PNT Program Offices Are Under Pressure To Assume Integration Responsibilities

Since the advent of the Global Positioning System (GPS) more than 20 years ago, robust positioning, navigation and timing (PNT) capability has quickly emerged as a core and defining ingredient of a modern, networked military that can operate with precision across all domains: air, land, sea, space and cyber. The result is that GPS-enabled systems are now ubiquitous across the U.S. military enterprise. In all, more than 700 military platforms are estimated to rely upon GPS signals for PNT capability. As one military planner put it, "GPS is fundamental to everything we do. It is a part of our plumbing today."[1]

In leveraging PNT capabilities so fully, the U.S. military has created enormous battlefield advantages for itself – but also worrisome critical dependencies. Myriad threats have emerged from known, unknown and potential adversaries that can jam, spoof or otherwise disrupt GPS signals that these many systems rely on.

Consequently, military leaders are now planning for the prospect of operating in degraded and denied PNT environments and, in preparation, developing new systems and upgrades that can deliver PNT capability even in highly contested environments. Across the Department of Defense (DoD), system program offices are busily modernizing and augmenting GPS and GPS-enabled systems and developing diverse alternatives from which to source PNT capabilities in the event GPS signals are disrupted and denied.

While DoD program offices manage these PNT-enabled platforms and systems, the complex integration work involved is often handed to the Original Equipment Manufacturers (OEMs) that designed and built them. That integration work consists of deciding all aspects of how a system will be designed and built. Those decisions concern which technologies, standards, and protocols to use; how various components will communicate with each other or with outside systems; as well as the many complex trade-offs that must be made between capability, performance, cost, weight, space, power, and compatibility with outside systems.

As these PNT modernization efforts proceed, two powerful imperatives are pressuring DoD program managers to take over these critical integration responsibilities from the OEMs. One of those imperatives is mission-driven, the other, business-driven.

THE MISSION IMPERATIVE

DoD planners and leaders understand that building more resilient PNT capabilities requires thinking and architectures that transcend individual PNT-enabled systems. This is the premise, for example, behind the Army's "system of systems architecture" (SoSA) approach to Assured PNT. Army leaders explained it this way: "With hundreds of different Army systems that require PNT data, the PNT SoSA guides and constrains the development of all Army system-of-systems consuming or providing PNT information to include upgrades across platforms and domains, thus reducing inefficiencies and redundancies, while decreasing vulnerabilities and outpacing changing threats."[2]

It is one thing for an OEM to perform integration responsibilities on a system it designed and built, but fitting that system efficiently into a broader, overall schematic that delivers resilient PNT capability across multiple platforms requires integration from a higher-level perspective.

Also, threats to our PNT capabilities will continue to evolve quickly, and so must our PNT-dependent systems and platforms in response. That means embracing adaptability as a basic precept for how we develop, procure and sustain weapons systems to be effective and resilient over their life cycles. Creating resilient PNT requires common standards and protocols and a modular, open systems architecture approach to systems development and acquisition. There are many examples today of how common standards and open architectures can enable innovation to flourish, ranging from household lighting to the U.S. power grid to the Android mobile ecosystem. To accomplish this, program offices themselves must oversee the design and integration of their systems and platforms.

In contrast, GPS-enabled systems in use today – while conforming to government-specified interface control documents – are typically integrated into system-of-systems environments that were designed by their OEMs. As a result, they are not easily upgraded or interconnected with other systems, making the task of incorporating greater PNT resilience more time-consuming, technically challenging, and expensive. For example, the Air Force has developed an advanced, new military GPS signal called Military Code, or M-code, that will be more secure and resistant to jamming and spoofing. But swapping in M-Code receivers to replace existing GPS signal receivers across a vast inventory of military systems and platforms will be a daunting task because each is designed to proprietary interfaces, protocols, standards, and form factors. DoD Program Offices must, therefore, assume the integration work needed to ensure that their systems migrate to open, modular architectures using common standards that can easily accommodate upgrades after the fact.

As Kevin Fahey, Assistant Secretary of Defense for Acquisition, explained: "Our adversaries have access to many of the same technologies in the commercial marketplace that we do – without the hurdles that exist in our acquisition system. To maintain our superiority, our acquisition approach must be adaptive enough to enable rapid technology insertion, but also disciplined enough to ensure holistic interoperability once the systems are in warfighters' hands. Put simply, our challenge is to be the integrator among fast-moving innovators."[3]

THE BUSINESS IMPERATIVE

Cost containment and affordability are ever-important today for program offices. But when program offices remove themselves from the integration role, they lose the knowledge and control needed to contain costs. For example, when OEMs are handed all integration responsibilities, they typically resort to closed architectures and proprietary technologies and standards when designing and building systems. This shuts off competition and access to the technology in those systems for all but the OEM and its partners, dramatically escalating sustainment costs.

Another challenge is that when systems integration responsibilities are retained by OEMs, so too are the control, active oversight, and in-depth technical understanding of the programs. When this occurs, program offices can no longer perform independent technical analysis or validate defense contractor technical decisions and conclusions. This creates a situation in which the government develops or changes requirements for a system or platform without having full knowledge of the cost, schedule or technical risks to the program. The result is less ability to control costs. This lack of sufficient technical knowledge and understanding is widely acknowledged to have been a key contributor in many acquisition program failures in the last two decades that left enormous cost overruns, schedule setbacks, and performance problems.

Ever-tightening budget constraints make it unsustainable for DoD program managers to continue this way as they modernize their PNT capabilities. As Sean Stackley, former Assistant Secretary of the Navy for Research, Development and Acquisition, told lawmakers: "In building our budget, every program – things large and small – is subject to answering four most basic questions: What will it cost to buy it? What will it buy us in performance? What can we afford? And what can we do to make it more affordable? Simply put, we must change the cost equation."[4]

To change the cost equation, program managers must have not only the willingness, but the information necessary, to make hard choices and trade-offs in their programs. This information (referred to by some as the "technical baseline" of a system) is the data that enables a program office to "establish, trade-off, verify, change, accept, and sustain functional capabilities, design characteristics, affordability, schedule, and quantified performance parameters at the chosen level of the system hierarchy."[5]

Having DoD program managers assume integrator responsibilities is important for another key reason: increased competition. The best solution or best value for building a more resilient PNT capability for a given system or platform often will not always come from the platform's design-build team. It may come from a company outside of – or in competition with – the OEM's team. When the government serves as integrator, it can leverage competition at the system, component, and subcomponent levels to ensure that the best technical solutions are incorporated – wherever they come from.

DRIVING TOWARD OPEN SYSTEM ARCHITECTURES

Due to these mission and business imperatives, there is a growing appetite among policy makers to see the government take a firmer hand in steering programs to be accessible to new technologies, modular in design, and cost-conscious. The 2008 National Defense Authorization Act (NDAA), for example, directed the Defense Department "to minimize and eventually eliminate the use of contractors to perform lead systems integrator functions." And the 2017 NDAA directed DoD, beginning in 2019, to adopt a modular open system approach for its major systems to enable incremental development and enhance competition, innovation, and interoperability.

This thinking is also reflected in the Defense Department's guiding acquisition principles, collectively known as the Better Buying Power initiative, which aspires toward greater efficiencies through affordability, cost control, innovation, technical competence, elimination of unproductive processes and bureaucracy, and competition. The latest iteration of these principles (Better Buying Power 3.0), for example, urges DoD program offices to use modular open systems architectures to stimulate innovation. This will ensure, it says, "that our designs are modular and that the government is in a position to control all the relevant interfaces so that competitors with superior technology have the opportunity to win their way onto our programs. Often, this design feature has been either traded away because of competing requirements or lost because the government has failed to secure technical control and ownership of all the needed interfaces, including those required for software integration."[6]

Program Offices Must Bring The Right Expertise To The PNT Integration Challenge

While there are highly compelling mission - and business-related reasons for PNT program offices to assert a stronger systems integration role, doing so is easier said than done. Many program offices lack enough people with the right technical, engineering, and program management skills to translate a technical baseline into smart programmatic decision-making that results in a system with the optimal balance of cost and performance. They must have sufficient staff, laboratory, and technical resources to: decide system and subsystem designs; design and validate end-to-end performance models of the system; assess and mitigate cyber vulnerabilities in a system; understand and mitigate technology and system integration risks; design and perform tests of the system and conduct post-test analysis; and more.

The government's ability to serve effectively as a systems integrator is linked tightly to its understanding and ownership of a program's technical baseline. "Owning the technical baseline is essential to our future and it means the government program team, independent of the prime contractor, can make proper decisions to achieve successful acquisition outcomes," said William LaPlante, former Assistant Secretary of the Air Force for Acquisition.[7]

Moreover, the integration role for PNT systems is particularly challenging because of the added complexity we are seeing in PNT environments. Systems will be expected to source PNT capabilities from multiple technologies, including: GPS; combinations of GPS and Inertial Navigation System (INS); GPS augmentation technologies, such as chip scale atomic clocks; GPS modernization technologies, such as M-Code; and GPS alternative technologies, such as the eLoran and Galileo systems. To be more resilient, tomorrow's PNT solutions will be expected to operate on open systems architectures and to be agile, modular, and interconnected. Overlaying these features across a variety of closed, proprietary systems will require exceptional skill, vision, and knowledge of the systems, missions, and technologies involved.

Systems integration, done properly, will be critical to delivering PNT-dependent systems that are effective, resilient, and affordable over their life cycles. And those integration responsibilities should reside with the program offices, not with the OEMs, to achieve the desired mission and business outcomes. The challenge, however, is that the program offices managing the Defense Department's 700-plus PNT-dependent systems and platforms are at varying degrees of readiness when it comes to having the technical and engineering skills and resources to accomplish that.

Modernizing PNT-dependent systems to be more resilient and reliable in contested environments requires highly specialized sets of skills, expertise, knowledge and resources. Many program offices are readily equipped to develop and translate a program's technical information into sound programmatic decisions that produce an optimal balance of performance and cost, but some are not.

Program offices are more likely to succeed when they possess a broad view and solid understanding of the array of PNT-relevant missions across DoD. Through road mapping or similar planning exercises, leaders can increase their awareness of how multi-varied operations across DoD rely on PNT capability is critical in developing, testing and evaluating solutions that leverage other approaches and connections that can strengthen a system's PNT resiliency. It is also important in developing an effective "system of systems" approach to the PNT challenge.

Program offices must network with each other to share PNT solutions and best practices across DoD. The PNT challenges of disparate systems – and the solutions to those challenges – may have some traits in common. As a result, there may be important opportunities available to share resources and avoid duplication of work. This, of course, depends heavily on keeping up to date on the many research and development projects under way in the PNT space, both in the military and government lab organizations as well as in the corporate research and development domain. This kind of community awareness, along with test, evaluation and prototyping expertise can help program offices see better where promising advances lie and make better-informed technical decisions for leveraging those advances down the road.

Another important attribute: Having experience developing and working with open systems architectures within a DoD acquisition environment. Open systems design strives for greater affordability and adaptability through the use of modular design tenets and common standards for key interfaces. Program offices must establish supportive requirements, business practices, and technology development, acquisition, test and evaluation, and product support strategies needed for effective development of open systems.

Finally, program offices should have experience developing and integrating resilient architectures. Specifically, this means having the ability to identify, architect, test, and integrate backup sources for PNT signals that are optimized for particular systems and use cases. This is critical in designing solutions that operate reliably in contested environments where primary PNT sources are compromised or unavailable.

As program offices seek to incorporate greater PNT resilience into their platforms, they will need to be far more proactive in driving the technical features of their systems in a direction that fosters open, modular design and common standards and that result in optimal trade-off decisions. But doing so will require considerable expertise and resources in highly technical areas, include engineering, research and development, architecture development, testing, modeling, and electronics integration. We believe that program offices that build and maintain competencies in these specific areas will be best positioned for success as they modernize their PNT-dependent systems for the future.

OUR AUTHORS

For more information please contact our experts:

Kevin Coggins
Vice President
Coggins_Kevin@bah.com

William Nichols
Principal
Nichols_William@bah.com

Notes

1. Capt. Mark Glover, program manager for the Navy's Communication and GPS Navigation Program Office, as quoted in "Beyond GPS: The Navy's plan for assured position, navigation, timing," Barry Rosenberg, C4ISR & Networks, Sept. 4, 2015, https://www.c4isrnet.com/special-reports/pm-view/2015/09/04/beyond-gps-the-navy-s-plan-for-assured-position-navigation-timing/

2. Kevin Coggins, "Positioning, Navigation and Timing and What it Means for the Soldier," PNT Internal News and Announcements, Feb. 27, 2016: https://www.pmpnt.army.mil/positioning-navigation-timing-means-soldier/

3. Kevin Fahey, "Integrating Innovation: Keeping the Leading Edge," Defense AT&L (July–August 2015): http://dau.dodlive.mil/files/2015/06/DATL_Jul_Aug2015.pdf

4. Army Sgt. 1st Class Tyrone C. Marshall Jr., "Service Acquisitions Chiefs Testify on Reform," DoD News, Defense Media Activity, April 23, 2015: https://www.defense.gov/News/Article/Article/604507/service-acquisitions-chiefs-testify-on-reform/

5. The National Academies of Sciences, Engineering and Medicine, "Owning the Technical Baseline for Acquisition Programs in the U.S. Air Force," 2016: https://www.nap.edu/catalog/23631/owning-the-technical-baseline-for-acquisition-programs-in-the-us-air-force

6. Frank Kendall, "Implementation Directive for Better Buying Power 3.0 - Achieving Dominant Capabilities Through Technical Excellence and Innovation," April 9, 2015: http://bbp.dau.mil/docs/BBP3.0ImplementationGuidanceMemorandumforRelease.pdf

7. William A. LaPlante, Ph.D., "Owning the Technical Baseline —a Key Enabler," Defense AT&L (July–August 2015): http://dau.dodlive.mil/files/2015/06/DATL_Jul_Aug2015.pdf

About Booz Allen

For more than 100 years, business, government, and military leaders have turned to Booz Allen Hamilton to solve their most complex problems. They trust us to bring together the right minds: those who devote themselves to the challenge at hand, who speak with relentless candor, and who act with courage and character. They expect original solutions where there are no roadmaps. They rely on us because they know that—together—we will find the answers and change the world. To learn more, visit BoozAllen.com.