



June 2022

INTERNATIONAL SPACE STATION

Opportunities Exist to Improve Communication with National Laboratory Users

GAO Highlights

Highlights of [GAO-22-105147](#), a report to congressional committees

Why GAO Did This Study

Statute generally requires that a portion of the U.S. allocated research capacity be guaranteed to experiments on the national laboratory for non-NASA users like commercial entities. CASIS is responsible for selecting which non-NASA users can use the laboratory. In 2019, NASA commissioned an independent review that identified various challenges at CASIS, including poor communication with the user community.

GAO was asked to review CASIS and NASA activities related to the laboratory. Among other objectives, this report assesses the extent to which CASIS obtains input from and provides information to laboratory users.

GAO reviewed documents such as the cooperative agreement between NASA and CASIS and their operating principles. GAO also interviewed the chairs of CASIS's user advisory committee and its five subcommittees, and officials from NASA and CASIS.

What GAO Recommends

GAO is making four recommendations to NASA, including that it ensures CASIS (1) obtains input from its user advisory committee about resource allocation decisions, (2) takes steps to agree upon needed information about past allocations, and (3) provides the committee more information about planned resource allocations. NASA agreed with the first two recommendations, and partially agreed with the third, noting challenges with providing the flight queue. GAO continues to believe NASA has opportunities to provide additional information, as discussed in the report.

View [GAO-22-105147](#). For more information, contact W. William Russell at (202) 512-4841 or russellw@gao.gov.

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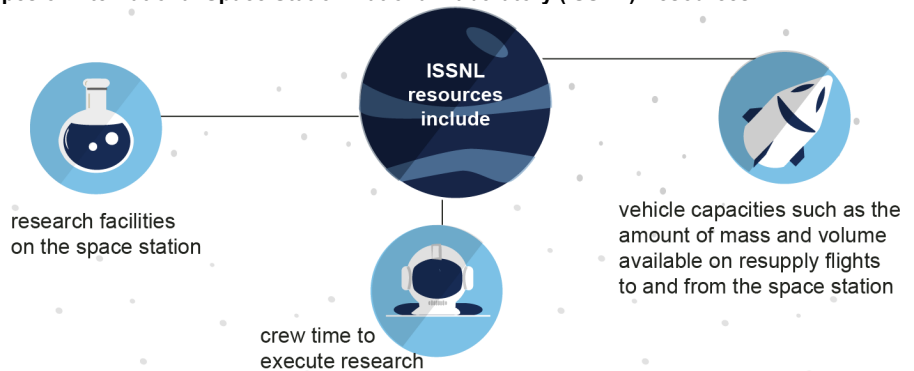
Opportunities Exist to Improve Communication with National Laboratory Users

What GAO Found

The Center for the Advancement of Science in Space (CASIS) manages the International Space Station National Laboratory through a cooperative agreement with the National Aeronautics and Space Administration (NASA). NASA is responsible for providing performance feedback to CASIS.

In November 2020, CASIS formed and staffed an advisory committee of laboratory users, such as academic researchers, with prior experience working with the space station to inform planning for and use of laboratory resources (see figure).

Types of International Space Station National Laboratory (ISSNL) Resources



Source: GAO analysis of Center for the Advancement of Science in Space documentation. | GAO-22-105147

CASIS officials have not obtained input from the advisory committee on how to allocate laboratory resources, even though the committee is chartered to advise CASIS on resource utilization. CASIS officials stated they have not obtained this input for several reasons, including that the committee is unlikely to provide a consensus perspective. However, a lack of consensus does not preclude communication. Diverse input could enhance CASIS's understanding of risks and opportunities across the laboratory portfolio.

Additionally, CASIS has not routinely provided the advisory committee information about past and planned resource allocations, including visibility into the flight queue for projects waiting to travel to the International Space Station. The chairs of the advisory committee and its five subcommittees told GAO they could more effectively advise CASIS if they had more information about past resource allocations. These members also stated that greater transparency into planned allocations would be valuable for users conducting time-sensitive research—such as biological science research involving cell and tissue samples. CASIS officials said they have not routinely provided the committee this information because the resource allocation process is complex and fluid. However, NASA and CASIS officials acknowledged laboratory users would benefit from improved visibility into the resource allocation process.

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Abbreviations

| | |
|-------|---|
| CASIS | Center for the Advancement of Science in Space |
| CEO | Chief Executive Officer |
| CSP | commercial service provider |
| ISS | International Space Station |
| ISSNL | International Space Station National Laboratory |
| NASA | National Aeronautics and Space Administration |
| RUPS | Resource Utilization Planning System |
| UAC | User Advisory Committee |

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June 7, 2022

The Honorable Eddie Bernice Johnson
Chairwoman
The Honorable Frank Lucas
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

The Honorable Donald S. Beyer Jr.
Chair
The Honorable Brian Babin
Ranking Member
Subcommittee on Space and Aeronautics
Committee on Science, Space, and Technology
House of Representatives

For more than 20 years, the International Space Station (ISS) has enabled scientific research and technology development not possible on Earth. The ISS provides the National Aeronautics and Space Administration (NASA) a unique platform to help advance space exploration, and Congress has enacted a law establishing the United States segment of the ISS as the ISS National Laboratory (ISSNL).¹ Congress also directed NASA to increase utilization of the ISS by other federal agencies and the private sector.² NASA has established objectives for the ISSNL to support non-exploration research and development and to help foster the development of a low-Earth orbit economy.

In 2011, NASA entered into a cooperative agreement with the Center for the Advancement of Science in Space (CASIS), a non-profit organization, to manage the activities of the ISSNL. In this role, CASIS is responsible for selecting which research and development projects are granted access to the ISSNL, and awarding grants to help fund these projects.

You asked that we review CASIS and NASA activities related to the ISSNL. This report: (1) assesses the extent to which CASIS collaborates with ISSNL users; (2) assesses the extent to which NASA and CASIS

¹ Pub. L. No. 109-155, § 507(a) (2005) (as codified at 51 U.S.C. § 70905).

² Pub. L. No. 109-155, § 507(b) (2005) (as codified at 51 U.S.C. § 70905).

have taken steps to improve management of ISSNL activities; and (3) describes NASA's reporting to designated congressional committees on plans to transition from the ISS to commercial space stations.

To assess the extent to which CASIS collaborates with ISSNL users, we reviewed the cooperative agreement between NASA and CASIS. We interviewed CASIS officials, including the CASIS Chief Executive Officer and the chair of the CASIS Board of Directors. To account for the user perspective, we also interviewed the chairs of the ISSNL User Advisory Committee (UAC) and its five subcommittees, and reviewed the committee's charter. To assess the extent to which NASA and CASIS have taken steps to improve management of ISSNL activities, we reviewed documentation of NASA and CASIS operating principles, strategic objectives, and annual performance metrics used from fiscal year 2019 through fiscal year 2021. We also interviewed NASA and CASIS officials about recent changes and potential revisions to the metrics.

To describe NASA's reporting to designated congressional committees on plans to transition from the ISS to commercial space stations, we reviewed the NASA Transition Authorization Act of 2017, which directed NASA to develop a plan to transition from the ISS to commercial enterprise. The act also required NASA to submit a report to designated congressional committees on the ISS transition plan no later than December 1, 2017, and every 2 years thereafter until 2023.³ We also reviewed the reports that NASA submitted in response to this requirement, and interviewed NASA officials familiar with their development. Further details on our objectives, scope, and methodology can be found in appendix I.

We conducted this performance audit from April 2021 to June 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

³ Pub. L. No. 115-10, § 303 (2017) (51 U.S.C. § 50111 note).

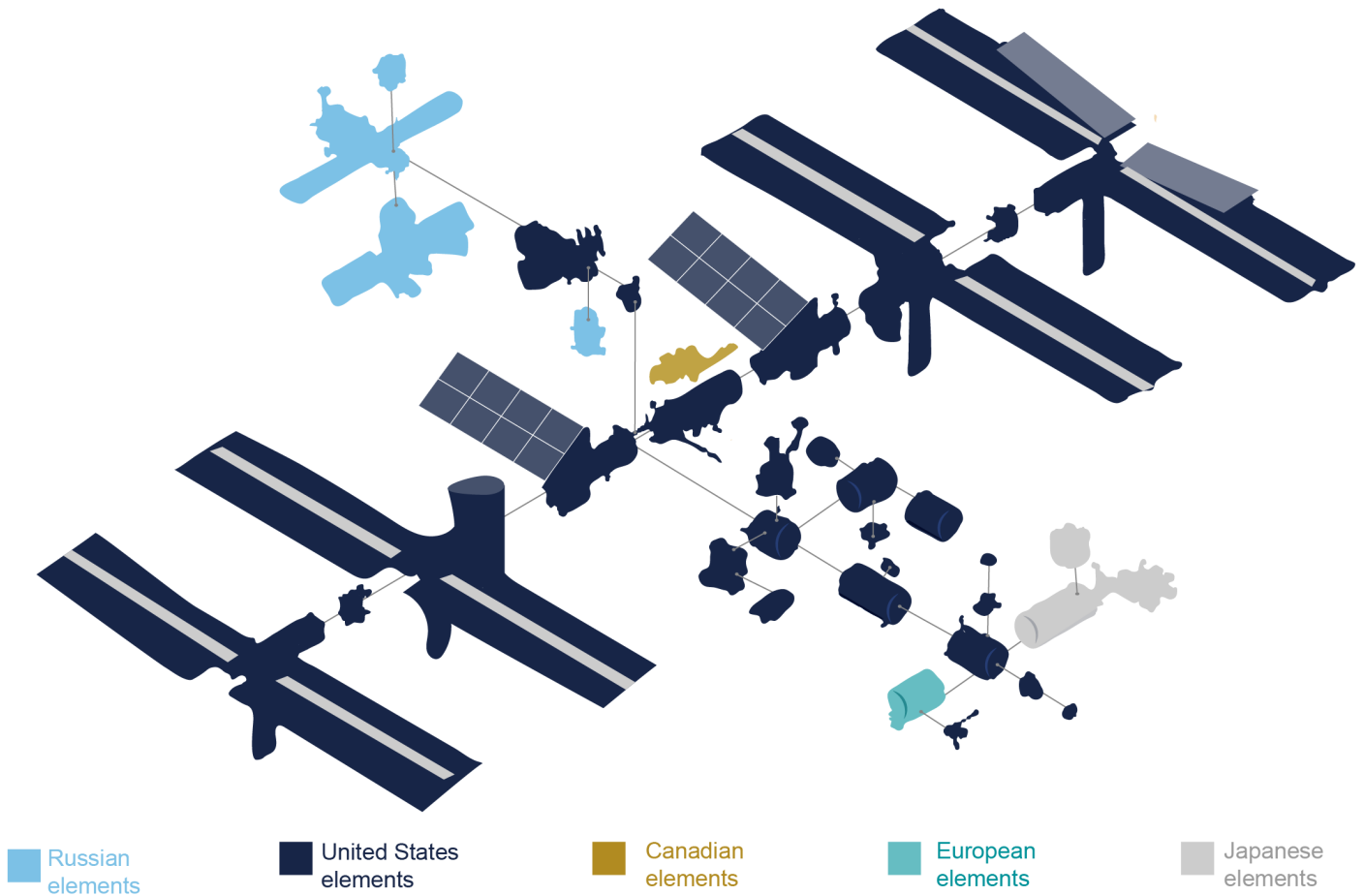
Background

NASA and its international partners have operated the ISS continually since 1998, completing its construction in 2010. In 2008, Congress directed NASA to ensure that the ISS remained viable for the United States to use through at least 2020, and then extended through at least September 30, 2024.⁴ NASA now plans to operate it through 2030. The ISS consists of operating segments managed by each of the five space agencies involved in the ISS's development. The agencies are from the United States, Russia, Canada, Japan, and Europe.⁵ See figure 1.

⁴ Pub. L. No. 110-422, § 601(a) (2008) (which included the 2020 date) and Pub. L. No. 114-90, § 114(b)(4) (2015) (which extended the 2020 date to September 20, 2024).

⁵ European countries that participate in the European Space Agency include Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

Figure 1: Segments of the International Space Station Operated by Different International Partners



Source: GAO rendering of National Aeronautics and Space Administration documents. | GAO-22-105147

Since 2005, Congress passed, and the President enacted, several laws affecting ISS operations. Among other things, Congress:

- designated a segment of the ISS as the ISSNL to further the policy of the United States to possess the capability for human access to space on a continuous basis;⁶
- generally required that the ISSNL experiments be guaranteed access to utilization of at least 50 percent of United States allocated research

⁶ National Aeronautics and Space Administration Authorization Act of 2005, Pub. L. No. 109-155, § 507(a), (codified at 42 U.S.C. § 16767).

capacity on the ISS, including crew time, equipment, and stowage on vehicles going to and from the ISS; and

- established that the ISSNL shall be managed by a non-profit organization that engages exclusively in activities related to managing the ISSNL.⁷

In 2010, Space Florida—the state government agency responsible for aerospace economic development—and consulting firm ProOrbis formed CASIS to submit a proposal to NASA to manage the ISSNL. NASA subsequently entered into a cooperative agreement with CASIS to manage the ISSNL from 2011 to 2020. In 2017, NASA and CASIS modified the cooperative agreement to extend CASIS management of the ISSNL to 2024. Among other things, the current cooperative agreement establishes that the CASIS Chief Executive Officer (CEO) and staff shall:

- select projects for execution on the ISSNL;
- help ISSNL users integrate research projects onto flight vehicles; and
- award grants to fund some selected projects.

Selecting ISSNL Projects

CASIS reviews research proposals and selects projects from a diverse group of potential ISSNL users. These users include companies developing new technologies, academics performing fundamental science, and other government agencies. For example, the National Science Foundation conducted tissue-engineering research on the ISSNL. Additionally, start-up companies can leverage their ISSNL research to raise additional funds after they complete projects.

As the ISSNL user community grew over time, so did the demand for ISSNL resources. For example, in fiscal years 2019 and 2020, ISSNL projects used more ISS crew time and vehicle stowage space than they were originally allocated. CASIS's primary focus has evolved from working to increase the utilization of ISSNL resources, to managing access to those resources.

In 2019, following a change in CASIS leadership, NASA commissioned an independent review team that studied CASIS's business structure, communication with the user community, how projects are scheduled to fly to and from the ISS, and NASA oversight of the ISSNL. In 2020, the

⁷ National Aeronautics and Space Administration Authorization Act of 2010, Pub. L. No. 111-267, § 504 (codified at 42 U.S.C. § 18354).

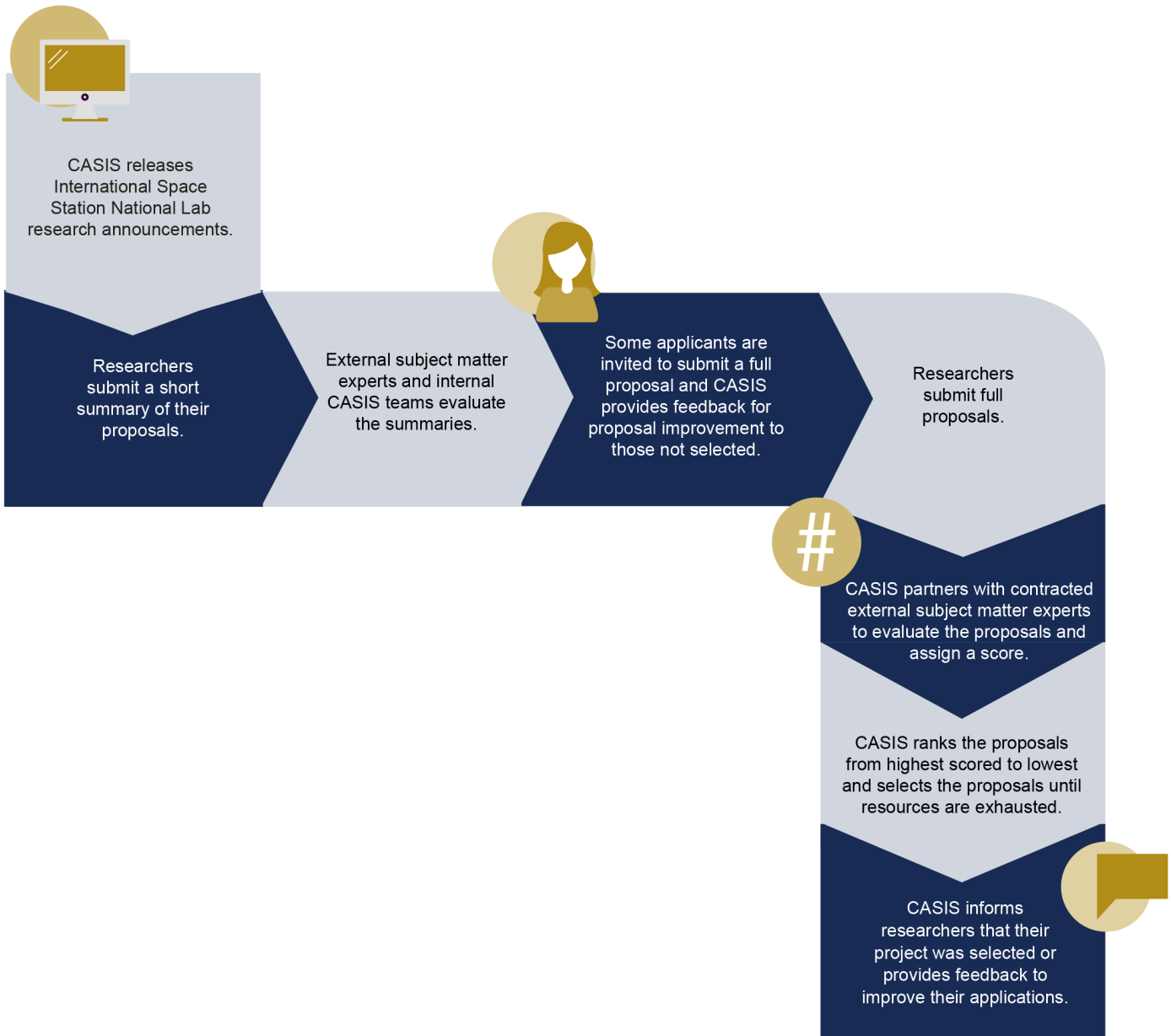
independent review team's report identified issues in each of these areas. The report made recommendations that CASIS adjust its business structure, create a UAC to improve communication with the user community, and clarify scheduling procedures for flying to and from the ISS. The report also recommended that NASA create a single point of contact for CASIS and develop a more unified mission and approach for operating the ISSNL.

The independent review team also reported that CASIS's process for reviewing users' research proposals was outdated and opaque. In response, NASA and CASIS established five "lines of business" to categorize research proposals and projects:

1. education and outreach,
2. fundamental science,
3. technology demonstration,
4. applied research and development, and
5. commercial facility utilization.

Additionally, in 2021, CASIS implemented a new process for reviewing research proposals and selecting ISSNL projects. The chairs of the UAC and its five subcommittees told us the new process is more fair and transparent than its predecessor. Figure 2 depicts this new process.

Figure 2: The Center for the Advancement of Science in Space (CASIS) Project Selection Process, as of 2021



Source: GAO analysis of Center for the Advancement of Science in Space (CASIS) documentation and officials' statements. | GAO-22-105147

Helping Users Prepare for Flight

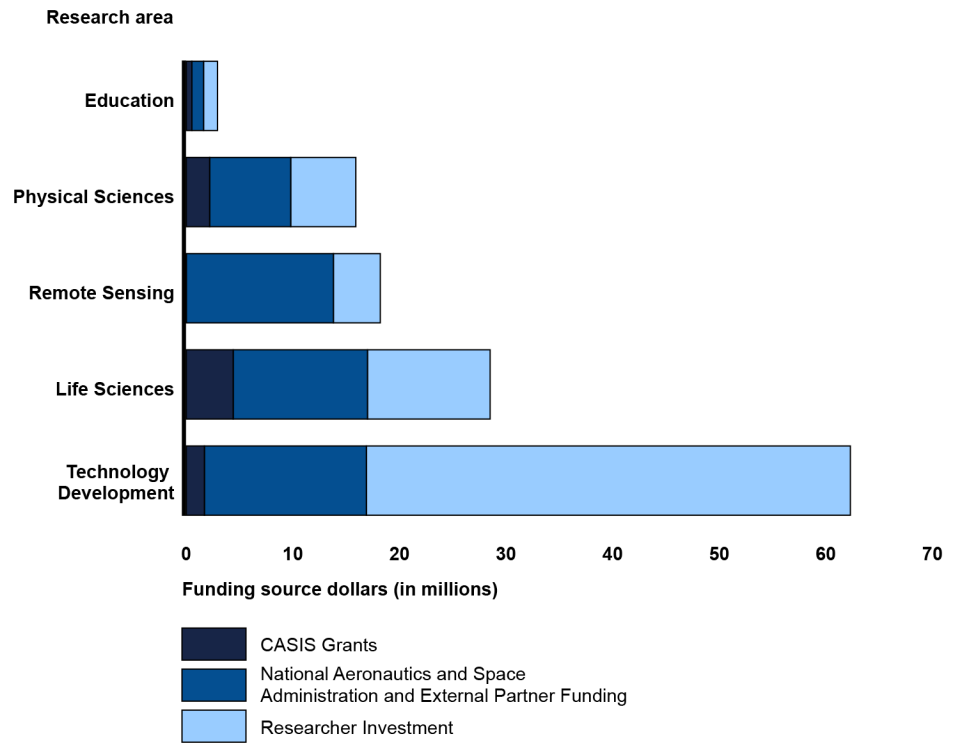
To help ISSNL users prepare for flight to the ISS, CASIS connects the users with third-party companies known as implementation partners. CASIS officials stated that these implementation partners help ensure the users' research projects can be successfully flown to and operated on the ISS. Among other things, they help the users identify specialized resource needs—such as temperature-controlled stowage—and develop instructions that ISS crew members can use to execute the users' research projects.

A subset of the implementation partners, designated commercial service providers (CSPs), have their own facilities aboard the ISS, such as an airlock to transfer projects between the interior and exterior of the ISS. In addition to submitting proposals directly to CASIS, users can submit their research proposals through a CSP. The CSP can then request that CASIS allocate ISSNL resources, such as crew time and vehicle stowage, to the user's project. CASIS officials stated that they review the CSP-submitted proposal through an abbreviated project selection process, allocate resources to the proposal, and place it in the flight queue for the ISS. In April 2022, CASIS officials reported that they rejected only five of the 393 requests submitted by a CSP.

Funding ISSNL Research

The cooperative agreement states that CASIS receives \$15 million each year from NASA. In fiscal year 2021, CASIS awarded \$5 million to ISSNL users via grants. CASIS grant funding represents a relatively small amount of the total funding budgeted for ISSNL projects. From fiscal years 2019 through 2021, CASIS grants constituted less than \$9 million of the \$128 million budgeted for ISSNL projects. Alternative funding sources include NASA, external partners, and the company performing the research. Figure 3 presents different types of funding sources for ISSNL projects.

Figure 3: Funding Sources for International Space Station National Laboratory Projects, in Fiscal Years 2019-2021



Source: GAO analysis of Center for the Advancement of Science in Space (CASIS) information. | GAO-22-105147

CASIS Has Opportunities to Improve Collaboration with ISSNL Users

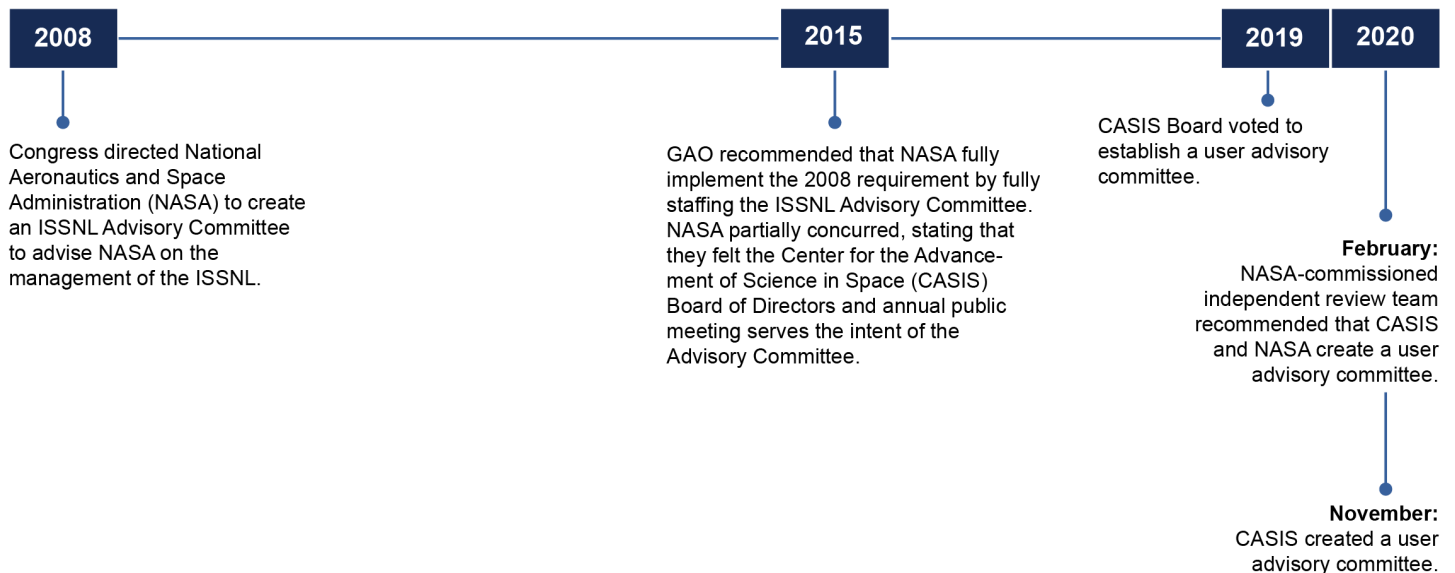
CASIS formed and staffed a UAC in November 2020 to help improve communication and inform CASIS leadership’s plans for the use of the ISSNL. However, the chairs of the UAC and its five subcommittees told us CASIS has opportunities to provide data that could help the UAC provide CASIS better advice, such as data about past and planned resource allocations.⁸ Further, these UAC members told us better succession planning would help increase the likelihood that the UAC will be a more effective collaborator in the future.

⁸ For the purposes of this report, resource allocation will refer to how ISSNL resources are divided amongst projects and research areas.

CASIS Created the UAC to Address Issues Involving Communication with ISSNL Users

In August 2019, the CASIS Board of Directors voted to establish a UAC. In November 2020, CASIS formed and staffed its UAC after the independent review team identified issues involving CASIS's communication with ISSNL users. CASIS's creation of the UAC came after three calls to create such a committee over the previous 12 years. See figure 4.

Figure 4: Timeline of Calls for an International Space Station National Laboratory (ISSNL) Advisory Committee



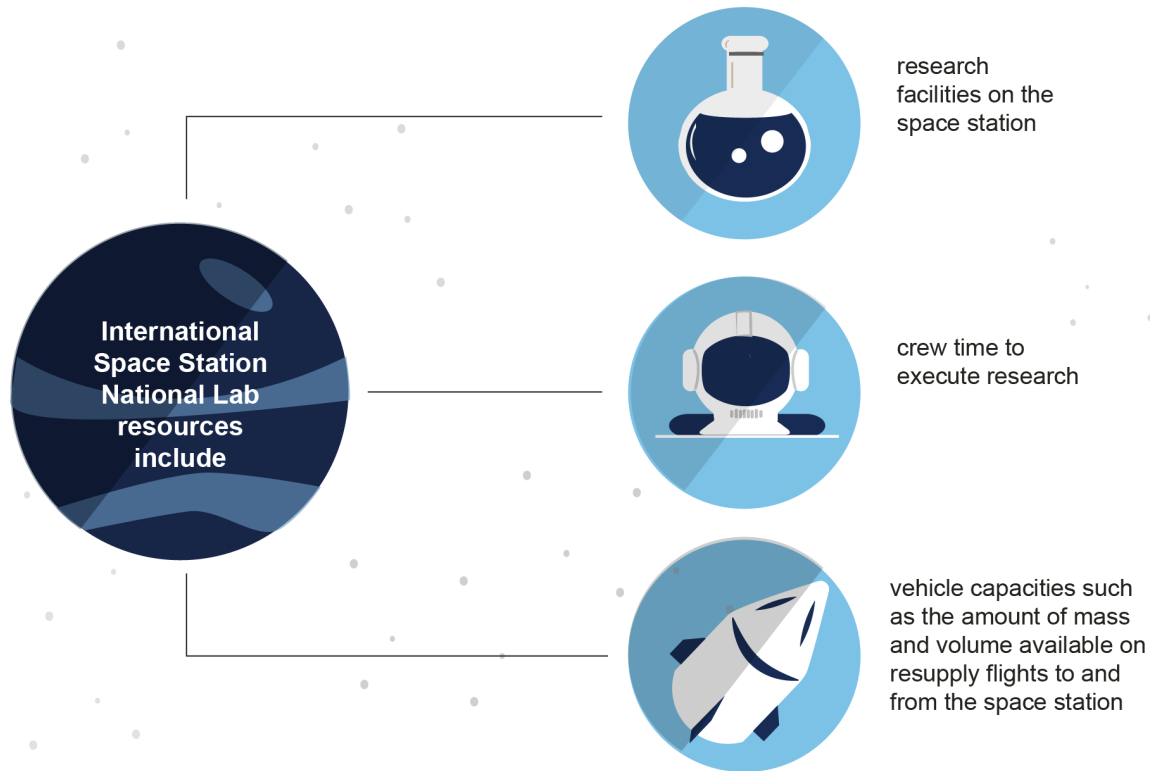
Source: GAO analysis of reporting and legislation: NASA Authorization Act 2008, Pub. L. No. 110-422, § 602 (codified at 51 U.S.C. § 70906). | GAO-22-105147

The UAC consists of 35 individual members selected by CASIS in consultation with the NASA Liaison for their experience working with the ISSNL and serving in various leadership positions. The members currently serve 2-year terms on one of the five subcommittees that align with the ISSNL lines of business.

CASIS Has Opportunities to Obtain UAC Input When Allocating ISSNL Resources

The UAC charter states that the committee seeks to inform CASIS leadership's plans for the ISSNL in order to ensure evaluation of user interests and improve utilization of the ISSNL. For example, the charter states the UAC should prepare information that can be used to inform decisions on the ISSNL utilization portfolio. However, CASIS leadership has not obtained input from the UAC when deciding how to allocate resources across its lines of business. Figure 5 depicts the types of ISSNL resources that CASIS allocates across the portfolio of ISSNL projects.

Figure 5: Types of International Space Station National Laboratory Resources



Source: GAO analysis of Center for the Advancement of Science in Space documentation. | GAO-22-105147

CASIS officials stated they have not obtained UAC input on ISSNL resource allocations for three primary reasons.

- **Users have diverse interests.** CASIS officials said the members of the UAC have diverse interests ranging from the pursuit of fundamental science to developing pathways to produce commercial items in space. The CASIS officials told us it is unlikely the UAC will provide a consensus perspective across the various represented interests.
- **Users could develop unrealistic expectations.** CASIS officials told us that they do not want to set unrealistic expectations that their resource allocation decisions will match UAC members' suggestions.
- **The UAC is relatively new.** CASIS selected the UAC members in November 2020. Both CASIS officials and the chairs of the UAC and its subcommittees stated that it was a slow process to begin meeting. In addition, these UAC members stated that the change in CASIS

leadership since CASIS selected the committee members also slowed the start of the UAC's operations and communication with CASIS.

Nevertheless, a potential lack of consensus from the users does not preclude CASIS from obtaining information from its UAC. As diverse perspectives can inform decision-making, diverse input could enhance CASIS leadership's understanding of risks and opportunities across the ISSNL portfolio.⁹ Further, as part of any solicitation for information, CASIS officials have an opportunity to communicate to UAC members that the cooperative agreement gives the CASIS CEO the authority to allocate resources across CASIS's lines of business. Officials can also communicate that CASIS's resource allocation decisions may not match the UAC members' suggestions.

The UAC charter states that the committee shall seek to inform CASIS leadership's plans for the ISSNL. Among other things, UAC members have specialized knowledge about performing low-Earth orbit research projects. Obtaining input from the UAC about ISSNL resource allocation decisions would better position CASIS leadership to fully leverage this specialized knowledge and make more informed decisions. NASA officials acknowledged that CASIS has opportunities to improve its collaboration with the relatively nascent UAC.

CASIS Has Opportunities to Provide ISSNL Users Additional Information about Past and Planned Resource Allocations

CASIS does not routinely provide ISSNL users, including its UAC, desired information about past and planned ISSNL resource allocations. The chairs of the UAC and its subcommittees believe they would be able to provide better advice if CASIS provided them with data showing how ISSNL resources were allocated in the past. Members also told us that greater transparency into CASIS's planned resource allocations, including the flight queue, would benefit the user community.

Past Resource Allocations

The chairs of the UAC and its subcommittees told us they could better advise CASIS on the utilization of ISSNL resources, in accordance with the UAC charter, if CASIS routinely provided the UAC with data showing how it allocated resources across lines of business in the past. Upon request, CASIS provided the UAC high-level data on ISSNL resource allocations in September 2021, but UAC representatives discovered the data did not fully meet their needs in part because the UAC representatives had not fully determined what they needed.

⁹ GAO, *Diversity At GAO: Sustained Attention Needed to Build on Gains in SES and Managers*, [GAO-08-1098](#) (Washington, D.C. Sept. 10, 2008).

The UAC chair explained to us that data needs differ across user groups. For example, the CSPs desire more detailed data than CASIS previously provided, while members of the UAC's education subcommittee desire entirely different information. In December 2021, UAC representatives stated they were working to clarify the types of data or information that each subcommittee needs. In February 2022, CASIS leadership told us they would be willing to work with the UAC to determine the data on past resource allocations that different user groups need, but CASIS and the UAC have not yet agreed on what data CASIS will provide. Federal internal control standards establish that management should externally communicate the necessary quality information to achieve the entity's objectives.¹⁰ Additional collaboration between CASIS and the UAC to determine which user groups need which data about past allocations would help the UAC better advise CASIS on the future utilization of ISSNL resources. NASA officials acknowledged that CASIS has opportunities to improve its collaboration with the relatively nascent UAC.

Planned Resource Allocations

The chairs of the UAC and its subcommittees told us that CASIS officials provide them individual updates on CASIS's plans to allocate specific ISSNL resources to their individual projects. These resources include access to particular research facilities on the ISS, designated crew time to execute research projects, and allocated mass and volume on vehicles flying to and from the space station. However, UAC representatives also told us that greater transparency into the entirety of CASIS's planned resource allocations, including the flight queue, would help the users determine why planned resource allocations change, and help them better prepare for additional changes in the future. They explained that this transparency would be particularly valuable for time-sensitive research, such as biological science research involving cell and tissue samples, which are only viable for a limited amount of time. The chairs of the UAC and its subcommittees told us the increased transparency would help improve the utilization of ISSNL resources.

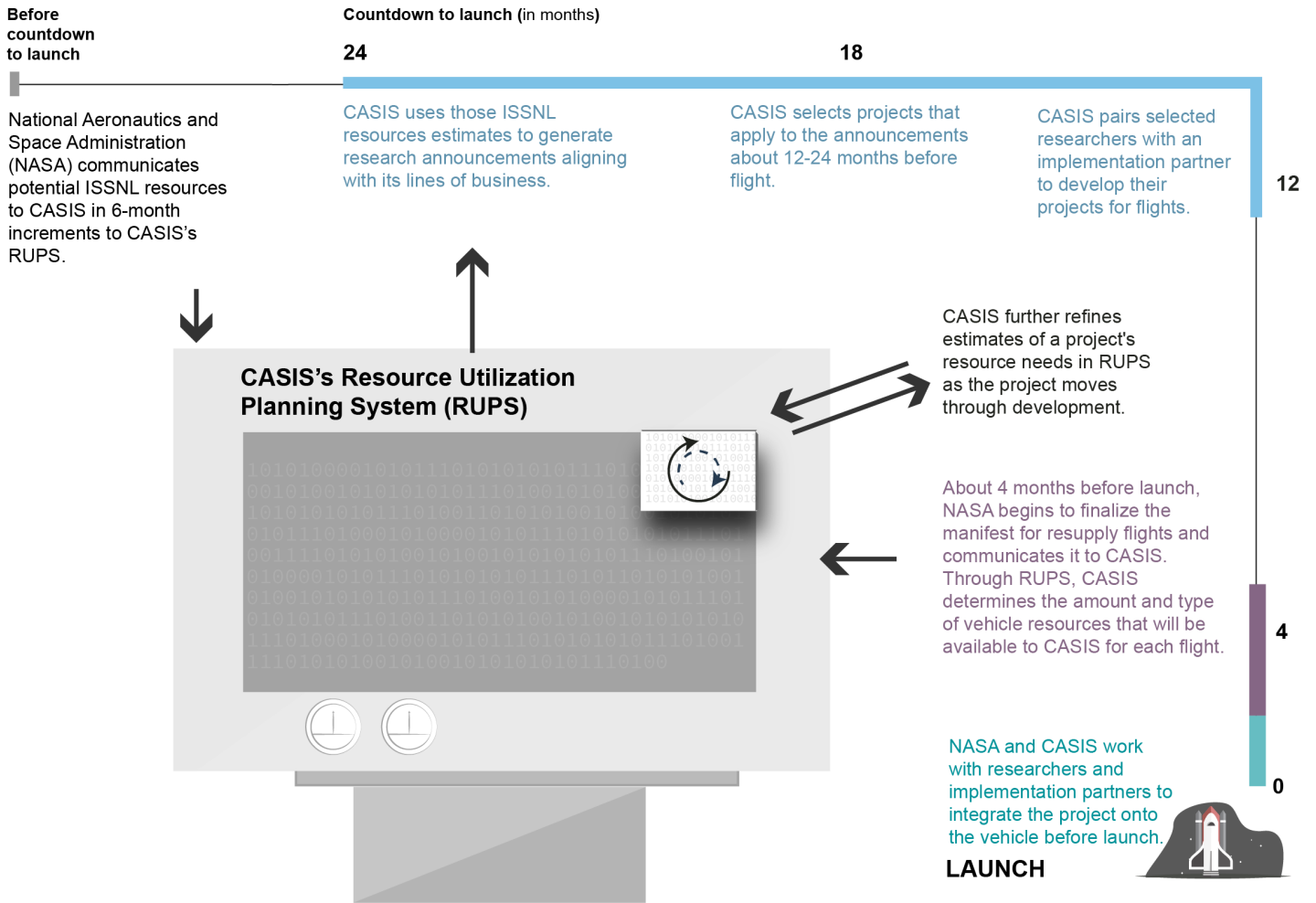
In addition, some CSPs say that they cannot confidently provide their customers a schedule for accessing the CSPs' facilities on the ISS. This affects the CSPs' ability to execute their business plans and raise capital, hindering growth of the low-Earth orbit economy—a joint CASIS and NASA goal. The cooperative agreement between NASA and CASIS states that CASIS should develop methods to provide planned resource

¹⁰ GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 10, 2014).

targets to CSPs so that they are better able to build credible business plans to utilize the ISS as a commercial service platform. To this end, NASA and CASIS officials told us they are planning to set aside a yearly allocation of ISSNL resources for CSPs in the future. In February 2022, NASA officials told us they were working with CASIS to socialize this construct with the UAC, and then incorporate this set aside into new CASIS guidance documents. While this action promises to help address CSPs' concerns, increasing transparency into the entirety of CASIS's planned resource allocations would further help CSPs understand the factors driving resource allocation decisions. It would also enhance the CSPs' communication with their customers.

CASIS officials told us they have not routinely provided users with greater transparency into the entirety of CASIS's planned resource allocations, because CASIS's resource allocation process is complex and fluid. CASIS officials use the Resource Utilization Planning System (RUPS) to develop ISSNL resource allocations, but in February 2022, they acknowledged the need to better educate ISSNL users on RUPS. Figure 6 depicts how CASIS officials use RUPS to allocate resources to a project.

Figure 6: International Space Station National Laboratory (ISSNL) Resource Estimation Process Before Launch



Source: GAO analysis of Center for the Advancement of Science in Space (CASIS) documentation and officials' statements. | GAO-22-105147

The ISS Research Integration Office within NASA—the overarching authority for the flight queue—communicates potential resource availability to CASIS. At the same time, the office must also account for crew supplies, vehicle maintenance, and requirements from other offices within NASA and from international partners. Additionally, on occasion, NASA officials stated that they have deemed non-ISSNL requirements a higher priority, for example, when an air leak on the ISS increased the requirement for nitrogen tanks.

While the ISSNL resource allocation process is complex and fluid, NASA officials acknowledged that CASIS has opportunities to improve transparency for ISSNL users, including the flight queue. Greater transparency into the entirety of CASIS's planned resource allocations, including the flight queue, could help ISSNL users and the CSPs. Increasing transparency in this manner would be consistent with federal internal control standards, which establish that management should externally communicate the necessary quality information to achieve the entity's objectives. This transparency could help CASIS achieve its objectives of (1) improving the utilization of ISSNL resources, and (2) growing the low-Earth orbit economy.

CASIS Has Not Established a Succession Plan for Its UAC

While CASIS appoints UAC members, it has not established a succession plan for the UAC chair and subcommittee chairs. The chairs of the UAC and its subcommittees told us that the UAC will likely be more effective in the future if CASIS establishes a succession plan before the chairs' term limits end in November 2022. In October 2021, CASIS officials reported that they had started to develop a succession plan for the UAC chair and subcommittee chairs. Both CASIS and UAC leadership said the goal is to develop a plan with overlap between current and new members. However, as of May 2022, CASIS and UAC leadership had not established a timeframe for finalizing the succession plan, or how current and new members' terms will overlap.

Federal internal control standards, which may be adapted to non-profit organizations, state that management should demonstrate a commitment to recruit, develop, and retain competent individuals. To do this, management defines succession plans for key roles to help the entity continue achieving its objectives. Without a finalized succession plan, the chairs of the UAC and its subcommittees told us there is an increased risk that they may unintentionally duplicate their efforts over time, among other things. While NASA is not responsible for the UAC charter, it is responsible for providing CASIS feedback on its activities.

NASA and CASIS Developed New Operating Principles and Objectives, and Are Refining Performance Metrics

As part of the response to independent review team concerns that CASIS lacked a consistent approach to its mission, NASA and CASIS collaborated to develop new operating principles and strategic objectives for the ISSNL. They also developed new performance metrics, including some that measure the long-term outcomes of ISSNL research. Further, after we shared the results of our preliminary analysis on the new metrics, NASA and CASIS established five metrics with targets measuring CASIS operations. Officials told us they plan to add targets for another seven metrics in fiscal year 2023. CASIS leadership plans to use these targets to identify performance gaps and take corrective actions.

NASA and CASIS Developed New Operating Principles and Strategic Objectives to Improve ISSNL Oversight

NASA and CASIS collaborated to develop new operating principles and strategic objectives, which they agreed upon in April 2021. NASA and CASIS took these actions as part of an effort to address ISSNL oversight issues identified by the independent review team. Among other things, the independent review team found that:

- CASIS lacked a purpose-driven mission statement, which led to shifting priorities.
- NASA provided CASIS with inconsistent strategic guidance, leaving CASIS to define and re-define success.
- The overall NASA culture did not embrace a unified approach to operating the ISSNL.

Further, NASA officials told us they plan to incorporate the new operating principles and strategic objectives into a future cooperative agreement update.

Operating Principles

NASA officials told us the new operating principles approved in April 2021 clarified each organization's respective responsibilities, in part by removing extraneous language in the cooperative agreement. These new operating principles specify roles for which NASA and CASIS are either solely or jointly responsible, as outlined in figure 7.

Figure 7: International Space Station National Laboratory (ISSNL) Operating Principles

Organization

Responsibilities



National Aeronautics and Space Administration (NASA)

- Funding CASIS management of the project solicitation, review, selection, and prioritization processes for the International Space Station National Laboratory (ISSNL).
- Conducting feasibility assessments of ISSNL payloads.

- Providing the on-orbit resources in accordance with legislative direction and availability.
- Managing the NASA operating structure and staff in accordance with cooperative agreement requirements.
- Providing performance feedback to CASIS relative to the annual program plan and ISSNL metrics.



Center for the Advancement of Science in Space (CASIS)

- Managing the project solicitation, review, selection, and prioritization processes for the ISSNL.
- Submitting an annual report to NASA on its management of the ISSNL.

- Managing the CASIS operating structure and staff in accordance with cooperative agreement requirements.



Joint – NASA and CASIS

- Maintaining single points of contact for coordination between organizations, specifically the ISSNL NASA Liaison, and the Chief Executive Officer for CASIS.

- Establishing the overall CASIS strategic objectives, the annual program plan, and the ISSNL metrics.

Source: GAO analysis of NASA documentation. | GAO-22-105147

Strategic Objectives

NASA personnel told us they established five strategic objectives with CASIS intended to help establish a general understanding about how CASIS should prioritize research projects and manage the resource allocation process. Table 1 presents the strategic objectives NASA and CASIS personnel agreed to for each ISSNL line of business.

Table 1: International Space Station National Laboratory (ISSNL) Strategic Objectives by Line of Business





| Line of business | Strategic objective |
|----------------------------------|--|
| Education and outreach | Execute a world-class education and outreach program that engages the public in the adventure of space flight and provides instruction about research in microgravity |
| Fundamental science | Support world-class, ground-breaking, non-exploration scientific research that utilizes and requires the unique platform of the International Space Station (ISS) |
| Technology demonstration | Support new non-exploration technologies that utilize and require the unique platform of the ISS |
| Applied research and development | Support non-exploration applied research and development that utilizes and requires the unique platform of the ISS, in particular in support of in-space production applications |
| Commercial facility utilization | Support the broader development of the commercial low-Earth orbit economy through utilization of commercially operated facilities and service providers |

Source: GAO analysis of National Aeronautics and Space Administration documentation. | GAO-22-105147

NASA and CASIS Are Continuing to Refine Performance Metrics Used to Assess CASIS Operations

Each year, NASA and CASIS personnel update the metrics used to measure ISSNL performance. For fiscal year 2021—partly in response to independent review team findings—they used the updates to further clarify ISSNL research priorities and inform resource allocation decisions. Among other things, NASA and CASIS personnel organized some of the metrics by strategic objectives, and established additional metrics measuring the outcomes of ISSNL research. They also retained some metrics measuring ISSNL and CASIS operations. Figure 8 presents our categories of selected fiscal year 2021 performance metrics.

Figure 8: Categories of Selected National Aeronautics and Space Administration (NASA) and Center for the Advancement of Science in Space (CASIS) Fiscal Year 2021 Performance Metrics

| Category | | | |
|---|--|---|--|
| Strategic Objectives | ISSNL Operations | CASIS Operations | ISSNL Research Outcomes |
| Examples | | | |
| <ul style="list-style-type: none"> Number of students participating in International Space Station National Lab (ISSNL) science, technology, engineering, and math programs and grants projects Number of new roadmaps developed for in-space production applications  | <ul style="list-style-type: none"> Total number of ISSNL payloads delivered Percent of resource utilization (e.g., crew time or cold stowage)  | <ul style="list-style-type: none"> Average number of days from solicitation close to announcement of project selection Number of new ISSNL payloads selected  | <ul style="list-style-type: none"> Number of peer-reviewed scientific journal publications from ISSNL projects Amount of funds raised post-award by start-up companies with ISSNL flight projects  |

Source: GAO analysis of NASA and CASIS documentation. | GAO-22-105147

In our previous work, we found that establishing performance metrics with quantifiable, numerical targets can help assess whether overall goals and objectives were achieved.¹¹ Additionally, in 2015, we recommended that NASA and CASIS collaboratively develop measurable targets for ISSNL metrics.¹² Both NASA and CASIS concurred with the recommendation, and they subsequently developed measurable targets. However, when NASA and CASIS personnel updated the performance metrics for fiscal year 2021, they created two categories: (1) metrics with assigned targets, and (2) metrics without assigned targets, used only for tracking purposes. NASA officials told us they did not set targets for some of the metrics because CASIS might not have control over the activity. For other

¹¹ GAO, *Managing for Results: Implementation of GPRA Modernization Act Has Yielded Mixed Progress in Addressing Pressing Governance Challenges*, [GAO-15-819](#), (Washington, D.C.: Sept. 30, 2015); and *Tax Administration: IRS Needs to Further Refine Its Tax Filing Season Performance Measures*, [GAO-03-143](#), (Washington, D.C.: Nov. 22, 2002).

¹² GAO, *International Space Station: Measurable Performance Targets and Documentation Needed to Better Assess Management of National Laboratory*, [GAO-15-397](#), (Washington, D.C.: Apr. 27, 2015).

metrics, NASA wanted to continue monitoring the activity, but officials said that they did not want CASIS to prioritize it. Overall, 12 out of the 34 metrics for fiscal year 2021 had assigned targets.

In March 2022, NASA and CASIS further updated their performance measures in response to our preliminary analysis, which found none of the metrics measuring CASIS operations had targets. Specifically, we shared with NASA that a lack of numerical targets for CASIS operations could make it difficult to assess CASIS operations in the following areas:

1. **Performance of recent CASIS activities.** NASA and CASIS have established numerical targets for all metrics for strategic objectives and some metrics for ISSNL operations. However, the time between project selection and activities measured in those categories of metrics could take multiple years. Metrics measuring these activities therefore do not provide NASA with insight into CASIS's recent performance. By adding targets to the metrics for CASIS operations, such as targets for the number of days it takes CASIS to select projects, NASA and CASIS can now better assess CASIS's project selection efficiency on a quarterly and annual basis.
2. **Performance of activities over which CASIS has direct control.** CASIS does not have sole or direct control over ISSNL operations or research outcomes, and it cannot achieve ISSNL strategic objectives on its own. NASA, implementation partners, and ISSNL users all play key roles. For this reason, performance assessments against many of the ISSNL metrics do not clearly delineate CASIS's contributions. By adding targets for the metrics for CASIS operations, such as the number of projects CASIS selects in a given time period, NASA and CASIS can now better assess CASIS's role in advancing ISSNL research.

The new set of fiscal year 2022 metrics includes targets for five metrics measuring CASIS operations, including metrics for the number of days it takes CASIS to select projects, and the number of projects selected by CASIS. In addition, NASA officials told us they plan to add targets for another seven metrics in fiscal year 2023.

In the past, NASA and CASIS leadership successfully used performance targets to identify performance gaps and take corrective actions. For example, in previous years, NASA and CASIS did not reach the established targets for ISSNL resource utilization. NASA officials told us CASIS developed RUPS in response, which has helped maximize the

use of ISSNL resources. Going forward, CASIS officials told us they plan to use performance targets in a similar manner. Setting additional targets for metrics measuring CASIS's operations will help enable NASA and CASIS leadership to conduct more timely and targeted assessments of CASIS's performance, and help them improve CASIS's operations over time.

NASA Provided Two ISS Transition Reports to Congressional Committees

NASA officials have planned to transition the agency's low-Earth orbit operations from the ISS to commercial space stations for several years. NASA intends its commercial low-Earth orbit development program to help stimulate private industry development of commercial stations, as well as a market environment in which a commercial provider can serve both government and private-sector customers. In December 2021, NASA announced that the President supported extending the life of the ISS from 2024 to 2030, which supports NASA's goal to transition low-Earth orbit capabilities to commercially owned and operated destinations beginning in 2029.

Congress passed and the President enacted the NASA Transition Authorization Act of 2017. The act required NASA to submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Science, Space, and Technology of the House of Representatives a biennial report starting no later than December 2017, and then in 2019, 2021, and 2023.¹³ The legislation indicates the report must include information such as the transition steps NASA is taking, including demonstrations that could be conducted on the ISS to stimulate and facilitate commercial services in low-Earth orbit.

However, NASA has submitted two reports to the required committees, both of which were submitted later than statutorily required. NASA provided the committees with the first report in March 2018, approximately 4 months after the first report was due, and the second report in January 2022, more than 2 years after it was due. NASA officials told us they did not finalize the second report closer to its original December 2019 due date because available details in the commercial low-Earth orbit development program were limited.

The second report includes information on NASA's plans to transition its low-Earth orbit activities off the ISS and onto commercial low-Earth orbit

¹³ National Aeronautics and Space Administration Transition Authorization Act of 2017, Pub. L. No. 115-10, § 303.

destinations by 2030. It includes interim goals for the next decade of ISS operations to enable a smooth transition to commercial services, and identifies steps being taken to develop both the supply and demand side of the low-Earth orbit commercial economy. In addition, the report addresses budgetary requirements, and the technical steps of its ISS de-orbit plan.

Conclusions

The ISSNL is a unique and important resource for companies and the scientific community. The laboratory allows for the use of low-Earth orbit to perform scientific research for a variety of purposes. NASA relies on CASIS to help manage key aspects of the ISSNL, including selecting projects for execution on the ISSNL. To respond to longstanding concerns about poor communication, CASIS recently formed and staffed an advisory committee of experts to provide input on the efficient utilization of ISSNL resources. While establishing the UAC was a step in the right direction, CASIS has opportunities to further improve the collaboration with ISSNL users by obtaining input on resource allocation decisions. CASIS can also take steps to agree upon and share data about past and planned resource allocations, including the flight queue, with the user community. For its part, the UAC has not worked with CASIS to agree upon the different types of data it needs to help perform its mission. A timeframe for finalizing a succession plan for the UAC would also help ensure current and new members' terms overlap to prevent unintentional duplication of efforts over time. Addressing these issues would help improve communication and could better inform resource allocation decisions on the ISSNL. With the extension of ISS operations to 2030, addressing these issues now has the opportunity to improve decision-making through the rest of the decade.

Recommendations for Executive Action

We are making the following four recommendations to NASA:

The NASA Administrator should ensure the CEO of CASIS obtains input from the UAC regarding ISSNL resource allocation decisions. (Recommendation 1)

The NASA Administrator should ensure the CEO of CASIS works with the UAC to agree upon the types of data and information on past resource allocations that the UAC needs to support CASIS. (Recommendation 2)

The NASA Administrator should ensure the CEO of CASIS provides ISSNL users visibility into the entirety of CASIS's planned resource allocations, including the flight queue. (Recommendation 3)

The NASA Administrator should ensure the CEO of CASIS establishes a timeframe for finalizing a succession plan for the UAC that allows current and new members' terms to overlap. (Recommendation 4)

Agency Comments and Our Evaluation

We provided NASA and CASIS a draft of this product for review and comment. In its written comments, reproduced in appendix II, NASA concurred with recommendations 1, 2, and 4 and stated that it will take actions in collaboration with CASIS to address those recommendations. Among other things, NASA stated that CASIS will work with the UAC to increase dialogue about resource allocation decisions, and revise the UAC succession plan.

NASA partially concurred with recommendation 3. NASA stated that CASIS will provide ISSNL users with visibility into CASIS's planned resource use, but will not include the flight queue noting logistical and other challenges with doing so. Nonetheless, we believe NASA has opportunities to fully address this recommendation without providing the flight queue itself. For example, NASA initially communicates potential ISSNL resources to CASIS in 6-month increments, and CASIS uses these resource estimates to generate research announcements and select projects. There are opportunities at these points in the process to increase ISSNL users' visibility into the flight queue. While both resource demand and availability routinely change over time, these changes do not preclude CASIS from increasing transparency. UAC representatives told us greater visibility into the changes would help them understand why the changes occur so they could better prepare for additional changes in the future. Ultimately, this increased transparency could help CASIS achieve its objectives of (1) improving the utilization of ISSNL resources, and (2) growing the low-Earth orbit economy.

NASA also provided written technical comments, with input from CASIS, which we addressed as appropriate. We also provided excerpts of the draft product to the UAC, and the chair provided written technical comments that we addressed as appropriate.

We are sending copies of this report to appropriate congressional committees; the Administrator of the National Aeronautics and Space Administration; the Chief Executive Officer of the Center for the Advancement of Science in Space; and other interested parties. In addition, the report is available at no charge on the GAO website at <https://www.gao.gov>

If you or your staff have any questions about this report, please contact me at (202) 512-4841 or russellw@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

A handwritten signature in black ink that reads "W. William Russell". The signature is written in a cursive style with a large, prominent initial "W".

W. William Russell
Director, Contracting and National Security Acquisitions

Appendix I: Objectives, Scope, and Methodology

This report (1) assesses the extent to which the Center for the Advancement of Science in Space (CASIS) collaborates with users of the International Space Station National Laboratory (ISSNL); (2) assesses the extent to which the National Aeronautics and Space Administration (NASA) and CASIS have taken steps to improve management of ISSNL activities; and (3) describes NASA's reporting to designated congressional committees on plans to transition from the International Space Station (ISS) to commercial space stations.

To assess the extent to which CASIS collaborates with ISSNL users, we reviewed documentation establishing the roles and relationships between CASIS, the ISSNL User Advisory Committee (UAC), and NASA. Specifically, we reviewed the UAC charter and cooperative agreement between NASA and CASIS to identify the UAC's responsibilities in advising CASIS, information CASIS should provide the UAC, and succession planning for the UAC. We also reviewed CASIS's manual for making resource allocation decisions using its Resource Utilization Planning System (RUPS). The manual describes the purpose of RUPS, how an ISSNL project moves through the RUPS lifecycle, and roles and responsibilities for CASIS officials. Additionally, we reviewed resource utilization data that CASIS provided the UAC in fiscal year 2021, including crew time utilization and investor network participation dating back to fiscal year 2017.

To collect the perspectives of both CASIS and the users, we interviewed CASIS officials, including the CASIS Chief Executive Officer and the chair of the CASIS Board of Directors, to discuss communication challenges and opportunities. We also interviewed the chairs for the UAC and its five subcommittees to discuss the usefulness of the information CASIS provided the UAC, and opportunities to improve communication. We assessed the UAC charter and cooperative agreement to evaluate the information exchanges and communication challenges. We also used federal internal control standards for externally communicating necessary quality information.¹ Additionally, we used federal internal control standards demonstrating a commitment to recruit, develop, and retain competent individuals to evaluate the UAC succession plans.²

¹ GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 10, 2014).

² [GAO-14-704G](#).

To assess the extent to which NASA and CASIS have taken steps to improve management of ISSNL activities, we reviewed the independent review team report issued in February 2020. The report identified challenges involving the relationship between NASA and CASIS, and included recommendations to improve NASA oversight, among other things. We also reviewed information documenting actions NASA and CASIS took in response to the independent review team recommendations. This included documents establishing strategic objectives for the ISSNL, operating principles for NASA and CASIS, and annual performance metrics used to assess CASIS's performance from fiscal years 2019 through 2022.

We further reviewed each of the performance metrics for fiscal year 2021 to determine whether there were measurable targets. In our preliminary analysis, we found that NASA and CASIS had not established targets to measure CASIS operations. In January 2022, we shared our preliminary analysis with NASA officials. In response, NASA and CASIS finalized a new set of fiscal year 2022 metrics that includes targets for five metrics measuring CASIS operations. We also interviewed NASA officials to understand why they established the new strategic objectives, operating principles, and performance metrics with CASIS in response to oversight concerns documented in the independent review team report.

To describe NASA's reporting to designated congressional committees on plans to transition from the ISS to the commercial space sector, we reviewed the NASA Transition Authorization Act of 2017, which required the reports and established the required submission schedule. We also reviewed the two reports that NASA provided Congress, in March 2018 and January 2022. We then interviewed NASA officials to discuss the release of the reports, and identify the factors affecting the timing of their release.

We conducted this performance audit from April 2021 to June 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the National Aeronautics and Space Administration

National Aeronautics and
Space Administration

Mary W. Jackson NASA Headquarters
Washington, DC 20546-0001



May 17, 2022

Reply to Attn of: Space Operations Mission Directorate

Mr. W. William Russell
Director
Contracting and National Security Acquisitions
United States Government Accountability Office
Washington, DC 20548

Dear Mr. Russell:

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to review and comment on the Government Accountability Office (GAO) draft report entitled, "INTERNATIONAL SPACE STATION: Opportunities Exist to Improve Communication with National Laboratory Users" (GAO-22-105147), dated March 31, 2022.

GAO found that although there have been steps to improve communication through the Center for the Advancement of Science in Space's (CASIS's) formation of a User Advisory Committee (UAC), there are more opportunities to further the collaboration between the International Space Station National Laboratory (ISSNL) and the low Earth orbit user community. With the extension of International Space Station (ISS) operations to 2030, addressing these issues now can improve decision making through the rest of the decade.

In the draft memorandum, GAO makes four recommendations addressed to the NASA Administrator.

Specifically, GAO recommends:

Recommendation 1: The NASA Administrator should ensure the CEO of CASIS obtains input from the UAC regarding ISSNL resource allocation decisions.

Management's Response: NASA concurs. NASA and CASIS have already begun coordination with the UAC to provide the UAC with a deeper understanding of how resources are allocated in the mission planning process. CASIS will conduct additional sessions with the UAC to increase this dialogue and obtain feedback. In addition, NASA and CASIS have drafted a proposed resource allocation process specifically in response to the Commercial Service Providers' request for increased certainty in planning access to their on-orbit facilities and intend to review this proposal with the UAC in the near future.

Estimated Completion Date: August 2022

Recommendation 2: The NASA Administrator should ensure the CEO of CASIS works with the UAC to agree upon the types of data and information on past resource allocations that the UAC needs to support CASIS.

Management's Response: NASA concurs. CASIS will work with the UAC and its subcommittees to understand what types of data, relevant to the post-Independent Review Team operations, would be helpful to increase their understanding of the resource allocation and flight planning process and agree on a mechanism to provide this data.

Estimated Completion Date: August 2022

Recommendation 3: The NASA Administrator should ensure the CEO of CASIS provides ISSNL users visibility into the entirety of CASIS's planned resource allocations, including the flight queue.

Management's Response: NASA partially concurs. As part of Recommendation 1, CASIS will work with the UAC to provide a deeper understanding of resource allocation, prioritization, and mission planning and obtain feedback from the UAC on how this visibility could be improved upon. This will provide ISSNL users with visibility into the CASIS planned resource use but will not include the flight queue as the recommendation is written. However, visibility into the overall ISS flight queue is not possible until the ISS program has had time to evaluate the needs of the ISS as a whole, which are subject to change on a flight-by-flight basis somewhat close to launch. This includes consumables, crew supplies, sustaining hardware, spares for failed hardware, and research from all U.S. and international partner sponsors. The final resources available to research, including ISSNL users, are not known until launch minus 16 weeks. Payloads are assigned to the available resources based on the integrated priorities of the overall research community.

Estimated Completion Date: August 2022

Recommendation 4: The NASA Administrator should ensure the CEO of CASIS establishes a timeframe for finalizing a succession plan for the UAC that allows current and new members' terms to overlap.

Management's Response: NASA concurs, and in fact, CASIS has responded to this action via a revised UAC charter which outlines UAC membership and terms enabling overlap and continuity of succession. The revised UAC charter, which includes the succession plan, will be provided to the GAO once it has been discussed with the UAC.

Estimated Completion Date: May 2022

We have reviewed the draft report for information that should not be publicly released. As a result of this review, we have not identified any information that should not be publicly released.

**Appendix II: Comments from the National
Aeronautics and Space Administration**

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Once again, thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Michelle Bascoe on (202) 358-1574.

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Kathryn L. Lueders

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

W. William Russell at (202) 512-4841 or russellw@gao.gov

Staff Acknowledgments

In addition to the contact named above, Nathan Tranquilli (Assistant Director), Cale Jones (Analyst-in-Charge), Meherdad Azadbakht, Breanne Cave, Meghan Kubit, Jeanine Navarrete, Edward J. SanFilippo, Sylvia Schatz, Robin Wilson, and Tonya Woodbury made key contributions to this report.

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