

## **Catching a New Wave: common principles for a new era of NASA science and commercial partnerships**

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Scientists and commercial space companies have a long history of working together at NASA, from the Apollo era all the way up to the recent launch of the James Webb Space Telescope and landing of the Perseverance Mars rover. All missions in NASA's Science Mission Directorate (SMD) rely and build on technology developments and innovative manufacturing methods from industry to create the instruments and spacecraft that produce the myriad data used by scientists all over the world.

The landscape of commercial space is rapidly changing, providing new ways to obtain scientific data, new platforms for experiments, and new types of partnerships between scientific organizations and the commercial sector. One more novel type of commercial partners are startups or venture funded companies. We in SMD have been seeking to diversify and modernize the ways in which we partner to continue to produce world leading science, whether on Earth, the Moon, throughout our solar system or across the universe consistent with the evolution that is occurring in commercial space. Although it is a work in progress, we have begun with six principles to create innovative connections between science and the commercial space sector.

### *1. Adapt our commercial partnerships based on science and mission needs.*

In SMD, we seek feedback from our leaders, mission developers and commercial partners on what is working well and what is proving a challenge to productive relationships between scientists and the companies. Due to the evolutionary nature of the commercial capabilities and of science needs, there is no simple formula for the number and type of partnerships we pursue, and we keep track of best practices and make changes when needed to ensure productive and efficient cooperation between scientists and experts in industry. We recognize that our commercial partnerships need to be continually examined as both SMD and commercial space needs change and evolve.

### *2. Maximize our "science per dollar."*

We use the rationale of "most science per dollar" to make decisions on whether and how an arrangement with an industry partner make sense. For example, development in SmallSats, CubeSats, and associated venture-class launch innovations have significantly shaped the opportunity space for all of SMD. These smaller spacecrafts allow for more science at a reduced cost and help to reduce the barriers of entry for early-career scientists as well as new vendors in commercial space, as well as the development of novel, multi-point measurements. Several current solicitations for missions across multiple science divisions in SMD include SmallSats. Innovations in launch vehicles allow for cheaper launches of

multiple spacecraft as well as rideshares with larger missions. For example, four ESPA-class missions are scheduled to join a large strategic SMD mission; these include a technology demonstration, other NASA science missions and a NOAA mission. The potential use of one launch to bring five missions to space will provide a much higher amount of science per dollar than could have been imagined just a decade ago.

*3. Encourage Principal Investigators to select new platforms and systems.*

SMD has experimented with opening new ways for Principal Investigators to propose platforms and spacecraft for their science missions, so commercial partners can get an honest market response from the science enterprise. However, more investigation is needed to understand whether SMD can signal to industry useful future demand information in this way. Our effort has not worked as predicted with three possible hypotheses: 1) the commercial solutions may not be a good match to science needs, 2) the commercial solutions may not be known to proposers, or 3) there may be obstacles – real or perceived – in our own proposal process that bias against the inclusion of promising commercial options. Perhaps there is a lack of strong connections between the scientific community and commercial space, so we will continue to bring together these communities to show scientists the new possibilities out there for conducting missions and to provide industry a better understanding of the needs for successful scientific data gathering.

*4. Undertake novel partnerships but be willing to cancel if they do not work.*

We have been making small commitments on novel types of partnerships, with the understanding that some of these experiments may fail. For example, SMD has been steadily improving its process for purchasing Earth Science data from commercial Earth observation satellite operators. This is a novel partnership for NASA, as we are used to building and operating our own Earth observing satellites and working with the data to meet our specific needs. So working with vendors with existing capabilities, designed to meet the needs of multiple users, was new – but we recognized the value in augmenting our own data sources for the benefit of more science. In the early days it was a struggle, both within NASA and our commercial partners as we could not fall into the trap of thinking all “commercial companies” are the same. With the rapid expansion of companies seeking to provide Earth observations, we have had to continue adapting our procurement processes to be responsive to NASA needs and changes in the commercial market. In some cases, we had to cancel projects or back off when we felt that we did not have an understanding with our partners. However, we have on-ramped several qualified vendors of Earth observation data over the past few years and released a solicitation for Commercial SmallSat Data Analysis proposals to promote scientific use of purchased data by the scientific and applied science communities. While not easy at first, trying novel approaches to partnering with industry can result in new and diverse ways of obtaining science and information about our planet for a wide variety of users.

*5. Be an early customer in a promising new business segment.*

SMD is looking for places where we can be an early customer for a product or service that has the promise to build a new business segment. One key example of how SMD is functioning as an early customer for new commercial space companies is NASA's Commercial Lunar Payload Services (CLPS). CLPS is a new model that allows rapid acquisition of lunar delivery services for payloads that advance capabilities for science, exploration, or commercial development of the Moon. So far, 14 companies have been vetted and are allowed to compete for NASA task orders to deliver payloads to the Moon. Investigations and demonstrations launched on commercial Moon flights will help the agency study Earth's nearest neighbor under the Artemis program. SMD has had multiple opportunities for scientists to propose instruments for delivery by CLPS, and 13 NASA-built payloads for CLPS deliveries are all nearing completion.

Integration of CLPS into SMD's regular competitive processes has been much faster than expected, and we recently established a new way for Principal Investigators to propose science instruments for the Moon with a CLPS delivery, Payloads and Research Investigations on the Surface of the Moon (PRISM). Soon, scientists will be able to propose their preferred destination on the Moon as well as the science they intend to do.

With CLPS and other efforts to be early customers, SMD is striving to create other models besides one of "government as an anchor tenant" as they do not often turn into good deals for the U.S. taxpayer. We also take a more hands-off approach with the CLPS companies, allowing them to develop their own technology and sell open payload space on their CLPS landers that will travel with NASA payloads. Over the next several years, as these models flourish, we will see lunar scientists working alongside the commercial sector on the surface of the Moon.

#### *6. Leverage investments in partnerships across NASA and the United States government.*

SMD is working across NASA and with multiple U.S. government agencies, such as the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), and the U.S. Space Force (USSF) to promote the use of new commercial partnerships and share lessons learned from each other. Examples include a NASA Space Technology payload riding along with a major NOAA mission and a U.S. Department of Energy payload getting a ride with CLPS. We are also coordinating with several U.S. Government agencies to develop standardized scientific licenses for commercial Earth observing data so that products from the growing commercial sector can be efficiently used by the U.S. government for the benefit of its citizens. SMD has developed a rideshare policy that allows for missions across NASA and the U.S. Government to take advantage of extra mass on our launches.

The above six principles are guiding SMD's efforts to take advantage of the rapid innovation in the commercial space sector. As we gain experience and lessons learned we will continue to evolve these principles. You will see themes of flexibility, willingness to try risky partnerships, and commitment to course-correct when required. Although this effort may hit bumps in the

road, we simply cannot pass up the opportunity – we want to catch that wave of science and a burgeoning commercial space sector working together to advance science.