CHIRP's Potential to Introduce a New USAF Space Acquisition Paradigm

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Abstract — The objectives of this paper are: (1) to explore lessons learned from the United States Air Force's (USAF) Commercially Hosted Infrared Payload (CHIRP); and (2) how those lessons can be applied to acquire operational space assets quickly and less expensively in the future. CHIRP is a payload configured with a SES-WorldSkies comsat. The goals of the CHIRP program are to perform a technological demonstration (tech demo), to advance the Technology Readiness Level (TRL) of staring Wide Field of View (WFOV) IR sensors, and associated data processing. The primary challenges relate to integrating up-front systems engineering with a particular payload and satellite on a commercial provider's launch schedule and field of view. Particularly, we highlight how these observations will affect the analysis of trade-offs when choosing between free-flying and commercially-hosted, staring IR missile warning payloads in the future.

With the launch of CHIRP, quarter-earth WFOV staring data is being processed with recently developed algorithms by the Air Force, and we will address for the first time the efficacy of this demonstration given known engineering regrets.

Because the CHIRP demonstration was a result of an unsolicited proposal by a commercial communications vendor, the Air Force was restricted in its vetting of traditional requirements. The parameters of this constraint will be delineated in this paper and weighed against the enormous cost benefit of an accelerated schedule of advancing missile-warning staring technology in a relevant space environment.

This paper will discuss both the technical challenges of working with a commercial communications satellite vendor and their subcontractors to achieve the maximum possible systems engineering and rigor necessary for this demonstration. Motivations of the contractor and the USAF were not always in sync and in fact often were conflicted.

Our conclusion is that complications in schedule and performance from commercially hosting full-earth field-of-view payloads are offset by the much lower costs compared to developing a free-flying spacecraft. CHIRP shows that hosted payloads are a cost effective means to advance TRLs with emerging technology.

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1. INTRODUCTION

The Space and Missile Systems Center (SMC) is the Air Force's product center for the development and acquisition of space and missile systems. The role of the Development Planning Directorate (XR) within SMC is to perform development planning activities in order to start "high-confidence" programs of record. SMC/XR does that through focused demonstrations but also through decision support on future concepts to external customers for Analysis of Alternatives and other decision points.

There is currently a major drive by the Air Force to try to develop less expensive and more quickly fielded options for accomplishing its space missions.¹ Among the options being considered is the increased use of commercial hosted payload opportunities for advancing TRLs, proving concepts and to field operational assets. Helping to drive the push for increased use of hosted payload opportunities is, on one side, the downward pressure on Department of Defense (DoD) budget coming from Congress and the steady increase in space and counter-space capabilities being developed and fielded by potential adversaries. Given the relatively slow technology refresh rate and upward spiraling costs of major programs of record, the DoD will probably find it increasingly difficult to justify putting a large number of critical capabilities into single satellites that often cost over \$1 billion each and which often utilize already obsolete technology by the time they are finally launched. This use of taxpayers' money will also come under additional scrutiny as our adversaries' counter-space capabilities become more mature.

¹ "Report on Technology Horizons – A Vision for Air Force Science & Technology During 2010-2030," Vol 1, AF/ST-TR-10-01-PR, 15 May 2010.

Fortunately, these concerns and trends are being addressed directly by the DoD. For example, Ambassador Gregory L. Schulte, Deputy Assistant Secretary of Defense for Space Policy has frequently pointed out publicly that “space is increasingly a shared domain in which we operate with more and more spacefaring countries - both close allies and potential adversaries”. The challenges of operating in such an environment are detailed as the “3 Cs: congested, contested and competitive” in the *National Security Space Strategy* (January 2011), jointly drafted by the DoD and Director of National Intelligence (DNI).²

Congestion relates to both the physical space and use of the radiofrequency spectrum. The potential to disaggregate mission capabilities using hosted payloads is pertinent in reducing the risks posed by the physical congestion of space. The 22,000+ man-made objects in space currently being tracked by the DoD, of which only ~1,100 are active satellites, not to mention the hundreds of thousands of smaller objects, currently too small to track, pose a substantial risk to existing and future DoD space assets. This risk manifested spectacularly when a defunct Russian COSMOS satellite collided with an Iridium satellite in 2009, creating 1,500 more trackable pieces of space debris.³

Contested space relates directly to adversarial threats potentially posed by other nations and non-state actors. “Today space systems and their supporting infrastructure face a range of man-made threats that may deny, degrade, deceive, disrupt, or destroy assets. Potential adversaries are seeking to exploit perceived space vulnerabilities. As more nations and non-state actors develop counterspace capabilities over the next decade, threats to U.S. space systems and challenges to the stability and security of the space environment will increase.”⁴

Space is also quickly becoming a much more *competitive* domain as other nations quickly develop space technology expertise and the ability to field technologically advanced assets at relatively low cost. “Although the United States still maintains an overall edge in space capabilities, the U.S. competitive advantage has decreased as market-entry barriers have lowered.”⁵ Market-entry barriers, both in terms of cost and access to suppliers, have been lowered in large part due to the globalization and internationalization of the space industrial base. “International advances in space technology and the associated increase in foreign availability of components have put increased importance on the U.S. export control review process to ensure the competitiveness of the U.S. space industrial base while also addressing national security needs. U.S. suppliers, especially those in the second and third tiers, are at risk due to inconsistent acquisition and production rates, long

development cycles, consolidation of suppliers under first-tier prime contractors, and a more competitive foreign market. A decrease in specialized suppliers further challenges U.S. abilities to maintain assured access to critical technologies, avoid critical dependencies, inspire innovation, and maintain leadership advantages. All of these issues are compounded by challenges in recruiting, developing, and retaining a technical workforce.”⁶

Hosted Payloads as a Potential Solution

Given these trends, officially recognized by the DoD and DNI, it comes as no surprise that the US Air Force is beginning to place more focus on developing *resilient* and *robust* architectures through disaggregation. To a large extent, this involves examining ways to reduce costs and developmental lead times while also fielding more assets with the essential capabilities to enable operational architectures to continue supporting the warfighter even when threatened by the accidental collisions or adversarial action. Resilience refers to the architectures ability to “fight through” interference (e.g. physical or radiofrequency disruption). By robust, the Air Force means the architectures should relinquish as little capability as possible and thus continue to provide the support demanded by the warfighter and add additional capability when possible.

As discussed above, senior DoD and USAF leadership have openly recognized that we will no longer be able to rely primarily on the legacy “Battlestar Gallactica” model of loading as much capability as possible into large, complex and expensive satellites. The risk of losing that capability to accidental or intentional incidents is rising. Furthermore, the developmental lead time for such assets is so long that the technology underpinning the assets will mostly be obsolete before the satellite is even launched, while our adversaries are fielding potentially technologically advanced assets in the meantime. Instead, the DoD will begin to first consider how capabilities can be fielded using shorter lead time, less expensive methods: mainly as hosted payloads or small satellite free-fliers launched as a rideshare. Acquiring large, complex and capability-rich satellites that take a long time to develop and produce will be an approach reserved only when capabilities deemed necessary to the operation of a particular architecture cannot be fielded on smaller assets.

In essence, the Air Force stands at the cusp of a paradigm shift in how it will acquire future operational space assets. It is against this backdrop of shifting military space priorities and concerns that the CHIRP sensor recently launched flawlessly on an Ariane V rocket into the French Guiana twilight sky.

2. CHIRP PROGRAM

In January 2008, the Government received an unsolicited proposal for a “Commercially Hosted Infrared Payload”

² *National Security Space Strategy – Unclassified Summary*, Dept. of Defense and Director of National Intelligence, January 2011, p. 1.

³ *Id.* at 2.

⁴ *Id.* at 3.

⁵ *Id.*

⁶ *Id.*

Flight Demonstration Program. The CHIRP proposal was for a rideshare project to test out the new WFOV technology. As shown in Figure 1 below, the submitter Americom Governmental Services, now a part of SES World Skies, proposed placing a prototype sensor onto an Enhanced STAR 2.4 satellite bus manufactured by Orbital Sciences Corporation. Also as depicted in Figure 1 below, this bus was already scheduled to launch into geosynchronous orbit in 2010 as a commercial communications satellite, but it had sufficient capacity to host a small ¼ earth IR staring payload. The CHIRP proposal included five elements: the launch vehicle, the space vehicle, the satellite operations center, the CHIRP Mission Operations Center (CMOC), and CHIRP Mission Analysis Center (CMAC).⁷

CHIRP Project Graphic Summary

Figure 1⁸

The Government went on contract with SES in June 2008, using a firm, fixed-price contract. The Government elected to test out one of SAIC's ¼ earth sensors on the rideshare. The cost was far less than any free-flier alternative. Not only would this be a cost effective and quick way to mature the technology (as opposed to the long schedules typical to military free-flier programs), but it would also pave the way for opportunities to better align the military and commercial space sectors for future "rideshares."⁹

⁷ Joseph Simonds, Jie Zhu Jacquot, Charles Kersten, Patricia Lew and George Sullivan, "Lessons Learned from Hosting an Infrared Payload on a Communications Satellite," 2010 IEEEAC Paper # 1219, updated January 15, 2010, p. 2.

⁸ 3GIRS-RR = Third Generation Infrared Surveillance Risk Reduction.

⁹ "Lessons Learned from Hosting an Infrared Payload on a Communications Satellite" at 3.

The CHIRP Sensor

Figure 2

As the prime contractor, SES has been responsible for both coordinating with the comsat provider to load and launch the payload and for communications between the satellite and the ground station. Prior to the CHIRP program, SES, had already contracted with Orbital for the construction of three satellite buses: OS1, OS2, and OS3. OS2 was the designated comsat host for CHIRP, with a launch date scheduled in May 2010, but CHIRP ultimately flew on OS3. As a part of SES's offering, Orbital would provide a unique feature, a Secondary Payload Interface (SPI). The SPI permits the USAF to control the secondary payload independently from its satellite host. Orbital also agreed to take responsibility for establishing and managing the CMOC. Orbital then subcontracted to SAIC to execute the flight demonstration and manage the CMAC, which will process mission data and assess its quality.¹⁰ Figure 3, on the following page, provides a graphical depiction of this contractual flowdown.

SES, the comsat provider, had already contracted to launch on an Ariane V rocket outside the US. Though US Government payloads are typically required to be launched on US-made launch vehicles, this policy does not apply to a "government secondary scientific payload for which no US launch service is available."¹¹ Consequently, the Government was not required to use a US-made launch vehicle for CHIRP.¹²

¹⁰ *Id.*

¹¹ Office of Science and Technology Policy, U.S. Space Transportation Policy 7 (2005).

¹² "Lessons Learned from Hosting an Infrared Payload on a Communications Satellite" at 3.

CHIRP Contractual Flowdown

Figure 3

Furthermore, both the launch and primary payload are commercial. This effectively locks the government and its contractor into a tight and typically immutable schedule. The CHIRP program was fortunate that SES had to delay the OS-3 launch by a year, otherwise CHIRP's launch would have been delayed far longer due to a Government-caused delay related to the flight readiness of the payload. This was a deviation from the norm for commercial launches which normally go off on schedule. There are many advantages, from both lower costs and being forced into a compressed timeline, to being tied to commercial launch schedules. However, this leaves the Government and its contractor very little time to address technical concerns and problems that ultimately arise. These problems, however, fortunately did not prove fatal to the CHIRP program. On the contrary, these challenges provided the Government and industry with many valuable lessons learned to apply to future hosted payload efforts. CHIRP, though delayed by a bit more than a year, ultimately launched and has been providing the Government with a wealth of data for use in maturing WFOV technology for use on future payloads.

3. CHIRP LESSONS LEARNED

Generally, lessons learned from CHIRP can be split into two broad categories: contracting and technical. Both are applicable to any future hosted payload, particularly if the payload is rated to have a Technology Readiness Level (TRL) below 7¹³, like CHIRP was prior to launch.

TRLs are measures used to assess the maturity of an evolving technology. The DoD uses a scale of 1-9, ranging from basic principles observed and reported to actual system "flight proven" through successful mission operations. Prior to launch, CHIRP had a TRL of 6, i.e. a model or prototype had been demonstrated in a relevant environment, because the sensor had been tested and calibrated in a simulated space environment. After launch and successful on-orbit check-out, CHIRP's TRL increased to 7, i.e. a prototype demo in an operational environment.

Contracting lessons learned

Probably the main lesson learned from CHIRP was, when upgrading a ground sensor to flight with an aggressive schedule, it is better to finish that work before contracting for launch and integration if the Government wishes to take advantage of the cost savings associated with a commercial integration and launch contract. In addition, there needs to be a systematic vetting of the comsat's ability to accommodate the technical needs of the payload.

With CHIRP, the Government too aggressively tried to push the development schedule to accommodate the launch schedule and ultimately had to negotiate a \$17.5 million engineering change proposal (ECP) with SES to delay the launch by about a year, raising the cost of the integration, launch and data analysis contract from \$65 million to \$82.5 million. In addition, the duration of flight operations was reduced from 12 months to 9.5 months. This issue also caused significant tension between the Government and SES because the matter of who should bear the cost of this risk gave rise to substantial debate. The Government claimed that since CHIRP was not the sole reason for the delay of the OS3 launch, then the Government should not be responsible for bearing all additional costs. The fact that SES ultimately would have had to delay the launch for its own reasons contributed to this sentiment. Part of the SES delay was due to contamination of the reaction wheels. However, the Government also acknowledged the CHIRP payload could not make the original launch date. Had OS3 launched on schedule, CHIRP's launch would have been delayed indefinitely. Fortunately, the originally scheduled launch was able to be delayed and thus allowed CHIRP to be fully tested and integrated with the space vehicle. SES was able to accommodate the delay by reconfiguring their constellation of comsats thus allowing the Government to pay for the Government's portion of the delay of the originally scheduled launch. Nevertheless, the final negotiated price for CHIRP integration, launch and data analysis was still a fraction of the typical integration and launch cost for a free-flier military payload on a US launch vehicle, which can easily run into the hundreds of millions of dollars.

In order to avoid a similar problem in the future, Government clients seeking to launch low TRL hosted payloads on commercial satellites should complete the development of the payload up to space flight qualification.

¹³ "Technology Readiness Assessment (TRA) Guidance". United States Department of Defense. April 2011, pp. 13-14.

When the payload is in its final stages of testing, then the Government should begin to examine commercial integration and launch opportunities and deliver the payload to the integrator as Government Furnished Property (GFP) at contract award. This approach would reduce the risk of government-caused delays to an absolute minimum and lower costs. If the payload is high TRL, then the Government should consider either a single contract with the integrator to have the payload(s) built on subcontract or to contract separately and simultaneously for both the construction of the payload and acquisition of a launch date and integration services. Ultimately, the contracting approach chosen will depend on the maturity of the hosted payload sensor TRL.

The next contracting lesson learned for hosted payload acquisitions is an old one – “keep it simple”. The complex contract structure surrounding the CHIRP project gave rise to significant communication problems. SES contracted with Orbital to build three communication satellites: OS1, OS2, and OS3. The contract called for Orbital to deliver these spacecraft at three-month intervals. SES contracted with Orbital to integrate the payload onto OS2 (later OS3), and Orbital then subcontracted this responsibility to SAIC. Thus, SAIC had two separate contracts: one with AFRL to manufacture the sensor and another with SES to integrate it. Initially, this arrangement seemed ideal: SAIC would develop the payload and then could apply their experience to integrate it on the bus.¹⁴

However, privity of contract issues and conflicting interests presented problems, particularly in the flow of critical technical information and schedules among the parties. As depicted in Figure 4 below, SAIC established a firewall around its team working on sensor development and its team responsible for ground development. This firewall not only cut off communication between the teams and the prime contractor but also between the two teams themselves. Although Orbital was the middleman between SES and SAIC, it failed to relay communications between those two parties. The companies authorized only one person to bridge the gap between the various teams. This arrangement greatly constricted the flow of vital information and hampered efficient solutions to technical issues. This in turn led to delays in the schedule.¹⁵ These communication problems were resolved following the changes in leadership at SES, Orbital and the transfer of administration of the SAIC-RR contract from AFRL to SMC.

Pre-Integration and Test CHIRP Contractual Structure

Figure 4

This experience should lead future Government planners of hosted payload programs to seek the most streamlined contracting structure(s) possible. In other words, where possible, one contract should be used for both acquiring the payloads and launch services. If that is untenable, then the contracts should run sequentially, i.e. the period of performance for the integration and launch contract should only commence after the payload(s) is(are) space-qualified. Concurrent contractual periods of performance, in which one prime contractor is developing the payload while the other has already reserved a launch and is planning integration activities, should only be pursued if the payload(s) is(are) high TRL and there is a particular urgency on the Government’s side to get the payload(s) into orbit.

Technical Lessons Learned

Here, we delve into significant technical challenges faced by the CHIRP team prior to launch. Some of the problems can be fixed through better systems engineering, design or contracting. Other problems result from characteristics inherent to commercially-hosted payloads and require the program managers and technicians to devise creative solutions. In the future, the US Government must take these issues into consideration when performing trade studies on whether to host payloads commercially.¹⁶

With regards to the space vehicle, the first lesson learned to be noted is that the Government should obtain necessary systems engineering documents detailing specifications of

¹⁴ “Lessons Learned from Hosting an Infrared Payload on a Communications Satellite” at 8-9.

¹⁵ *Id.* at 9.

¹⁶ *Id.* at 6.

the space vehicle design prior to the start of payload development. “Before contract signing, the Government was not provided the necessary systems engineering documents detailing specifications of the space vehicle design. This created many non-optimal sensor configuration decisions in which the Government had to sacrifice performance to accommodate the ‘do no harm to the space vehicle’ paradigm. First, the payload baffle had to be shortened because of interference between it and one of the vehicle’s antennae. The sensor optics were hence exposed to the omni antenna, a source of additional and variable scattered light that contributes to sensor noise and clutter in the background, making targets harder to detect. Second, the payload cryocooler was designed with insufficient knowledge of the heat dissipation plan for the space vehicle. These problems could have been avoided or at least mitigated more effectively if high fidelity 3D CAD drawings, thermal model, and space vehicle con-ops were provided to the Government before contract signing.”¹⁷

Regarding the technical aspects of the space vehicle itself and the interface between CHIRP and the comsat bus, CHIRP relies on the comsat for power, space and transponders to downlink IR data. Information such as attitude, space vehicle monitored analogs, or time is not propagated from the space vehicle to the payload. Uncertainties in the space vehicle downlink time latencies raised concerns about obtaining accurately time-tagged attitude and line-of-sight information to correlate with the payload data. CHIRP must rely on in-scene star and static source identification for high fidelity line-of-sight calculations. “Another issue with the commercial host is the auto-promotion of the space vehicle data on the ground. The excessive timeframe necessary to accredit the ground system from an information assurance standpoint required CHIRP to resolve the issue with the standard sneaker net solution. The ephemeris and space vehicle data is transferred once a day and nominally lag the payload data by 12 hours. While this initially appears only to delay the start of the data analysis, uncertainties in the space vehicle downlink time latencies and the 12 hour time-lag makes it difficult to correlate accurately time-tagged attitude and line-of-sight information with the payload data. This affects the accuracy of the data processing results. Even if this correlation was possible, the accuracy and frequency of attitude data transmitted by the commercial host may not be sufficient for CHIRP as most commercial space vehicles do not have the same level of requirements in terms of ephemeris and attitude accuracy as an IR payload. There are many potential solutions for this problem, which can be incorporated into future systems. One possible solution is to add on-board infrastructure for information transfer between the space vehicle and payload. In this case, the payload will still be at the mercy of the space vehicle for required information. Another solution is to make the payload self-sufficient by adding components, like IR star trackers and GPS capability; however, this increases payload cost,

weight, power and size. These are trade-offs that must be made prior to selecting the host satellite.”¹⁸

The Government was also faced with the challenge of properly calibrating the CHIRP sensor on-orbit and to monitor focal plane array degradation. “A typical approach to calibrating a sensor on-orbit is to either provide on-board calibration sources or take flat field background images of deep space. Given the WFOV nature of the CHIRP sensor and the size of the calibration source that is required, the first alternative was not feasible within the allowed weight budget. The second approach is also not feasible, because CHIRP is not gimballed and the space vehicle provider’s contractual responsibilities to its communication customers prevent it from nodding the satellite periodically during CHIRP’s mission life. The second option also requires on-board storage for when the space vehicle nods off-axis and the line of sight ground communication breaks. Furthermore, once communication is restored, there is currently insufficient bandwidth to telemeter both the stored data and real-time data.”¹⁹ However, “for future payloads, a self-sufficient design that takes into consideration space vehicle capabilities, power, and weight limitations can help mitigate on-orbit calibration requirements.”²⁰

The problems mentioned above are currently being addressed real-time by the program office now that CHIRP is on orbit. The program office is documenting the lessons it is learning from the methods it is employing to address these problems, as well as others. Once the efficacy of these solutions is determined and all technical lessons learned are compiled, the program office will issue a separate report documenting the technical lessons learned from the execution of the CHIRP technology demonstration.

While not necessarily a lesson learned, it is also worth mentioning that the Government and satellite owner/operator must determine prior to contract award how to address certain potential problems should they arise. Among these include risk-sharing in the event a technical problem with the bus affects the hosted payload performance or vice versa. In addition the owner/operator of the host may deem it necessary to reposition the satellite in a manner that renders the hosted payload useless for its intended purpose. These technical matters must be addressed during the contract drafting process.

4. LIFE AFTER CHIRP

Despite its potential, the Third Generation Infrared Surveillance (3GIRS) program, the successor to the program stood up in XR to generate competition for the current Space-Based Infrared System (SBIRS) GEO 3 satellite and explore alternative technologies²¹, was officially zeroed out

¹⁸ *Id.* at 6.

¹⁹ *Id.* at 6-7.

²⁰ *Id.* at 7.

²¹ Rpt (FOUO), USAF, “Report on Third Generation Infrared Surveillance

¹⁷ *Id.* at 7.

of the budget after the conclusion of the CHIRP demonstration. At the time, CHIRP had yet to fly but the cost savings and technological advantages of utilizing hosted payloads to augment operational DoD space architectures would be validated by a successful CHIRP demonstration.

For example, one could spend ~\$216 million to develop, test, integrate and launch a sensor within 3-4 years, as well as provide experimental ground support operations, or one could spend the ~\$1.5 billion to build and launch a typical legacy “Battlestar Gallactica” (which does not include all the Program Office support costs, ground support development and operations, etc.) loaded with multiple sensors and capabilities, albeit relatively outdated by the time the satellite is launched. However, the legacy system is already a proven technology, is operational, certified and providing a critical national capability. Nevertheless, the risks posed by investing so many resources in such systems are rising steadily.

An analogy to investing in securities markets can be drawn. The first thing a prudent investor learns is that it is always better to diversify one’s risks and not assume an inordinate amount of exposure in any position – a basic, fundamental tenet of risk management. Here, one could invest a very large amount of resources into fielding one complex and very expensive target for adversaries and space debris, the loss of which could threaten the functionality of the whole architecture. Alternatively, one could use the same resources to field several smaller assets, the loss of any one of which, while detrimental, would not deprive the warfighter of the architecture’s capabilities.

Fortunately, these points have not been lost on DoD leadership and SMC’s leadership in particular. SMC leadership recently stood up the Hosted Payload Office (HPO) within XR to help SMC directorates facilitate the identification and utilization of hosted payload opportunities. SMC/CC cited both the laser focus Congress has placed on cutting military spending, as well as the objectively impressive cost savings and short acquisition timeline of the CHIRP demonstration. These factors are what are driving the DoD to consider the disaggregation of mission architectures, i.e. reallocating mission capabilities from a few large, high-capability satellites to multiple smaller, less expensive, and more modern assets. While it may still be necessary to field large, exquisite assets as “motherships” for the architecture, the preference going forward will probably be to first see how mission capabilities could be acquired via hosted payloads or small sat rideshares before deciding to acquire large, expensive free fliers.

Hosted Payload Office

The HPO is tasked with performing concept and architecture development and risk reduction, as well as design development, procurement, test, launch, and operations of government payloads within operational architectures on commercial and/or government hosts.²² The HPO will be responsible for supporting both architecture alternative analysis and end-to-end systems engineering from payload to mission architecture integration. Furthermore, the HPO will coordinate with SMC directorates for detailed implementation of hosted payload options.²³

The term “hosted payload” can be interpreted in different ways by different organizations. The most on-point HPO definition for the purposes of this paper is provided in the Futron Corporation’s *Hosted Payload Guidebook*: “an instrument or package of equipment affixed to a host spacecraft, which operates in orbit making use of available capabilities of the host spacecraft, including mass, power, and/or communications.”²⁴

The HPO quickly engaged industry, in particular the newly-formed Hosted Payload Alliance (HPA) and companies that are offering or will offer hosted payload launch opportunities (e.g. Intelsat, SES, Iridium, etc.) and payload development (e.g. SAIC, Orbital, Loral, Boeing, etc.). The first manifestation of these efforts was the Hosted Payload Forum at SMC on September 19, 2011, jointly coordinated by the HPO and the HPA which attracted a substantial audience and formed the basis for organizing future workshops to explore the opportunities and challenges inherent to commercial hosting of DoD payloads.

Encouraged and stimulated by the DoD’s new Space Strategy calling for disaggregation of architectures and the high visibility stand-up of the HPO, SMC directorates quickly began to engage the HPO.

OPIR Applications – 3GIRS redux

Shortly after the HPO stand-up, XR was engaged on the possibility of conducting follow-on demonstrations of other WFOV sensors, launched as hosted payloads to support the Overhead Persistent Infrared (OPIR) architecture. The project goes by the official title of Commercially Hosted IR Payload Replenishment (CHIRP+).

CHIRP+ is envisioned to potentially both advance the TRL of WFOV sensors designed specifically to be launched as hosted payloads or rideshares and integrate them into the OPIR architecture. If this new project reached fruition (i.e.

(3GIRS) Technology Maturation Plan,” Apr 09, SD 6-3; Award Nomination (U), SMC/XR-MW, “Alternative Infrared Satellite System (AIRSS) Team,” Jan-Dec 06, SD 6-174.

²² Program Management Directive (PMD) for Space and Missile Systems Center Hosted Payload Office (HPO) (draft), September 2011, p.1. (hereafter HPO PMD)

²³ *Id.*

²⁴ Hosted Payload Guidebook, Futron Corporation, August 2010, p. 10.

gets the funding and top cover it needs), CHIRP+ will demonstrate disaggregation by providing enhancements to Battlespace Awareness capabilities within the SBIRS Program (the fourth of SBIRS five OPIR mission sensor requirements) by providing persistent coverage of specific geographic areas with rapid frame rates, multiple spectral bands, and less than full-earth fields of regard.²⁵ Future demonstrations (currently none are being actively planned) may address the other OPIR requirements. The five OPIR mission sensor requirements for Space-Based Infrared Systems (SBIRS) GEO today are defined as follows:

1. **Missile Warning:** The sensor design provides reliable, unambiguous, timely, and accurate missile warning information to the President of the United States, the Secretary of Defense, Unified Commanders, and other users. This mission includes both global and theater functional requirements to support strategic and theater ballistic missile warning, and the notification and implementation of passive defense and force posturing. sensor message information includes missile launch origin, typing, trajectory, and impact point.
2. **Missile Defense:** The sensor will provide reliable, accurate, and timely information to defensive systems. This mission includes both national and theater functional requirements to enable active missile defense and attack operations against hostile forces. The sensor serves as a critical element of the nation's Ballistic Missile Defense System (BMDS), providing initial missile tracking data and hand-off to radar tracking and kill vehicle systems. It supports several critical BMDS functions, including launcher detection, target discrimination, and target hit/kill assessments.
3. **Technical Intelligence:** The sensor will provide reliable, accurate, and timely IR target signature and threat performance data to warfighters, the intelligence community, weapon system developers, and other users. This wideband data may be used for target classification and identification templates and algorithms for sensor operational missions. Sensor data will also be used to monitor activities and provide information to policy makers and other users on observed military tactics, new foreign technology development, arms control compliance, and proliferation activities. Its taskable sensors will track evolving and changing threats and improve IR target phenomenology.
4. **Battlespace Characterization:** The sensor will provide reliable, accurate, and timely data to enhance situational awareness, non-ballistic missile

threat warning, decision support, battle damage assessment and intelligence information (for land, sea, air, and space) for unified commanders, Joint Task Force (JTF) Commanders, and other users. Battlespace characterization will apply the sensor product to the immediate needs of the warfighters, providing an IR view of the battlefield. This enhanced situational awareness enables more efficient resource management within the battlespace.

5. **Civil/Environmental uses:** Support to national, state, local, foreign, and civil and environment agencies. Applications include support for natural and man-made disasters and events (e.g., cloud cover, ash clouds, snow and ice accumulation, electrical grid blackouts, forest fires, floods).

Currently, the HPO is examining the possibility of building and launching 2-3 hosted 6 and 9 degree OPIR WFOV payloads by FY16. Requirements documents are being drafted and the planning of this acquisition is spinning up vigorously. This program has high-level visibility, and given the success of CHIRP, the new direction of DoD space policy and acquisition strategy, and the fiscal constraints on the Government, the planets seem to be aligning nicely to push this effort along. The USAF would apply the CHIRP lessons learned and develop the sensors fully through spaceflight qualification before contracting for the launch, while engaging industry through the HPO to get an idea of what launch options will be available in the notional schedule timeframe. The sensor development contract type will probably be either firm-fixed-price (FFP) or cost-plus-fixed-fee (CPFF), depending on the funding available and the nature of the final technical requirements for the sensors. This acquisition will be competed as a multiple-award FAR 15 source selection. In the meantime, the HPO may begin developing an acquisition framework for acquiring commercial integration and launch services, either by establishing an indefinite quantity/indefinite delivery (IDIQ) contract to acquire launches for all directorates, or if demand for hosted payload launches does not manifest, then do a multiple-award commercial acquisition for DTP launches, which will require the host spacecraft to be inserted in geostationary orbit.

Space Weather

In addition to examining hosted payload opportunities for the OPIR architecture, the HPO is also looking at potential applications in the areas of space weather. Opportunities for launching space weather sensors on the Iridium Next constellation are currently being examined given the planned constellation's unique orbital characteristics. While details of specific sensors and plans are not yet available, SMC sees this as an opportunity to meet future space weather architectural requirements at far lower costs than sending up the sensors as free fliers. As with OPIR sensors, however, there are many obstacles to overcome. In addition,

²⁵ Demonstration Infrared Payload Statement of Work (draft v4), USAF/AFSPC/SMC, 3 November 2011, p.2.

while the possibility of launching on Iridium Next would be a unique opportunity, the HPO is interested in evaluating the all options available and wishes to get relevant feedback on this via future engagement with industry.

5. CHALLENGES TO DoD USE OF HOSTED PAYLOADS

While fiscal, policy and technological trends are stimulating considerable interest in the potential for the DoD to use hosted payload opportunities to disaggregate and augment operational architectures, many challenges remain.

Money and Politics

Perhaps the largest single obstacle at this time is the lack of committed funding for standing up new hosted payload projects. Most of the money that would otherwise be available for hosted payload projects is still tied up in legacy programs, as appropriated by Congress. It will require a substantial effort by SMC and AFSPC leadership to refocus funding priorities to include HPO-related efforts even though HQ, SMC and AFSPC leadership strongly support hosted payload initiatives. In a challenging funding environment, this will require some change from the current paradigm.

Culture

Finally, a significant cultural shift will be required in order to support the shorter commercial timeframes and stripped-down requirements inherent to commercial launch schedules and driven by the SWAP constraints of hosted payloads and the host satellites. The current acquisition “horseblanket” process, in which an analysis of alternatives can take up to 24 months to complete, will need to be substantially revised and streamlined, possibly with whole sections removed in order to enable to the Government to acquire assets more quickly. Furthermore, the requirements development and definition approach would have to be inverted from how it currently stands. Instead of planning to field an asset and figuring out how many capabilities can be fit into that asset, the focus should be on identifying a single or small set of capabilities and developing the smaller, inexpensive asset to provide those capabilities. The DoD should place priority on developing such assets, as that is the only way to relatively inexpensively field a disaggregated architecture. The analysis of alternatives spectrum should have simple assets as most desired and highly complex assets that require long developmental timelines and major investment as least desirable.

5. CONCLUSION

In conclusion, the success of the CHIRP program may be beginning of a new paradigm for DoD acquisition of space assets. XR has proven the concept is valid and operational assets can potentially be disaggregated and fielded as hosted payloads at a fraction of the cost and time that larger, legacy

assets are fielded. This also allows the DoD to field more technologically advanced assets than it has done traditionally. CHIRP has proven that the commercially hosted payload approach is a viable method for disaggregating at least some of SBIRS OPIR mission areas. Nevertheless, many challenges remain, namely in the areas of fiscal commitment, political opposition and cultural change. What is necessary now is for SMC, through the HPO, to build on the momentum of CHIRP’s success and to capitalize on hosted payload opportunities. If successful, this effort will make our military space architectures more resilient and robust while using taxpayers’ money more efficiently and effectively.

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BIOGRAPHIES

Joseph Simonds is the Director of Contracting for SMC/XR. He has served as a senior advisor in the Acquisition Center of Excellence and the Contract Review Committee. He is the former Deputy Director of Contracting for Launch Vehicles and worked in the GPS program office and the Satellite Control office as a business advisor and contracting officer. He has a BA from Antioch

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1. Joseph Simonds & Andrew Mitchell, "Operational Experiments on Commercial Spacecraft," IEEEAC Paper # 1294, Version 2, updated October 31, 2008.
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