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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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Thank you for participating,

Gregory Hamilton
President
Aviation Week Network

Acknowledged, agreed, and submitted by

_____ 17 May 2022

Nominee's Signature Date

Nominee's Name (please print): **Ari Vogel**

Title (please print): **Director, Deep Space Exploration**

Company (please print): **Lockheed Martin**

NOMINATION FORM

Name of Program: Lucy

Name of Program Leader: Rich Lipe

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☒ Customer Approved

- Date: 17 May 2022
- Customer Contact (name/title/organization/phone): Donya Douglas-Bradshaw, Lucy Project Manager, NASA Goddard Space Flight Center, 301-286-6952

☐ Supplier Approved (if named in this nomination form)

- Date: _____
- Supplier Contact (name/title/organization/phone): _____

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.

Lucy is a first-of-a-kind NASA mission that embarked on her journey to explore Jupiter's elusive Trojan asteroids on 16 October 2021. Operating farther from the Sun than any previous solar powered spacecraft, Lucy will visit a record-breaking nine asteroids over twelve years – one asteroid in the main belt between Mars and Jupiter, and the remaining eight Trojan asteroids trail Jupiter in its orbit (https://www.nasa.gov/mission_pages/lucy/overview/index). Scientists believe the Trojan asteroids are very early remnants from the creation of our solar system that were scattered and captured in Jupiter's orbit. They have remained relatively unblemished for more than four billion years, making them a perfect time capsule (https://www.nasa.gov/mission_pages/lucy/overview/index). In addition to Lucy's radical purpose and vision, its name is a nod to the 3.2 million year-old skeleton named "Lucy" by its discoverers. Similarly to how the Lucy fossil advanced our knowledge of human evolution, scientists hope the Lucy spacecraft will uncover new knowledge about the origins of our solar system and planets (https://www.space.com/lucy-asteroid-mission).

The profound importance a mission like Lucy will have on humanity's progression immediately touched and inspired the entire Lockheed Martin Deep Space Exploration (DSE) team to persevere and execute, with excellence, during Lucy's development, production and Assembly, Test, and Launch Operations (ATLO) phases. The ambitious goal of getting Lucy into orbit in a timely manner fueled an incredible wave of creativity and innovation amongst the Lucy team members. The team was not only operating at the peak of the pandemic, but also under immense pressure to deliver the spacecraft to Astrotech Tech Operations (ASO) on time and on budget, as the launch window for Lucy was extremely short due to the innovative trajectorsy required for all the Trojan encounters: twenty-three days starting on 16 October. A miss to the launch window would've resulted in a one year slip to launch and a significant increase to cost, and again, due to the trajectory, the mission would never launch if both the primary and backup windows were missed

Given the DSE team was not ready to accept any form of delays to Lucy, it prepared to face schedule and cost challenges with utmost urgency – but it was not easy. The start of the COVID pandemic in 2020 coincided with a critical phase of development for the Lucy program and threatened the team's readiness to support Lucy's fixed launch date in October 2021. Lockheed Martin was challenged with maintaining the health and safety of the team while delivering a spacecraft that met the science objectives within the cost and schedule constraints, with acceptable risks. The uncertainty surrounding the pandemic coupled with some pre-existing hardware delivery challenges required a proactive plan to both ensure Lucy's readiness and to convince NASA that Lucy remained a viable program as it approached a Agency decision gate. The DSE team developed the Feasible ATLO Shortened Timeline (FAST) and Feasible ATLO Shortened Timeline for Environmental Readiness (FASTER), which created a path forward that protected the program from that uncertainty while also addressing known and potential future delivery delays. FAST and FASTER consisted of an ATLO schedule compression, use of hardware surrogates, staffing increases and contingency plans, remote ATLO support, heightened safety protocols, and a novel approach to launch site operations. Lucy's success over the years hinged on the social/relationship equity built up over time. Recognizing that we could not lose site of the "human factor" the DSE team introduced the Lucy 6-15 messaging tool and a "Peace and Love" Plan that not only standardized a low-risk operating approach, but also helped maintain a sense of team spirit.

We knew that getting to launch was going to be hard, but we had a plan; more importantly, we knew we had the team to get us there! Getting Lucy across the finish line and into orbit was arguably the most difficult and all-consuming task for the team to accomplish. Even today, as the spacecraft is facing an anomaly with one of the solar arrays, we can say with confidence there is no better team than ours to address and resolve this extremely complex and challenging problem. Keeping the mission in mind is what pushed the DSE team to get the Lucy spacecraft to where it is today. The solar array challenge shall too be resolved by the brightest and most passionate team members, and the latest information on the anomaly is available on NASA's Lucy blog. We cannot wait to see what mysteries the Trojan asteroids unfold in the coming years.

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 Corporation:** The DSE team at Lockheed Martin has an incredible heritage of interplanetary missions that have resulted in groundbreaking discoveries for each planet in our solar systems, including Pluto, asteroids and several moons. Lockheed Martin is most notably known as a defense contractor with a rich planetary heritage and it is incredibly important to the corporation to maintain this position to not only deliver value to our stakeholders, but also because it is a core aspect of Lockheed Martin's vision and values. In fact, given the unclassified nature of planetary missions and discoveries, LM often utilizes our planetary heritage knowledge to inspire and spark imagination amongst the next generation of space enthusiasts, engineers, and leaders both internally and externally. Driving towards successful execution of the Lucy program was second nature to the Lucy team as its mission tied so closely to LM's values and rich planetary history. The Lucy program was also unique in that it honored and recognized collaboration from a diverse group of folks, including university students, high school and college interns, a 'women of Lucy' series leading up to launch, and mult-functional groupsall of which highlighted the importance of diversity, equity, and inclusion to Lockheed Martin. The diversity of the Lucy DSE team's ideas, perspectives, and views is what propelled the team forward and enabled Lucy to launch on time and under budget.
- **Value to Customer:** As a longstanding partner with NASA, we have built more interplanetary spacecraft than all other U.S. companies combined and more than any other company in the world. We are honored to have explored the entire solar system with NASA, building spacecraft or systems that have explored every planet and numerous asteroids and small bodies, protected this one, and provided high-definition imagery and observations from the Earth to the Sun and beyond. LM values placing our customer's needs first. We knew how important it was for NASA's Goddard Space Flight Center (GSFC) to be first to explore the Trojans on a Discovery class budget even though the Trojans are the Planetary Decadal's New Frontiers target list, so we made it our primary focus as well. For our customer, having a team with

the skill and talent that LM has is so important when working on one of our most challenging missions to-date given how long the Lucy spacecraft has to survive in space and the approximately 4 billion miles it has to travel. We lead the pack in building unique technologies that help us do things we've never done before. And on the ground, our mission support teams keep spacecraft flying and information flowing to scientists for analysis. It's missions like Lucy that really showcases the depth and breadth of Lockheed Martin as a full-service partner that will further develop our ecosystem for space exploration. We build spacecraft that go out and explore our universe, teaching us more about ourselves and our origins, as well as extending the boundaries of what's known. We're known for building unique technologies that help us to do things we've never done before. We provide full lifecycle support, including spacecraft operations, and we do all of this at the best value while being flexible to meet any mission needs. Our customer regards our capabilities in high value and because of this, we were chosen to be the trusted ones for such a high-stake mission.

- **Value to Members of Team:** Not only was the purpose of Lucy's mission a driving force for the members of our DSE team, but so was the fact that Lucy was a one-of-a-kind program. Lucy was not just a production program, it was a development one. Often times, there are unique engineering challenges that come with a development program, such as challenging new design requirements, new/upgraded hardware and software designs and supply chain/procurement challenges, to name a few. The challenges from Lucy resulted in learning opportunities for our engineers, giving them the tools needed to be faster, more agile, and innovative for future development programs.
- **Contribution to Greater Good:** As NASA Administrator Bill Nelson said, "Lucy embodies NASA's enduring quest to push out into the cosmos for the sake of exploration and science, to better understand the universe and our place within it," Lucy's findings will unfold newfound discoveries of where we came from, where we're going, and how we will get there. Lucy's mission reminds us that our neighboring planets are more closely related to us than we know. The power of information that the Lucy mission will gather will not only help humanity prepare for and uncover the unknown, but also inspire the future generations in STEM who will arguably be most affected by what Lucy discovers. The most exciting part about this mission is what is yet to come, and knowing that whatever scientists find in space has great potential to benefit us here on Earth. At Lockheed Martin, we help our customers explore our universe, so humankind can learn more about the origins of all life and Earth's past – which could better help us understand Earth's future climate and the possibility of becoming an interplanetary species. This mission is also exciting because there's a generation who watched the Lucy launch on 16 October 2021 that will continue to see and be a part of the key milestones of this within the next 2 – 5 years and all the way to 2033. It's really exhilarating to think about how this mission can have so many touch points for so many people and that it will be an inspiration for so many future STEM leaders.

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)

- **Lucy Software Predictive Metrics:** Lucy software development processes are tightly integrated with all disciplines. The development processes specify extensive quality metrics and predictive measures that address both product performance and process performance. Integrated defect tracking tools are

used throughout software development processes. Low software defect density is among industry best with operational system repeatably showing lower than 1 defect per 20K SLOC. The FSW design features self-logging performance metric collection throughout all integrated platforms, digital simulation, HWIL testbeds, and spacecraft during ATLO and operations. Regular management review cadence addresses all development process and quality metrics throughout all development phases. Electronic customer access is provided to all development products and metrics. No surprises.

- **Lucy's Flight Software Design:** Lucy's modularized flight software reuse allowed development to focus on mission unique features such as target tracking and range based science acquisition. Autonomy, with extensive fault management, supports long duration unattended operation. The flight software provides a programmable spacecraft for science and operations team with rich featured high level language sequencing. Onboard parameter data configuration supports full mission with extensive configurability for the operations team to adapt the spacecraft to emerging mission needs. The Lucy operations team realizes the power of a single "Do Encounter" command.

- **Lucy Telecom Predictive Metrics:** The telecommunications subsystem uses Lockheed Martin internally developed RF link analysis tools based on models from the Deep Space Network literature and NAIF SPICE toolkits. These tools are augmented with detailed predictions of the RF antenna patterns on the spacecraft. The tools predict RF performance with planned and programmed spacecraft attitudes in the background sequence. The predicted performance is regularly checked through automated tools to compare predicted and actual RF performance on both the spacecraft transponder and DSN receiver. The difference between predicted and actual performance is less than 1 dB.

- **Lucy Thermal Predictive Metrics:** To ensure Lucy performs as expected many of the subsystems uses predictive tools to ensure its safety and performance. The thermal subsystem uses Thermal Desktop, a geometric thermal modeler, that can predicted expected temperatures in flight within +/- 3C. Our standard trajectory as well as all planned activities are analyzed ahead of time prior to executing on the spacecraft to ensure we maintain all components within their allowable temperature limits.

One of the largest driving factors for the Lucy team was the relatively short twenty-three day launch period Lucy was presented with. Schedule was paramount to us. Knowing there was little to no room for schedule delays, the DSE team heavily leaned into our heritage ATLO knowledge to strategically plan for COVID impacts, personnel assignments, schedule compressions, opportunities for acceleration, etc. The minute Lucy began ATLO, we knew exactly how long our testing and assembly operations were going to take. This gave us an advantage because we were able to identify schedule opportunities and threats based off past performances.

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)

The COVID-19 pandemic coincided with the Assembly, Test, & Launch Operations (ATLO) phase – arguably the most critical phase – of development for the Lucy program and threatened the team's readiness to support Lucy's fixed launch date in October 2021. The uncertainty surrounding the pandemic coupled with some pre-existing hardware delivery challenges required a proactive plan to both ensure Lucy's readiness and to convince NASA that Lucy remained a viable program as it approached a formal decision gate. .

Considering the aggressive nature of the program, it was not surprising that in early 2020 the program encountered four significant hardware delivery challenges. In March 2020, delivery margin eroded for two of three science instruments while they dealt with significant technical issues. The solar array development encountered technical and manufacturing issues that halted progress. The propulsion system fabrication and assembly fell behind schedule early in the effort. All four of these developments hadsignificant scope still ahead. While these types of issues are not uncommon for a development program, the pandemic added a level of complexity, challenged recovery plans, and threated our ability to meet our planetary launch window.

The pandemic, the policies intended to deal with it, and the periodic loss of support due to quarantine or illness led to a constantly evolving environment at all work locations that persisted through the remainder of all Lucy ground operations, including launch. The FAST and FASTER plans created a path forward that provided resiliency while also addressing known and potential future delivery delays.

The LM Lucy program manager first introduced the Feasible ATLO Shortened Timeline (FAST) plan concept in March 2020 as the initial impacts of the pandemic came into focus. By intentionally compressing some portions of the ATLO schedule and augmenting key personnel using risk pool funds to allow for later deliveries, FAST enabled Lucy to survive one or more significant COVID impacts such as a mass quarantine event or temporary shutdown either in ATLO or one of the struggling deliveries. The FAST plan was first vetted by our customer over the spring and summer of 2020 before it was rolled out in late June. It was baselined prior to the Lucy system integration review (SIR) in July. The SIR is the gate to proceeding with full-up spacecraft level integration and testing. Following SIR in August was Key Decision Point-D (KDP-D) where NASA assessed whether Lucy was ready to progress into system level integration and test. Below are detailed aspects of the FAST plan:

- **ATLO Schedule Compression**

To provide additional schedule margin, the team modified the baseline five-day schedule to a seven-day schedule between propulsion module delivery in October 2020 and shipment to the launch site in July 2021. Compressing the back end of the schedule wasn't enough, as all four at-risk deliveries each had their own unique risks and potential impacts to ATLO. Enabling ATLO to make meaningful progress every day regardless of the actual delivery dates was the guiding principle of the FAST plan. To balance the schedule benefits and cost for additional personnel, the program manager selected target dates for the propulsion system and solar arrays that created sufficient margin for them to sustain at least one two-week work stoppage prior to delivery. The Soutwest Research Institute (SwRI) management team, which includes the Projects Principle Investigator, did the same for the two at-risk instruments. The ATLO team and the program planner iterated the schedule and recovered as much of the schedule impact as possible by rearranging tasks and leveraging hardware surrogates. The team avoided negative work and regression testing as much as possible. The resulting schedule changes and new need dates for the at-risk hardware optimized the tradeoff between increasing schedule margin for the struggling deliveries,keeping overall critical path schedule impacts to a minimum, and accepting increased technical risks due to modifications to the overall test program. The final version of the FAST plan that rolled out in late June 2020 set the

transition to the 7-day schedule on January 4th, 2021 after returning from the holiday break. This provided the necessary schedule relief to all the at-risk deliveries, provided adequate additional single line flow margin, and allowed some additional On-the-Job Training time for new team members before they were allocated to color teams (teams with specific, overlapping work days/shifts). The FAST plan preserved the baseline spacecraft ship date on July 30, 2021 and the baseline 5-day weeks for operations at the launch site.

- **Use of Surrogates**

The team considered the use of hardware surrogates for all at-risk deliveries. The need for the propulsion module surrogate was identified early as a must-have to physically support the flight harness and avionics, and to allow powered testing to start on schedule in ATLO. By completing the verification of the harness and the functional test of most of the subsystems, issues could be found and dealt with before the propulsion module arrived, thereby significantly reducing downstream schedule risk.

- **Staffing Increases to Support Two Squads**

The FAST plan added budget for additional staff and groups supporting ATLO to enable the transition to seven-day work weeks and facilitate the formation of two squads. The funding allowed areas to either defer planned roll-offs or add additional staff. The budget was tailored for each group, adding only enough to split the existing team and not add a second full team. The timeframe for the increased staffing was August 2020 through July 2021. The staffing surge began before the split in January 2021 to provide time for training new personnel.

Splitting the team into two squads served three purposes:

1. It allowed the seven-day schedule to execute without mandating overtime.
2. It allowed a physical separation of the two squads so that if either were to suffer from an outbreak or quarantine, the other team could still make progress toward launch.
3. It increased employee safety by reducing potential contacts. Having employees work Friday, Saturday and Sunday meant there were fewer people on campus during their working time. By staffing two smaller teams instead of one larger team, the number of personnel present at or near the spacecraft at any one time was reduced.

Between the approval of FAST and the switch to the seven-day schedule, the initial two-squad concept evolved into a plan that identified five teams based on roles and responsibilities. The teams were named for colors to aid both verbal and visual communication. Red and Blue were the powered test squads based in the test control center. Orange and Green were the floor team squads, based on the floor with the spacecraft. The Silver team included members not assigned to one of the other four teams. Each colored team worked a different schedule; teammates were encouraged to flex their time as necessary to minimize overtime, and thus cost to the program.

- **Protocols and Lucy 6-15**

Integral to the FAST plan was the development of a set of protocols designed to address COVID concerns in ATLO using the methods recommended by the CDC. In addition to mask requirements, some of the protocols used during Lucy included: minimal personnel in the Test Control Center (TCC) and on the floor, scheduled visits, no communal snacks or meals, physical separation of off-color team members, beginning and end of shift station disinfecting, elimination of in-person meetings, installation of plexiglass dividers in the TCC, reassignment of TCC and work stations to maximize space between people, and implementing a limit for the maximum number of people allowed in the change room.

When the team was approaching the split into color teams at the end of 2020, the ATLO manager created Lucy 6-15 as a means of re-energizing the protocols as well as answering specific questions the teams were asking about the physical separation between the color teams. Lucy 6-15 was a messaging tool intended for people to control their contacts by remaining greater than six feet apart

and limiting in-person contact to no more than fifteen minutes per day. This setup was ideally suited for short interactions with members of other color teams. Lucy 6-15 was added to the ATLO presentation template as a constant reminder and was adopted by the program as a slogan during ATLO. These measures proved to be effective, as no workplace transmissions or quarantines were recorded. As a result of the 6-15, we are extremely proud to say there were zero Lucy ATLO shifts lost due to COVID.

- **The Feasible ATLO Shortened Timeline for Environmental Readiness (FASTER) Plan**

The team anticipated that FAST would need real-time adjustments, and almost as soon as FAST was baselined, planning for the Feasible ATLO Shortened Timeline for Environmental Readiness (FASTER) began. The FASTER plan primarily addressed stress points, oversights, and lessons learned from the early execution of the FAST plan. FASTER included additional budget to provide relief to areas for added personnel to enable surges more effectively, and supplemented personnel that were single points of success within the team.

The team encountered several issues that became lessons learned addressed in FASTER. Some backups and deputies for key individuals were unable to adequately backfill for their absences. Technical issues that typically would have been caught pre-ATLO were discovered during single line flow due to reduced in-person contact with the hardware. Some anomalies exceeded the capability of the assigned color teams. FASTER was also formulated with the advantage of having mature delivery dates for Ralph and the solar arrays in mind, and as such was much more specific than the FAST plan.

The FASTER staffing steadied the performance of the team, created some key redundancies, and enabled the high level of performance that was required to compress the schedule between modal survey and thermal vacuum test. Additional budget was added for the engineering support teams after the FASTER plan was implemented to further reduce the burden on individuals.

- **Completion of FASTER, Transition to the Peace and Love Plan**

FASTER and the color teams were terminated two weeks prior to shipment of the spacecraft when half of the ATLO team were deployed to Temporary Duty (TDY) travel as the advance team. A seven-day work week schedule was no longer required at this point, as FAST/FASTER was fully successful in recovering all schedule impacts and holding the ship date.

The Peace and Love Plan was created by the ATLO manager to both re-focus the team for launch site operations and to intentionally re-integrate the color teams. Despite the best efforts of all involved, natural divisions and rivalries formed between the teams, and the overall team dynamic had suffered as a result. The term ‘Peace and Love’ was not only a tie to the origin story of the Lucy mission’s name, but also well suited to describe the intent of the plan. Peace and Love reasserted the Lucy 6-15 protocols and merged the team to return to a more standard operating mode.

- **Launch Site Operations**

Despite re-merging the teams and ending the color team construct just prior to shipment, the launch site did have non-standard approaches that provided additional protection to the team. In the Launch Services Support Plan (LSSP), Lucy requested seating accommodations at the processing facility that would allow for social distancing in the desk areas. Lucy was processed at Astrotech in Titusville, Florida and the high number of programs in work at Astrotech resulted in the team being scattered around the Astrotech campus rather than being concentrated in one or two areas. This inadvertently aided the social distancing as the teams that were selected to sit in each area were teams that were already working together, thus minimizing their contact with others that were passing through. Lucy 6-15 remained the baseline for personnel to control their exposures. At the launch site, zero shifts and zero personnel days were lost due to either presumed or confirmed positive tests.

The FAST and FASTER plans were born out of necessity and from a unique combination of an aggressive development program executing during a global pandemic. Given that environment and the

short time Lucy was operating in it, they proved highly effective and successful in completing and launching Lucy on time. The value of creating plans to deal with situations during significant uncertainty proved to be more effective and proactive than waiting and seeing what happens. LM's mitigation efforts during the pandemic were recognized by not just our team members, but also NASA. In NASA's 2021 Office of Inspector General (OIG) report, Lucy was the only major Science Mission Directorate (SMD) program listed that did *not* have major impacts due to COVID-19. This nod of acknowledgement from NASA was a testament to how quickly and successfully the Lucy team was able to shift its operations to meet the mission's launch date.

Despite the many challenges the Lucy team faced during the peak of pandemic, it is arguably dealing with the most complex form of VUCA today with the solar array anamoly on Lucy. Having launched approximately 7 months ago, Lucy is currently in the beginning stages of following her innovative trajectory to tour the Trojans. There are mission-ending consequences if we make the wrong decision with a redeployment attempt or Use-As-Is determination, which poses a great deal of uncertainty and complexity for the Lucy team. Our ability to affect change from where we stand is quite limited and that has been very challenging for the team. We do know, however, that the Lucy team did not come this far to give up now. The team will persevere and make the best possible scientific decision to progress Lucy further into orbit and eventually reach the Trojan asteroids. Lucy's mission and purpose is what has fueled the team's creativity and brilliance until this point, and we have no doubt it will continue to do the same as we methodically uncover the best path forward and solution for Lucy.

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)

The Lucy team experienced one of the most revolutionary times during the pandemic. We learned how to be agile, operate remotely on new platforms like Zoom, practice social distancing in a high-paced ATLO environment, and think quickly on our feet. We knew we needed to become smarter than the virus or else Lucy was going to be significantly delayed.

One of the initiatives that came out of the FAST plan was Remote ATLO, which contained direction and scope to improve remote capabilities for supporting ATLO. Traditional ATLO in DSE required in-person support in the test control center (TCC) for ATLO, systems, and subsystem personnel. Due to the limitations of the furniture layout and the size of the TCC, adequate social distancing was not possible when fully staffed. Establishing the remote capability enabled roughly half of the personnel to monitor tests from elsewhere, which then enabled a reorganization of the remaining stations in the TCC to achieve adequate social distancing. The only personnel that had physical access to their station in the TCC for every test were the test conductor, test engineer, ground data system (GDS) engineer, systems engineer, and a single customer representative. Unless a subsystem or instrument was the subject of a test, all others supported remotely. This capability also mitigated concerns over potential exposure quarantine events for key personnel because they could participate from home.

There were two elements that combined to enable remote ATLO. The first was the capability to remotely access the Advanced Spacecraft Integration and System Test (ASIST) ground stations via virtual network computing (VNC). This was straight forward for LM personnel, but not so much for non-LM personnel

such as customer and subcontractors as they had to follow several steps to gain access. The GDS and IT teams collaborated with network security to develop a streamlined process in a fully compliant manner. The second element leveraged Zoom to create an over-the-shoulder experience for personnel that wished to monitor a test but did not have to manipulate telemetry pages or query data. The test conductor set up the Zoom meeting each morning and broadcasted the customer's chosen telemetry screen, the real-time test procedure execution, and the best set of camera feeds monitoring the spacecraft. Zoom also served as the voice network to tie in the remote personnel.
Almost every meeting on Lucy was remote from the onset of the pandemic through launch.

To address the concern that not everyone responded well to remote meetings, LM project leadership enhanced communication on the program and attempted to create means to improve employee engagement. To that end, the program manager established a weekly all-hands meeting to broadcast status and notes so that remote personnel could follow along and understand at a high level the overall state of the program. This meeting was intentionally designed to ensure those that were remote maintained a connection to the program that went beyond schedule and technical status. The program managers ensured multi-directional communication was present during these meetings by seeking inputs from team members on how to proceed with technical challenges, including members in critical decision making, and by providing an open space for team members to bring up process improvement ideas. No idea was ever immediately dismissed during these routine tagups; it was important to management that everyone felt comfortable speaking up in the room.The Lucy leadership also included the customer in these regular tagups, which tremendously helped with mission alignment and expectations. The program manager also created a weekly newsletter that highlighted the behind-the-scenes efforts made by individuals that wouldn't get the attention they normally would if the team was physically together. The ATLO manager added content to the daily ATLO meeting that augmented the status to provide a feel for the progress of ATLO that included pictures of the day. The slides briefed in the morning meeting were posted on the server daily so even if people missed the meeting itself, they had access to the information and could refer back to the data to fully understand what the near-term plan was.

The remote ATLO test support capability turned out to be a transformative solution that will now be baselined in all future DSE missions. The flexibility it allowed the team was very well received and concerns about impacts to operations from technical issues, waiting for someone to come online, or lack of focus proved to be unfounded. While there were some delays trying to get a hold of people, they were no more frequent or difficult to overcome than the challenge of trying to physically locate someone in the building who is overdue for a call to stations. The personnel supporting test remotely were subject to distractions when not sitting in the test control center, but they quickly developed tricks and techniques that worked for them to enable a level of concentration that was on par with local support. Leadership also was quick to intervene if a particular person was struggling to stay focused.