INTELLECTUAL PROPERTY

(This section must be signed)

Individuals **outside your company**, including the companies listed above and other third parties, potentially including your competitors and others in your industry, may receive and/or review award submissions. All information submitted should address the program's management, leadership, and processes in a manner that you are comfortable sharing with third parties freely and without restriction, and may not include any classified or proprietary information or materials. Do not include any materials marked Confidential or Proprietary or bearing any similar legend. All responses and other submissions, whether in whole or in part ("Submissions"), shall be deemed not to be confidential, proprietary, and/or nonpublic information of any sort for any purpose.

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Acknowledged, agreed, and submitted by

Kevin T Bredehoft Digitally signed by Kevin T Bredehoft
Date: 2022.05.13 14:30:33 -07'00'

Nominee's Signature _____ Date _____

Nominee's Name (please print): **Kevin Bredehoft**

Title (please print): **Associate Director, HAWC Program Manager**

Company (please print): **Raytheon Missiles and Defense**

NOMINATION FORM

Name of Program: Hypersonic Air Breathing Weapon Concept (HAWC) _____

Name of Program Leader: Kevin Bredehoft _____

Phone Number: (520)741-5078 _____

Email: Kevin.T.Bredehoft@rtx.com _____

Postal Address: 1151 E Hermans Rd _____
Tucson, AZ 85756
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☒ Customer Approved

- Date: 5/13/2022; DISTAR case 36247 _____
- Customer Contact (name/title/organization/phone): Andrew Knoedler/Program Manager/DARPA/

☒ Supplier Approved (if named in this nomination form)

- Date: 4/28/22 _____
- Supplier Contact (name/title/organization/phone): Chris Gettinger/ Director/ Northrop Grumman Systems Corporation/(561)459-0614 _____

PLEASE REFER TO PROGRAM EXCELLENCE DIRECTIONS
AS YOU COMPLETE THIS FORM.

EXECUTIVE SUMMARY: Make the Case for Excellence *(Value: 10 pts)*

What is the vision for this program/project? What unique characteristics and properties qualify this program for consideration?

(12 pt. Times New Roman) LIMIT YOUR NARRATIVE TO THIS PAGE.

As our global competitors continue to rapidly develop highly capable hypersonic systems, the US Department of Defense (DOD) has emphasized the critical need for hypersonic weapon capability, making it one of the top DOD priorities. Hypersonic weapons are a vital part of the US DOD modernization strategy to ensure continued US dominance of the tactical battlefield.

The DARPA Hypersonic Air Breathing Weapon Concept (HAWC) program is focused on demonstrating airframe and scramjet propulsion technologies for direct integration into hypersonic cruise missiles. In September 2021, the Raytheon HAWC program, along with DARPA, the USAF, and partner Northrop Grumman, conducted a historic flight that successfully demonstrated scramjet ignition, scramjet-powered climb and acceleration, and missile cruise flight at hypersonic speeds utilizing tactically applicable engine, airframe, and manufacturing technologies. By meeting the primary test objectives, the team demonstrated the viability of an efficient long range, hypersonic cruise missile for the United States. Defense contractors Raytheon Missiles & Defense (RMD) and Northrop Grumman Systems Corporation (NGSC). in partnership with the Defense Advanced Research Projects Agency (DARPA) and the United States Air Force (USAF) jointly developed the missile and propulsion system proven in this historic flight.

The team was asked to move fast to reach this historic milestone so it was imperative that they could solve problems quickly in the midst of a very dynamic and technically complex environment. The team established and leveraged close customer relationships that facilitated quick and agile corrective actions, using advanced program management methods such as bi-weekly roadblock meetings, an incremental Consent to Ship review process, comprehensive cross-functional alignment, and robust risk management, all of which contributed to team success. Daily standups, transparent communication, weekly onsite customer presence, and collaborative contractor-customer problem solving were instrumental in facilitating team success.

As a result, the RMD-NGSC HAWC architecture can be readily leveraged for a hypersonic cruise missile program of record offering next generation capability to the U.S. military with proven, viable engine and airframe technologies. Scramjets have long been seen as immature, unreliable, and an unlikely choice for a tactical weapon system. HAWC's development and successful flight have proven the real world readiness of a relevant, scramjet powered system. Building on the legacy of pioneering developments of scramjet technology programs like the X-43 and X-51, the team leveraged trusted partnerships within industry and the U.S. Government to jointly develop this critical capability. The technologies demonstrated also have direct applicability to future usage in larger scale military and commercial aircraft. The successful test represents the technological tipping point toward a range of flight vehicles that travel at speeds greater than 1 mile per second.

Do not exceed 10 pages in responding to the following four descriptions; allocate these 10 pages as you deem appropriate, but it is important that you respond to all four sections. DO NOT REMOVE THE GUIDANCE PROVIDED FOR EACH SECTION.

VALUE CREATION *(*Value: 15 pts*)*
Please respond to the following prompt:

- Clearly define the value of this program/project for the corporation
- Clearly define the value of this program/project to your customer
- Clearly define the value of this program/project to members of your team
- Clearly define the contribution of this program/project to the greater good (society, security, etc.)

(12 pt. Times Roman)

Value to the Corporation

HAWC is the precursor to the USAF Hypersonic Attack Cruise Missile (HACM) program of record and the USAF is expected to make a contractor downselect decision in 2022. As stated by the DoD, this is a vital capability that is needed to counter emerging threats from peer adversaries and is expected to be produced in large quantities over the next several decades. RMD designed the HAWC demonstration system with tactical application in mind from the start so that the system could be quickly fielded with minimal system design changes after a successful demonstration. The successful flight test on HAWC proved the real world utility of a hypersonic cruise missile that is ready to transition quickly to a program of record. RMD and NGSC continue to invest in hypersonics and the successful HAWC test highlighted the importance of continued investment. RMD has invested in technology, facilities, processes and equipment to improve performance and testing. One of the HAWC Program pillars is to develop affordable system designs and manufacturing approaches. Manufacturing processes developed as a part of the HAWC Program will be applicable to a number of missile programs across RMD and industry.

One of the program's significant process improvements centered around incorporating an incremental Consent to Ship (iCTS) process, in which the team held reviews at more frequent intervals during the build process, rather than having one large CTS review after the missile was built. Although this process appears on paper appears to add days to the schedule, it allowed the team to catch issues while there was still the opportunity to correct them. Implementing this approach allowed for issues to be caught at lower levels of assembly, where it is less time consuming to correct them and actually resulted in a 10-20% reduction in the vehicle build timeline. It also resulted in a higher quality vehicle build, particularly of lower priority test instrumentation, that proved to be vital sources of data in understanding hypersonic flight environments. Having the full suite of sensors during the flight test was crucial in verifying the flight met all of its objectives, and provided valuable data to validate affordable system designs, performance models, and manufacturing approaches that will be directly leveraged to field air-breathing hypersonic missiles to our warfighters in the near future.

Northrop Grumman also incorporated innovative techniques that allowed for improved performance. Through the use of 3D-printing/additive manufacturing (AM) technologies, the team incorporated significant weight reduction of the scramjet enabling longer range performance. AM was also a key enabler in producing the geometries necessary to enable crucial engine performance characteristics.

Program Management and RMD Leadership compiled and documented valuable lessons that will be applied on other RMD programs. The close relationship and transparent communication between the industry and customer team fostered trust, allowing the team to work through issues quickly. Ensuring the DARPA/USAF Program Office was kept informed on cost/schedule impacts allowed for them to

effectively manage the broader group of USG stakeholders, preventing unnecessary delays and ensuring continued support from the government team.

Value to Customer

As stated on the DARPA website, the Agency's mission is to create breakthrough technologies and capabilities for national security. DARPA's aim is to be the initiator and not the victim of strategic technological surprises by working with innovators inside and outside of government. The HAWC flight verified that scramjet propulsion is beyond the proof-of-concept stage of earlier flight experiments in the first two decades of this century to a system that can be manufactured affordably while delivering a payload with military utility at ranges long enough to give U.S. forces a winning advantage. In addition, the overall propulsive efficiency of the scramjet engine result in a significant reduction in required fuel load compared to any previously demonstrated scramjet-powered vehicle, enabling a vehicle sized for carriage on conventional fighter and bomber aircraft. The HAWC missile provides a breakthrough capability and is critical to helping DARPA meet their mission and transition transformative technology to a DoD program of record.

Value to Members of your Team

FEATURED

Scramjet-Powered Hypersonic Weapon Launched for the First Time, It's American

Home > News > Military Bits & Pieces 28 Sep 2021, 11:40 UTC · by Daniel Patrascu

Whatever the nations that will be involved in our planet's next big war, chances are we'll probably see, ever so briefly, incredible weapons at work. Like, say, hypersonic rockets, capable of traveling so fast they'll render defense systems useless.

Several nations are working to develop such systems, and each take turns bragging about their accomplishments. This time, it's the Americans who beat the drums, after they've just completed the first flight test of something called HAWC.

HAWC stands for Hypersonic Air-breathing Weapon Concept, and it's a bit of hardware being developed by Raytheon, Northrop Grumman, and Lockheed Martin. We've already got wind of the weapon's successful rocket motor live-fire test which took place back in May. This, time, the entire thing flew, and apparently flew beautifully.

The successful September 2021 HAWC flight test was the culmination of years of ground-breaking work by the Raytheon, Northrop Grumman, DARPA, and USAF team members. The significance of this tremendous milestone was recognized across the DOD and industry. "This is a history-making moment, and this success paves the way for an affordable, long-range hypersonic system in the near term to strengthen national security," said Colin Whelan, vice president of Advanced Technology at Raytheon Missiles & Defense. "This test proves we can deliver the first operational hypersonic scramjet, providing a significant increase in warfighting capabilities." Northrop Grumman leadership also recognized the importance of the flight test.
"We have reached a milestone in delivering a game-changing capability to the warfighter," said Dan Olson, vice president and general manager of Weapon Systems Division for Northrop Grumman. "Decades of learning advanced manufacturing techniques and industry partnerships helped us define what is now possible."

HAWC team members feel fortunate to know they are advancing cutting-edge technology that is crucial to the United States. There is a tremendous amount of

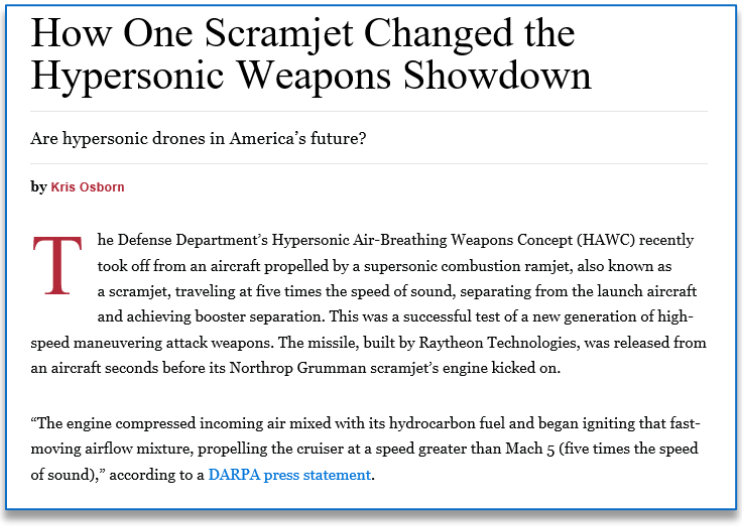
pride among the team members for being part of this historic program. Despite the challenges of the global pandemic, the team worked together seamlessly with full integrated weekly on-site presence so that dialog could flow freely. Jointly solving both technical and programmatic challenges created a unique teaming environment. The close working relationship and transparent communication with the industry partners and DARPA/USAF customer team promoted a "one team" mindset among all participants, allowing all employees to see their influence in the final product and equally share in the team's success.

Underlying the efforts of the HAWC team is the realization that their work is critical for national security in the face of threats from peer nations. Each team member recognizes the magnitude of providing this technology to the US military. In a world where the daily news frequently alerts us to hypersonic missile tests being conducted by Russia and China, the need to quickly develop this technology is evident. The successful HAWC demonstration is a point of great pride for the team, not only for their accomplishments, but for the years of learning that made this milestone possible. Most importantly, the HAWC program is proud to be building the foundation required to deliver the crucial capability to the US warfighter.

Value to Greater Good

The benefit of hypersonic weapons in combat is undeniable. Speed provides a significant advantage, offering the potential for military operations from longer ranges with shorter response times and advanced effectiveness. HAWC observed remarkable fuel efficiency in the flight test, which proved efficient operation of a tactically sized system over long ranges. As our global competitors and adversaries continue to rapidly develop highly capable hypersonic systems, the US Department of Defense (DOD) has emphasized the critical need for hypersonic weapon capability, making it one of the top DOD priorities. Hypersonic weapons are a vital part of the US DOD modernization strategy to ensure continued US dominance of the tactical battlefield.

Although the HAWC system is a demonstration program and is not currently in production, the successful flight test in September 2021 demonstrated the viability of an efficient long range, hypersonic cruise missile for the United States. The manufacturing approach, control algorithms, and thermal and vibration management techniques enabled sustained, long range, hypersonic cruise flight of HAWC using conventional hydrocarbon-based fuels and demonstrated the capability to carry tactically-sized payloads over significantly longer distances than any previously demonstrated scramjet-powered vehicle.



How One Scramjet Changed the Hypersonic Weapons Showdown

Are hypersonic drones in America's future?

by Kris Osborn

The Defense Department's Hypersonic Air-Breathing Weapons Concept (HAWC) recently took off from an aircraft propelled by a supersonic combustion ramjet, also known as a scramjet, traveling at five times the speed of sound, separating from the launch aircraft and achieving booster separation. This was a successful test of a new generation of high-speed maneuvering attack weapons. The missile, built by Raytheon Technologies, was released from an aircraft seconds before its Northrop Grumman scramjet's engine kicked on.

"The engine compressed incoming air mixed with its hydrocarbon fuel and began igniting that fast-moving airflow mixture, propelling the cruiser at a speed greater than Mach 5 (five times the speed of sound)," according to a DARPA press statement.

The system also implemented significant features. The first use of a hydrocarbon fuel with a long shelf life as the hypersonic propulsion fuel allows for safe handling in field operations, while its long shelf life eliminates the need for traditional day-of-flight liquid fueling operations. HAWC also used a new insensitive munitions compliant scramjet engine ignition system with an order of magnitude reduction in weight and volume compared to previously demonstrated scramjet ignition systems. In addition, the flight demonstrated safe aircraft separation and extended operation with a Flight Termination System qualified for hypersonic vibration and thermal environments.

The technology demonstrated by the HAWC Program paves the way for future programs of record to develop affordable air-breathing hypersonic weapons that can be deployed on a variety of platforms, including Navy ships and Air Force jets. Being at the forefront of hypersonic scramjet technology, the HAWC Program has set the bar and the pace for not only RMD hypersonic programs, but for the Defense Advanced Research Projects Agency (DARPA), the DOD, and for the entire country.

RMD's mission is to create a safer future by being the place our customers turn to tackle their most complex challenges. There are many challenges that must be overcome when designing and building an affordable and reliable hypersonic missile. These challenges include material thermal properties, aerodynamics, and affordable manufacturing approaches, among others. Through the hard work and dedication of the joint industry-government team, air-breathing hypersonic technology is well poised for fielding to U.S. warfighters in the near future.

METRICS (Value: 15 pts)
Please respond to the following prompt:

- What are your predictive metrics?
- How did you perform against these metrics?
- How do your predictive metrics drive action toward program excellence? Please provide examples.

(12 pt. Times Roman)

The team implemented a robust Integrated Master Schedule (IMS), defining daily milestones to ensure the program remained on-track. This allowed the team to react quickly to any issues with the potential to impact the schedule, and understand schedule risks the program faced. The team adapted to issues and revised the schedule each day. This facilitated timely discussions on barriers that Program or RMD leadership needed to help remove. Daily stand-up meetings included all stakeholders from the team, including customers. The status sheet, shown in Figure 1, was published daily prior to the daily stand-up meeting. During these stand-up meetings, the team reviewed any ongoing issues, describing the action required to close the issue, identifying the actionee, and capturing the need date to support the build/test schedule. The stand-up focused on tactical execution of the program while maintaining focus on the schedule to which the team had committed. Concentrating on the barriers and the actions required to resolve these barriers helped ensure quick resolution and alignment with the schedule. Customer involvement in the daily stand-ups ensured they were made aware of issues in a timely manner.

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Flight Test Vehicle 1 Status [Mon 9/6/21]

Tasks to iCTS

Build Step	ECD
PCS Acceptance	9/6
Electrical Mate	9/7
Electrical Mate Checkout	9/8
Mechanical Mate	9/10
ESS Vibration Testing	9/13-9/15
Acceptance Test	9/16

General Status

- Completed instrumentation check-out on PCS
- Passed PCS Acceptance Test
- Discovered off-nominal electrical check on W34; upon further evaluation it was determined to not be an issue and will be accepted via MRB
- Notified ETF we plan to be there 9/13

Roadblocks to iCTS

- **Acceptance**
  - Engineering: Need electrical test variance
  - Material Review Board: Need to accept W34 harness by 9/16
- **Other**
  - May need to deconflict ETF test asset with other advanced program

Raytheon Missiles & Defense

4

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Figure 1: Daily Status Tracker

In addition to the daily stand-up meetings, the team implemented bi-weekly roadblock meetings with RMD, NGSC, and DARPA senior leadership. In order to convey the status of each of the roadblocks, the team created a stoplight chart, shown in Figure 2.

(U) Schedule Uncertainty Assessment – 8/25

			Probability of Readiness for Flight Test Month: Sep.		
	Baseline Activities Prior to FT-1	**2 Weeks Prior**	**Current**	**Key Knowledge Point(s)**	**KP Completion Date**
Builds	Updated engine brackets	Complete	Complete	Final acceptance	Complete
	FT-1 Cruiser	90%	Complete	FES Complete PCS Complete Build & ATP Complete	Complete Complete Complete
	FT-1 AUR	85%	90%	Build & ATP Complete	2-Sep
Aircraft	Test Aircraft Availability	99%	99%	Readiness Review	31-Aug
		Min. Confidence in FT-1 Date	90%		

FT-1 Readiness Assessment Criteria
- Pacing items for flight readiness (in order of potential impact):
  - FT-1 Build
- Recent completions:
  - Cruiser Fueling & CG/MOI
  - Software Qualification
- Watch Items/Updates:
  - Resolving readiness review findings on SW functions; do not anticipate overall delay to schedule

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Figure 2: Schedule Uncertainty Assessment "Stoplight Chart" for Leadership

At a quick glance, the stoplight chart provides all the relevant information regarding the state of each of the key activities leading up to the flight test. This includes the probability that the item will be ready to support the flight test, the knowledge points supported, and the need/completion date for each activity. Though it may seem overly deterministic to assign a numerical probability to uncertainty, it was a highly effective way to convey risk and drive discussion on relative uncertainty. Any issues or watch items that were at risk of impacting the flight test were identified. The colors tied to probabilistic ranges where 0-51% was red, 51-89% was yellow, and 90-100% was green. This quickly highlighted the areas that needed the most attention, allowing the team to place resources where they were most needed and would be most effective. It also allowed for easy and quick communication of issues to leaders within Raytheon and across the DoD who were keenly interested in our readiness for flight.

This approach allowed for straightforward communication of barriers that needed to be resolved and was used effectively to resolve issues associated with RMD, NGSC, and government owned items. As an example, the team discovered that we had a test asset conflict in our environmental test facility. RMD leadership was able to broker test time between programs, implement multiple shifts, and avoided a potential two week delay to the schedule that would have caused us to miss our scarce test slot on the test range.

DEALING WITH PROGRAM COMPLEXITY (VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, OR VUCA) *(Value: 25 pts)*

Please respond to the following prompts:

- *10 pts:* Describe areas of VUCA faced by your program and why.
- *15 pts:* Explain how your team responded to these challenges.

(12 pt. Times Roman)

Dealing with new and groundbreaking technologies inherently brings uncertainty and complexity to a program. To date, hypersonics development has been mainly grouped in two categories, Air Breathing vehicles and Boost Glide vehicles. Until the HAWC flight was conducted, boost glide systems were perceived to be more mature because they can leverage much of the development from the Space Program and Cold War era weapons development, specifically ICBM reentry vehicle design. Air-launched hypersonic air-breathing systems have been viewed as less mature. Much of this view was driven by challenges and delays experienced by previous efforts, resulting in the belief that hypersonic airbreathing engines, known as Scramjets (Supersonic Combustion Ramjets), were too complex and not operationally robust. As a forerunner in the field of hypersonic air breathing vehicles, the tasks faced by the HAWC team were incredibly complex. The speeds encountered by hypersonic weapons make the thermal and vibration management a challenge, and the viability of an efficient, hydrocarbon fuel powered long range cruise missile had not been demonstrated.

In order to deal with the complex process of building the flight round, the team implemented an incremental Consent to Ship (iCTS) process. This was consisted of multiple build reviews at set increments during the build process which ultimately culminated in CTS of the entire flight vehicle. The reviews were conducted as a joint industry-government team. In a standard consent to ship, the team will gather after the hardware build is complete to review the pedigree and readiness to ship the round to the test site. If issues are discovered, the team must decide whether the issues are acceptable as-is, or whether rework is required. In many cases, rework can delay shipment and the subsequent flight test. The HAWC team realized that if obstacles are discovered sooner, there are additional opportunities to overcome them with a minimized schedule delay. For instance, if a build is complete and a problem is found with an internal sensor, the team is left with the option of either accepting the faulty sensor and conducting the flight test without all the desired data collection, or they can choose to deconstruct the missile in order to fix or replace the faulty sensor. Deconstructing the missile and fixing the sensor will add costly schedule delays and will cause re-work to rebuild the round. By conducting an incremental consent to ship, the HAWC team added in checkpoints along the build process where Subject Matter Experts were brought in to conduct reviews at lower levels before the full missile build was complete. In the example of the faulty internal sensor, this issue would have been caught before the missile was closed up and allowed the opportunity to correct the sensor functionality without having to tear down parts of the build.

By implementing this incremental process, the HAWC team did encounter a number of situations where faulty sensors were able to be corrected before it was too late in the process and also avoided multiple instances of costly rework at higher levels of assembly. If a traditional consent to ship approach had been followed, these issues likely would have been accepted for flight, as they did not pose a significant risk to the success of the flight. However, by having the opportunity to discover and fix the problem earlier, the team was able to collect large volume of high quality, crucial flight data, which enabled a deeper post-test evaluation and understanding of the flight profile and flight environments. This knowledge will be a key emabler in the transition to a hypersonic cruise missile program of record.

Another method which helped to manage complexity and volatility was the conduct of daily standup meetings. This allowed the team to get together to discuss any challenges or hurdles so that the correct attention could be put on each issue in a timely manner, allowing the program to attack challenges as they arose and keep on schedule. Including the Customer in these standups helped to build transparency and trust, as well as provide all stakeholders with the opportunity to aid in problem-solving. The HAWC team, inclusive of industry and government members, truly functioned as one team working toward a common goal.

ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP *(*Value: 35 pts*)*
Please respond to the following prompts

- *15 pts:* Describe the innovative tools and systems used by your team
- *10 pts:* Define how you developed, led and managed people
- *10 pts:* How did you leverage skills and technologies of your suppliers?

(12 pt. Times Roman)

Describe the innovative tools and systems used by your team

The tools described in prior sections: incremental Consent to Ship (iCTS), schedule uncertainty tracker with associated bi-weekly leadership meetings, daily status tracker, and daily status meetings all expound the importance of communication. The program management team firmly believes that these tools are only effective if there is a culture where people felt comfortable communicating problems where they would not be ostracized in the process. Due to the speed of the program, the firsts associated with building something new, and technical complexity of the tasks, there was a high degree of volatility, and failures were inevitable. Everyone at all levels of the organization within the RMD-NGSC team and within the HAWC customer team felt comfortable sharing "bad news." Embracing bad news was not for the purpose of venting, it ensured that communication of the problem was only the first step towards establishing an action-oriented path forward, making necessary adjustments in the plan, and identifying creative solutions to the problem at hand. Though identifying effective communication as a key tool may not appear inherently innovative, it was key to our success. Effective communication fostered trust at all levels of the team within industry and the government. Trust allowed us to discuss issues openly without fear of retribution, and open discussion allowed for innovative ideas to emerge quickly. Trust and effective communication also ensured that the government team had the information they needed to maintain advocacy for the program during the hard times.

Define how you developed, led and managed people

The team established and leveraged close customer relationships that facilitated quick and agile corrective actions. Best practices focused around clear, frequent, and transparent communication with program stakeholders. A fully integrated team meant having a weekly physical (on-site) presence so that dialogue on technical and schedule issues could flow both ways. The COVID-19 pandemic brought new challenges, but the team adapted. Although it was difficult, the team adjusted by reconfiguring the operational approach, including implementing multiple shifts, to keep the program on track. Work hours were staggered so that in the event of quarantine, the whole team would not be affected resulting in significant schedule delays. Additionally, the team agreed to weekly testing during the highest periods of community exposure in order to quarantine personnel before they had exposure to the broader team.

On-site customer presence fostered the "one team" mentality felt by both industry and government. Subject Matter Experts (SMEs) from all parties worked together to jointly solve both technical and schedule problems. There was a shared sense of ownership and investment in the program, as the customer technical team played a role in helping develop the technology. The trust and collaborative nature of the program kept everyone focused on the end goal. Working as one team provided DARPA

and the USAF Program Management teams with an informed understanding on cost/schedule impacts, allowing them to effectively manage broader U.S. government stakeholders on expectations to include cost and schedule. This also allowed for effective management of delays due to technical learning to ensure continued support of the effort as challenges arose.

We did not restrict personnel assignments to traditional Engineering roles. We were fortunate to have a very talented team who could perform an array of tasks and recognized they were capable of taking on a broad array of tasks that were likely outside their traditional job assignment. This allowed us to operate efficiently with a relatively small team where capable people were provided the resources needed to solve and implement solutions. We assigned leadership roles to the best candidate even if they did not report to a functional organization that traditionally would staff the specific role. Program leadership recognized their role was to remove barriers for the team, regularly seek feedback on what the team needed, and solicit diverse feedback before making decisions. In addition to being an efficient way to operate, it also proved to be highly beneficial for the career advancement of the team because they were able to gain experience in a broad array of tasks and gain knowledge at an accelerated rate. This knowledge sharing outside of functional norms will make these individuals more capable and well rounded. During a period where we are trying to fill voids left by high rates of retirement, this approach accelerates the readiness of highly capable people to fill positions of expanded influence and leadership.

It was also important for the RMD-NGSC team to maintain focus on the critical tasks and milestones. The HAWC system implemented innovative technology, and it was inevitable that there would be challenges along the way. When issues arose, program leadership quickly identified a recommended plan and path forward in order to guide discussion with the customer, and also to keep the team focused on moving forward and resolving issues. Rather than bringing the customer problems as soon as they arose and before action plans were identified, there was a concerted effort to work through issues methodically. This prevented treating issues like a "firefighting" exercise.

As a result of these practices, the entire team, all of whom had individual roles, stayed in sync. The team was able to respond quickly to actions and was also able to generate creative solutions from multiple perspectives. As the plan changed, team members were more easily able to adapt because there were less surprises.

How did you leverage skills and technologies of your suppliers?

Suppliers have been a key part of the HAWC program and were an essential part of the team's success. As mentioned throughought this nomination, the major partner on the program was Northrop Grumman, who developed and provided the supersonic combustion ramjet (scramjet) engine.

Although Northrop Grumman's primary contribution was development of the scramjet engine, their role didn't end there. Their experience and expertise made them a valued partner of the overall HAWC team, and they were involved in key decision making and milestone events including execution and analysis of the successful flight test.