5-2010

Operationalizing Small Space: Challenges of Moving from Research, Development, Test, and Evaluation to Operations

B. E. Wilson

Jeffrey E. Haymond
Cedarville University, jhaymond@cedarville.edu

Operationalizing Small Space: Challenges of Moving from Research, Development, Test, and Evaluation to Operations

Col Burke E. "Ed" Wilson, USAF
Commander, 45th Space Wing and Director Eastern Range
Patrick AFB, Florida

Col Jeff Haymond, USAF
Vice Commander, Space Development and Test Wing
Kirtland AFB, New Mexico

Operationally responsive space (ORS) is both an ideal type and an emerging reality. As an ideal type, ORS provides a vision of how space can become more relevant at the tactical level of conflict. ORS is quickly gaining relevance to all space activities, and the tenets learned in pursuit of specific ORS capabilities hold increasing promise for application across the space enterprise. As ORS has matured it provides a glimpse into how space systems could be developed, acquired, and operated. For example, the first operational ORS system (ORS-1) is being developed now to support an urgent operational need for US Central Command. If successful, ORS-1 will demonstrate an unprecedented way to field "good enough to win" space capabilities for the warfighter with aggressive cost and schedule mandates. Yet as impressive as the capability may ultimately be, it is critically dependent upon a broader set of capabilities that emerged out of the small space research, development, test, and evaluation (RDT&E) culture at Kirtland AFB, New Mexico centered around the Space Development and Test Wing (SDTW), Air Force Research Laboratory's Space Vehicles Directorate, and the ORS Office. Whether launching Minotaur rockets, conducting satellite command and control (C2) with the Multi-Mission Satellite Operations Center (MMSOC), pushing state-of-the-art plug and play technologies, or using scientific and technical best practices, ORS is leveraging a broad array of Air Force small space capabilities. Nonetheless, this dependence has implications, which must be recognized and addressed. Specifically, the RDT&E-derived small space processes are instrumental for ORS success in terms of cost and schedule. However, they are not currently operationally robust enough to support both a growing ORS portfolio of missions, as well as an emergent small space mission area. This paper will defend that thesis, and offer specific suggestions regarding how to correct this deficiency.

Figure 1. TacSat-3 launch.

Some question whether there is a small space mission area, especially given the lack of requirements in the traditional sense—no one has tasked the Space and Missile Systems Center (SMC) to develop small space capabilities per se. Instead, our legacy RDT&E space enterprise has become increasingly relevant operationally, which has led to heightened expectations. The ability to package increasingly potent capabilities into smaller, less complex (and less costly) systems is pushing small space into a new league. An example from the 1990s may be a good analogue. During the 1990s, after the National Reconnaissance Office (NRO) had been officially acknowledged, we openly discussed the differences between Air Force Space Command (AFSPC) and NRO as being between "white" and "black" space. However, we soon found this distinction to artificially define seams, and recognition of a new category called "gray" space characterized space systems that could support both "white" and "black" space requirements. Space-based radar and the transformational communications satellite were examples of this gray space.

A similar parallel seen in small space today is the distinction between designating a mission as either "RDT&E" or "operational." The designation leads to divergent development, acquisition, test and operational processes, which in general leads to less oversight, redundancy, and rigor for RDT&E systems. The allure is faster, more cost effective mission design, development, acquisition and ultimately fielding to operations. As noted, advances in technology are making RDT&E systems much more capable—to the extent that combatant commands (COCOM) are increasingly interested in the capabilities small space can bring to the fight. Consider just a few of the recent or current small space missions. The Experimental Satellite System-11, known as XSS-11, was launched in 2005 as an AFRL experiment to gain insight into proximity operations. It was developed using RDT&E processes and launched and operated using RDT&E boosters and C2 systems. Yet XSS-11 was vital to the development of the emergent space control mission area. Do warfighters today care about the lessons learned from XSS-11? We suspect so, but it was only the first in a trend. TacSat's 2 and 3 followed, with TacSat-3 providing hyperspectral imagery to COCOMs.

AFSPC is conducting initial planning to support a transition of TacSat-3 to operations after the one-year experiment concludes. The new Minotaur IV "RDT&E" rocket is preparing to launch the Space-Based Space Surveillance System (SBSS) and the Hypersonic Technology Vehicle-2A missions. And of course, the first ORS satellite is being developed now. Determining the right balance between rapid, agile processes typically associated with RDT&E system development and the more rigorous, yet slower (and costly), traditional processes is a key challenge for responsive space missions.

Clearly, the answer to "how much" operations processes cannot be none; the importance of these missions dictate that we have the robustness required to meet warfighter needs. ORS-1 was identified as an urgent operational need; the "urgent" designation requires leveraging the right RDT&E processes, while the "operational need" mandates operational rigor and robustness. The challenge is finding the proper balance across the full spectrum of functionality—development, acquisition, testing, logistics, training, mission assurance, operational procedures, contingency operations, and so forth.

Consider one segment of the small space enterprise; launch systems, which primarily leverages Minotaur rockets developed in the Rocket Systems Launch Program (RSLP). RSLP was established to oversee safe storage and handling, aging surveillance, and safety of flight for excess intercontinental ballistic missile (ICBM) motors and components to support both test launch requirements and the operational ICBM fleet (as required). Several recent events provide valuable insight. First, a closer look reveals that since the RSLP assets were declared excess to operational need in the early 1990s (Minuteman) and 2000s (Peacekeeper), the assets were dropped from official Air Force supply processes. While this made sense from the perspective that no one would be requesting those assets to replace depleted inventory, the Air Force lost the ability to positively control the inventory of RSLP assets associated with the nuclear enterprise—a lesson we have recently relearned across the larger Air Force. We can and must be able to track critical assets at all times to include RSLP motors and components. Second, the handling of these critical launch assets requires the consistent application of technical orders. General C. Robert Kehler challenged the SDTW leadership during their inspector general outbrief to strictly follow ops procedures with the admonition, "you can call it a target, you can call it test, but it's operations!" Given the necessity to launch safely and successfully, this is wise counsel—no matter what the purpose. Lastly, the inability to appropriately resource the system development and mission assurance of the Minotaur IV was assessed by multiple independent review teams as one of the primary root causes for recent launch delays, costing the larger space enterprise well in excess of $100 million. In response, senior Air Force leadership has made robusting the small launch capability one of SMC's top priorities for 2010.

Robusting the small launch capability means we must be able to launch Class A payloads if required. We can see the implications of this in figure 2 below. Using research, development, test, and evaluation heritage launch processes with Minotaur 1, AFSPC has a relatively affordable launch capability with a high success rate. With the expanded operational importance of key payloads such as ORS-1 and SBSS, we require a more robust operational launch capability such as point 2 in figure 2 below. The intent is to hit the "knee in the curve" for the most operational robustness while keeping costs relatively affordable. Once ORS systems have demonstrated their worth and we achieve the ORS future state of having many payloads available to launch at a quick pace, it may be possible to accept significantly more risk to achieve stringent cost and schedule goals, such as the future ORS state at point 3 below.

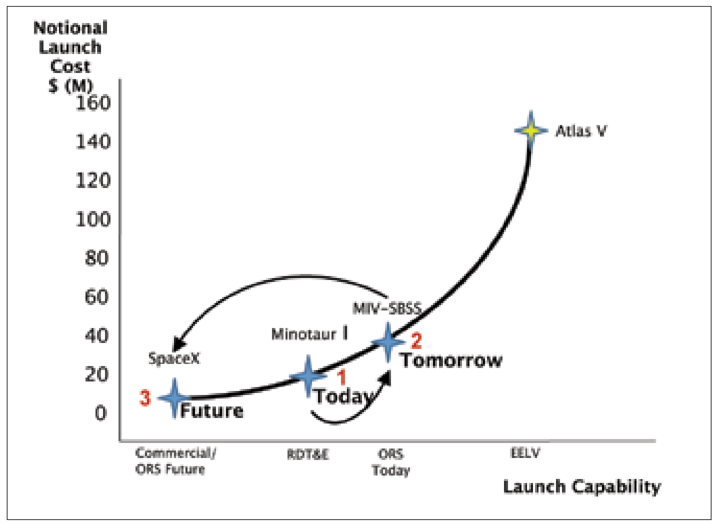

Figure 2. Small launch capability, launch Class A payloads.

Conversely, as the ORS-1 satellite has experienced cost growth, both the AFSPC commander and the secretary of the Air Force have pushed hard on wing leadership to meet cost and schedule goals. Meetings with key congressional staffers have only reinforced the need to develop capabilities cheaply, that are "good enough to win."

The fundamental question is whether the "good enough to win for RDT&E" with its rapid, agile strategy can be leveraged to make the leap to "good enough to win" for the warfighter with enough operational rigor to ensure mission success. These messages are in tension, but not in conflict; the importance of the mission sets in small space requires the underpinning of operational rigor, but we must be able to rapidly deploy these capabilities in a cost effective manner. While this seemingly is the impossible task of "having your cake and eating it too," this tension presents a unique opportunity to reexamine the way we acquire and operate space systems. ORS provides the impetus to evaluate every aspect of our acquisition and operational processes and develop a new "playbook" that exploits the strengths of operational and RDT&E communities. To overcome the weaknesses of the past and build operational robustness into the inherently flexible RDT&E processes, we must:

1. **Recognize an ounce of prevention is better than a pound of cure.** While the cost goals of ORS seem unobtainable when built upon an operational foundation, the opposite is closer to the truth. Wise early spending to build an operational foundation for ORS will significantly reduce downstream costs. While prescience of future ORS needs without firm traditional requirements is not a trait highly rewarded by AFSPC programming budget drills, it is nevertheless required; and therefore will likely have to be driven top down. We have clearly learned from "big space" that lack of resources at the initial stages of space system development and acquisition costs us in spades when we experience mission or acquisition failure. In a recent small space example, the ORS-1 satellite build decision was made in July 2008 with funding contingent on Congressional approval for the reprogramming of funds. Naturally, when delays were experienced with the reprogramming, the program lost momentum and incurred delays. When a program is intended to deliver a space capability in less than two years, it is vital that all aspects of the program are "ready to go" at program initiation.[1]

2. **Identify the processes to apply the "ounce of prevention."** While ORS has blanket waivers from the JCIDS requirements process, some of its supporting architecture pieces do not (such as launch and C2). AFSPC needs to deliberately review all small space processes across the life cycle to determine where the most bang for the buck is in terms of robusting the mission area. Some will require only money but preserve rapid schedule ability (i.e., preparing the infrastructure that ORS can leverage) such as improved logistics processes, expanded up-front launch mission assurance, full acquisition funding at program initiation, and so forth. Other processes may take money and time, such as full blue suit operations. Alternative operational constructs should also be assessed, especially in the area of satellite operations. With the future of satellite operations increasingly migrating from telemetry, tracking, and commanding (TT&C)-type operations to mission planning, perhaps the national and RDT&E model of contractor TT&C with blue-suit mission planning might be the best approach. If an existing process is not clearly providing value, it should be jettisoned. For example, the program executive officer of space waived the requirement to pursue certified earned value management reporting for ORS-1, as the very timelines we intend to support are faster than the certification process required of this financial data. Similarly, much program office and HQ AFSPC time was squandered trying to ascertain exactly which test processes would apply, and whether a test and evaluation master plan was required. The initial default answer across the major command and center functions seems to be that unless told otherwise, standard Air Force processes must apply. We must do a focused review on all AFSPC functional processes to determine which are absolutely essential to apply to ORS missions—with the burden of proof on the functional to demonstrate why their process is necessary.

3. **Build an ORS sandbox.** Nevertheless, we will undoubtedly find that many of the functions needed for big space are still required for small space, but they do not necessarily need to be done in the same order. In fact, many must be done in advance to be able to meet the timelines required. For instance, we must have the tasking, processing, exploitation, and dissemination (TPED) architecture in place for future versions of ORS-1. We must have frequency approval pre-approved for space downlinks. We must have satellites that fly on MMSOC. We must build an ORS box that bounds the requirements in advance to speed approval; if an ORS mission requirement comes through which fits in that box, it is ready to go. A key part of the ORS architecture is defining the standards that future responsive space systems must comply with; space common data link and MMSOC are only two parts of the standard architecture that are coming online now. We must continue with plug and play satellite buses and payloads. The tasking system for ORS-1, VMOC, must be leveraged for tasking other ORS missions beyond infrared imaging.

4. **Leverage the broader space enterprise.** Interestingly, the 1990s "gray" space category forced unprecedented cooperation between two historically separate space development processes (NRO and AFSPC).[2] Close collaboration between acquisition and operations is likewise essential to ensure the up-front integration is successful. With the ORS-1 satellite, 1st Space Operations Squadron (1 SOPS) operators work closely with both the Space Test

ORS provides the impetus to evaluate every aspect of our acquisition and operational processes and develop a new "playbook" that exploits the strengths of operational and RDT&E communities.

Squadron RDT&E satellite operators, as well as the Responsive Space Squadron acquisition arm to ensure that once on orbit, 1 SOPS will be ready. The collaboration required is not just within AFSPC or even the Air Force; we must also successfully integrate our programs with a TPED architecture that includes both Army and Navy capabilities. This means we need to learn how to test across an integrated, joint system. Our culture must embrace being part of a broader mission area; too often each organization focuses on what they do as "the mission," to the detriment of the broader collaboration needed for small space and ORS. Further, the resource constrained environment we face necessitates collaboration since no organization will have the resources to bring it all together. Within the specifics of the acquisition piece, for example, we are looking at how to transition from the ORS "jump ball" approach of picking a single agency to execute an urgent need, to an "all star" team where the Air Force may execute the majority of the effort, but will supplement with key external partners for a joint team.

Small space capabilities and ORS requirements are blurring the line between operational and RDT&E satellites. Small space technologies and budget realities will only accelerate this trend. ORS-1 is a critical satellite to meet COCOM requirements, but perhaps its most important function is to highlight the limitations in our current processes. By bringing to the forefront the functional requirements that drive cost and schedule, we may carefully consider the cost/benefit tradeoff of current operational and acquisition processes. Further, ORS-1 is reliant upon a small space architecture that must be robust enough to support operational missions. The ORS Office ultimately hopes to have enough capabilities "in the barn" that they can take increased risk and avoid the increased robustness that this paper argues is necessary, driving down both cost and schedule. That may be the case in some end-state, but that is not the state we find ourselves in today and in the near future. To the extent ORS is successful in the near term, it will provide capabilities that are few in number but critically important. In the end, some operational robustness must be relaxed, and some RDT&E processes must be strengthened. May we have the wisdom to determine the right balance.

Notes:

[1] All aspects must include ops procedures, logistics processes, defined risk acceptance and associated mission assurance, reporting requirements, test requirements, etc.

[2] Nonetheless, the partnership did not bear fruit with space radar, perhaps because of the lack of full commitment on both sides to a joint program.

Col Burke E. "Ed" Wilson (BS, Electrical Engineering, US Air Force Academy [USAFA]; MS, Electrical/Computer Engineering, Northeastern University, Massachusetts) is the commander, 45th Space Wing and director Eastern Range, Patrick AFB, Florida. He is responsible for the processing and launching of US government and commercial satellites from Cape Canaveral AFS, Florida, and is the final approval authority for all launches on the Eastern Range, a 15-million-square-mile area which supports an average of 20 launches per year aboard Delta and Atlas launch vehicles. He also manages wing launch and range infrastructure supporting the space shuttle and missile test missions.

Prior to his current assignment, Colonel Wilson served as the commander, Space Development and Test Wing overseeing 1,000+ military, government civilians and contractors responsible for delivering small, responsive space capabilities to users across the national security space community.

Colonel Wilson entered the Air Force in 1985 as a graduate of the USAFA. Colonel Wilson has been involved with the acquisition of satellite command and control systems, space surveillance software upgrades, ground antenna development, design and testing of nuclear hardened communications equipment, and a variety of advanced technology development projects.

Col Jeff Haymond (BS, Aeronautical Engineering, United States Air Force Academy [USAFA], Colorado; MS, Mechanical Engineering, University of Tennessee; PhD, Economics, George Mason University [AFIT]) serves as the vice commander of the Space Development and Test Wing, Kirtland AFB, New Mexico. The wing's mission is to develop, test, and evaluate Air Force space systems, execute advanced space development and demonstration projects, and rapidly transition capabilities to the warfighter.

Colonel Haymond entered the Air Force in 1985. He initially served as a propulsion test engineer for F-16/B-1/F-22 aircraft and transitioned to the space environment with an National Reconnaissance Office operations tour. Next, he led headquarters Air Force Space Command planning for the Satellite Control Network and Counterspace mission areas, before returning to the USAFA for a teaching assignment and AFIT PhD follow-on. Colonel Haymond returned to the space arena to work Space Commission implementation, and subsequently managed the space and missile legislative portfolio for the Office of Legislative Liaison. He returned to space operations as the director of operations and commander of the 1st Air and Space Test Squadron and then as deputy commander of the 30th Launch Group, Vandenberg AFB, California.