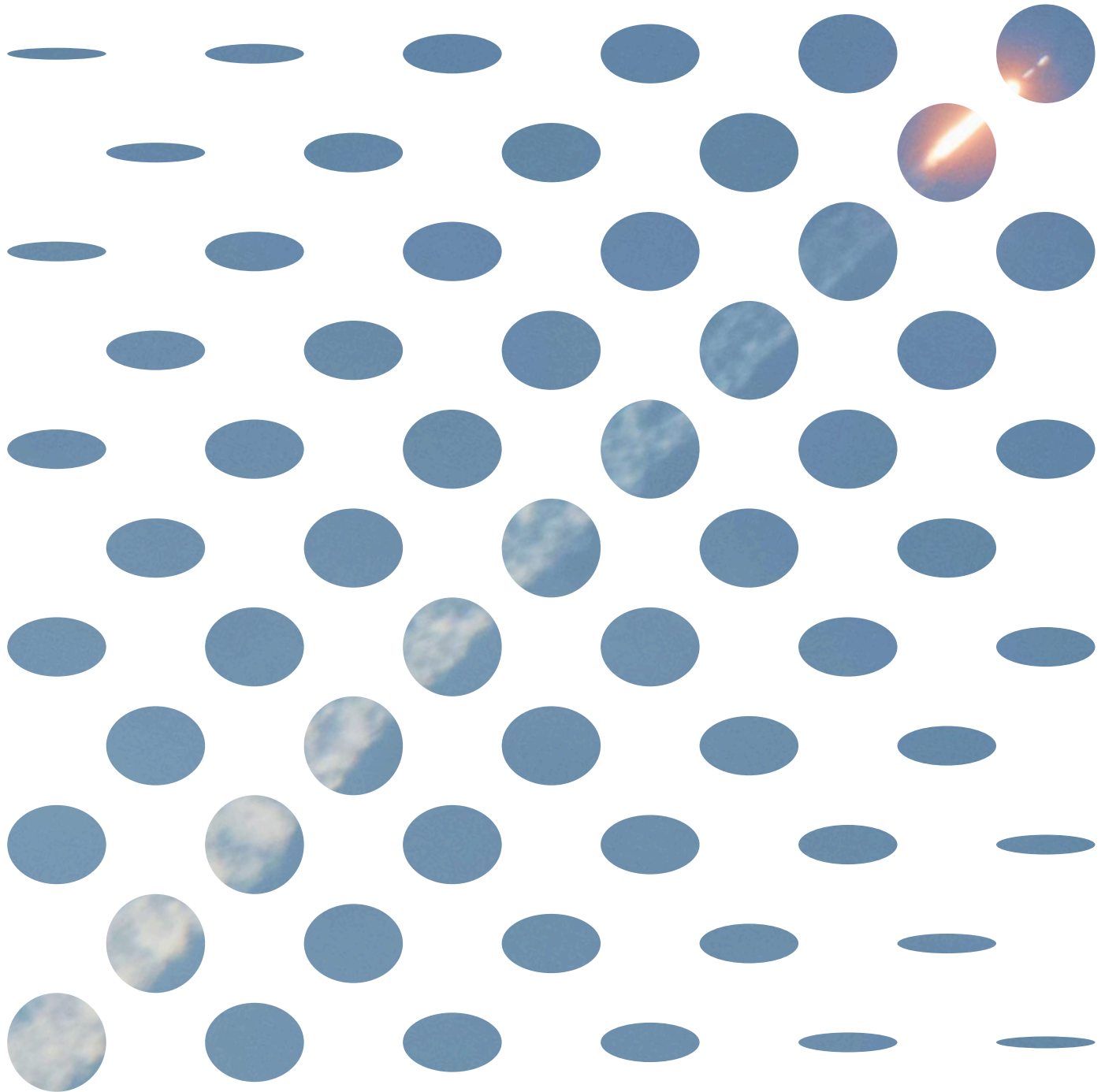


# The Brinson Exploration Hub

USER GUIDE



Version 1: 09/05/24

**The Brinson Exploration Hub**  
California Institute of Technology

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# The Brinson Hub User Guide (HUG)

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## Preface

In the summer of 2023, a group of California Institute of Technology (Caltech) and Jet Propulsion Laboratory's (JPL) faculty and staff were charged to formulate the goals, objectives, and initial processes that would form the basis of The Brinson Exploration Hub (a.k.a. The Brinson Hub) - all of which are reflected in this Brinson Hub User Guide (HUG). We are deeply grateful to The Brinson Foundation for their generosity as well as the confidence they have placed in Caltech and JPL.

This document is a guide - not a set of rules - outlining the intent and general direction of the Brinson Hub. The Executive Summary provides background and motivation, along with a high-level vision and the Pillars of the Brinson Hub, important for guiding activities at a strategic level. This guide should be viewed as a living document, one that is regularly reviewed and updated by both leadership and participants alike. Importantly, the document should provide flexible guidance to meet the intent of the endeavor.

## Executive Summary

Exploration, on Earth, throughout the Solar System, and of the Universe, is central to the ambitions of both Caltech and JPL. Caltech is an institution devoted to fundamental research and education. JPL, a division of Caltech, is a unique federally funded research and development center (FFRDC) within NASA at the forefront of technology and innovative space mission development. The history of collaboration between Caltech and JPL has enabled bold, ambitious ventures pushing the boundaries of science. The seeds of this partnership began in the 1930s and led to the launch of the Explorer 1 satellite in early 1958 (before the founding of NASA) which started the U.S. space program and was the first science experiment in space.

Over nearly a century, Caltech and JPL have developed a world-renowned and groundbreaking exploration paradigm that has advanced our scientific understanding of Earth and beyond, and changed humanity's view of itself and its place in the universe. Today, the same paradigm that has fueled so many decades of success operates in a new space ecosystem. Among notable recent changes is the dramatic reduction of costs and increased cadence of launches enabled by the commercial space industry. Many new entrants embrace greater risk - enabling shortened technology development timescales with rapid iteration toward eventual success.

We aim to harness these new approaches for both transformative scientific exploration and the rapid adoption and demonstration of new technologies. We believe this opportunity applies to all remote exploration be it on Earth, near-Earth, and in deep space environments. Building on our rich history of collaboration, Caltech and JPL aim to realize the potential of a new age of exploration for the benefit of science and society through The Brinson Exploration Hub.

Historically, we have worked within funding models with inherently conservative risk posture and slower pace. We imagine the Brinson Hub to be a means to break free of some of these constraints. The Brinson Hub will help realize concepts that would otherwise sit moribund, leveraging previous investment and strengthening the entire ecosystem through the feedback that only can be obtained through practical experience.

The Pillars that support the strategic vision of the Brinson Exploration Hub (see Appendix for more detail) are to:

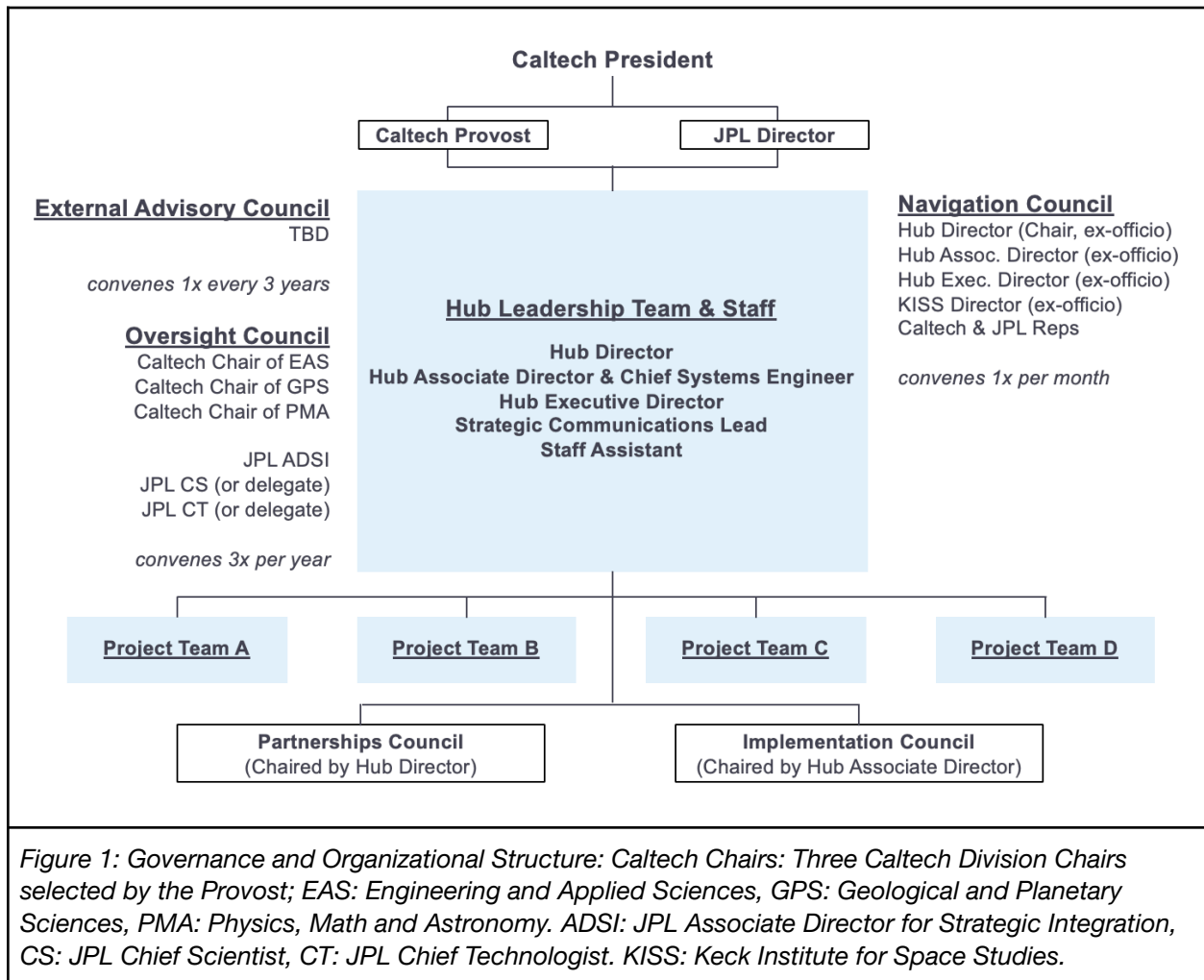
- I. Implement breakthrough exploration projects that drive scientific and societal benefit.*
- II. Produce a new generation of “space savvy” alumni.*
- III. Execute with speed, agility, and risk tolerance.*
- IV. Seize emerging opportunities in the broader ecosystem of Earth and space exploration.*
- V. Respond to the strategic ambitions of both Caltech and JPL.*

The Brinson Hub will implement missions or expeditions (ground-based, suborbital, or in space) that directly address important science problems and/or demonstrate key technologies that serve as essential foundations for future science exploration initiatives and/or provide important societal benefits. The life cycle for Brinson Hub projects will be adapted to the projects themselves, with progression transparently assessed.

The Brinson Exploration Hub is an endeavor that expects to adapt and grow with the demands of the new space ecosystem. Our focus on agility provides an environment for experimentation while achieving formative discoveries and education opportunities.

# The Brinson Exploration Hub

This section defines the initial operating structure of the Brinson Exploration Hub above the project level, allowing for flexibility and adaptability for individual projects. As the Brinson Hub matures, it is expected that this structure will evolve (Figure 1).



## Organizational Structure, Reporting and Governance

### Hub Leadership Team and Staffing

The Brinson Hub Leadership Team comprises the Hub Director (HD), Hub Associate Director (HAD), and Hub Executive Director (HED). Together, they provide the primary leadership of the Brinson Hub. The HD and the HAD, together with an Oversight Council (OC), and an External Advisory Council (EAC), provide awareness to the Caltech President, Caltech Provost, and JPL Director by meeting regularly (although not necessarily simultaneously) to evaluate and converge on the overall strategic

direction and management of the Brinson Hub. The Caltech President will constitute an independent external review committee at least every five years.

- **The Hub Director (HD)** is chosen from among the Caltech faculty and leads the Brinson Exploration Hub. The HD provides strategic direction, acts as an interface to Caltech and JPL, and serves as a faculty presence for involved students. The HD works directly with the Caltech Provost, JPL Director, and the Brinson Hub councils for strategy and management. The HD also chairs the Partnerships Council (PC). *Termed appointment.*
- **The Hub Associate Director/System Engineer (HAD)** is a JPL employee responsible for broad systems engineering leadership for implementation teams. The HAD assists the HD in developing and providing strategic direction for the Brinson Hub, and manages the Brinson Hub's technical activities, providing an interface to JPL. While this role provides leadership to Brinson Hub participants and staff, the HAD will also have a role akin to a Chief Engineer and will provide technical expertise across all implementation projects, in addition to chairing the Implementation Council (IC). *Termed appointment.*
- **The Hub Executive Director of Operations (HED)** is a Caltech employee, and manages the daily operations of the Brinson Hub and the operations staff. With oversight from the HD, the HED is responsible for executing day-to-day decisions on Brinson Hub business and non technical activities, and works directly with project teams to connect appropriate JPL subject-matter experts and external partners to Brinson Hub activities. The HED will also facilitate the relationship between the PC, the IC, and the Project Teams. Project Teams will report to the HED.
- **The Hub Operations Staff** is funded by the Brinson Hub and consists of both full-time and part-time roles supporting the day-to-day operations of the Brinson Hub. Additional staff is leveraged from Caltech and/or JPL until it is determined if a dedicated role is necessary.

#### Navigation Council (NC)

The Navigation Council (NC) consists of the Brinson Hub leadership team (ex-officio), Caltech faculty members, JPL staff members, and the Director of the Keck Institute for Space Studies (KISS) (ex-officio). The NC works closely with the Brinson Hub Leadership Team on major decisions. *Termed appointments.*

### Partnerships Council (PC)

The PC is a group of experts from both Caltech and JPL that provide Project Teams (as well as the Brinson Hub itself) responsive guidance on topics related to partnering with external entities. The PC will be chaired by the Hub Director. A key dimension of Brinson Hub and project success is the identification of sponsorship and other forms of funding and/or in-kind contributions, such that the Brinson Hub operating funds may be leveraged across multiple ongoing projects at different phases of development and implementation. Some project teams may come into the Brinson Hub with such approaches in-place; however, it is likely that many will need assistance with introductions to new partners, avenues for funding and contributions, and management of the partnership. The Brinson Hub will develop and maintain strategic partnerships for the benefit of the Brinson Hub's portfolio of projects, as well as access and leverage resources. The PC will maintain cognizance of partner capabilities and interests as well as funding avenues and contractual mechanisms. *Termed appointments.*

### Implementation Council (IC)

A Brinson Hub project may have an established core team including: Caltech & JPL Project Leads, engineers, students, and other scientific and project-specific roles. As Brinson Hub projects are intended to be lean and fast-moving, they will likely not have the resources to carry a cadre of engineering and other expertise through the full life cycle - multidisciplinary participants will be key. Furthermore, projects may occasionally have a need for a consulting expert. To this end, the Brinson Exploration Hub will establish and maintain an Implementation Council (IC). The IC will report to the Hub Associate Director who will manage resources.

Members of this team may possess a myriad of technical skills and disciplines envisioned to be useful. For example, experts in electronics, structures, robotics, thermal, etc. whether at Caltech or JPL. These experts will be maintained by their home organizations but have agreements and funding available where the Brinson Hub may call upon them to support a project for a short bounded period of time. Initially members of the Implementation Council would be drawn from Caltech and JPL, however, later they might come from a strategic partner. While project management will be encouraged to maintain a funding reserve to utilize this staff, the Brinson Hub will separately hold flexible unallocated funds to allow for swift resolution of issues. *Termed appointments.*



## Oversight Council (OC)

The Oversight Council (OC) meets three times per year to provide guidance on the overall strategic direction and management of the Brinson Exploration Hub.

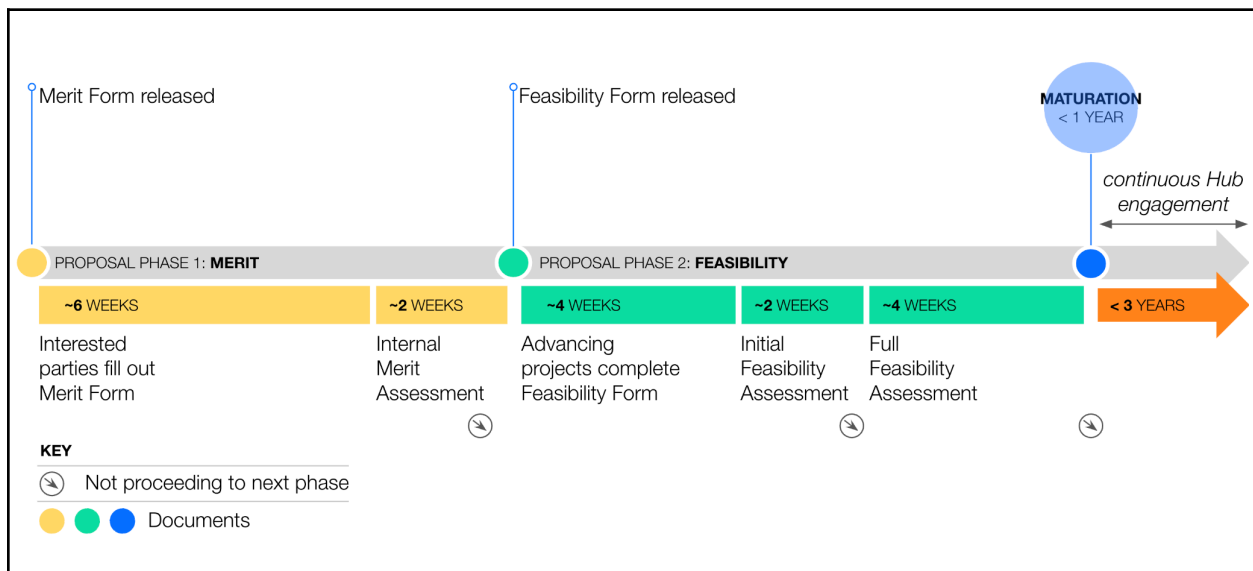
## External Advisory Council (EAC)

The External Advisory Council (EAC) convenes once every 3 years and reviews the progress made by the Brinson Exploration Hub according to the founding pillars.

## Project Teams

The Project Teams may be staffed according to individual project needs and will be accountable for the execution of the project. It is expected that each project will have leads from both Caltech and JPL. Both Brinson Hub staff and Project Teams will report to the HED, but Project Teams may have unique structures, created in concurrence with Brinson Hub's specified subject-matter experts and Brinson Hub leadership. As an organization that calls for novel methods of implementation, the Brinson Hub may require that Project Teams adjust their team structure to execute with speed, agility, and risk tolerance.

## The Lifecycle of Projects in the Brinson Exploration Hub



*Figure 2: The Brinson Exploration Hub project lifecycle model: A schematic of the expected life cycle of a project from proposal to full implementation. The Brinson Hub begins with initial ideas developed elsewhere, assesses the merit, project feasibility, and need for additional maturation, and then implements the project. There are multiple points where iteration may be required, and multiple points in which the project may cycle back to a previous phase or be off-ramped.*

Caltech and JPL already invest in blue sky idea development, which imagines and architects new science frontiers, enabling technologies, and associated implementation approaches at a “pencil and paper” level. These forward-looking and bold ideas are intended to be transformative rather than incremental. Lacking, however, are the foundational resources to implement these types of missions with the necessary “out-of-the-box” approach.

The Brinson Hub will solicit ideas from Caltech and JPL through a “Call for Exploration Projects.” A Merit Assessment phase and Feasibility Assessment phase will provide insight on whether the project addresses the Brinson Hub pillars and is achievable, respectively. Projects will be down-selected at each phase. Projects that pass both phases may undergo a limited period of maturation to evaluate and adjust their technical needs and approaches, while others may pass immediately into Implementation. The cadence of calls for projects and assessments may change based on the capacity of the Brinson Hub and the number, size, and complexity of the projects.

#### Ideation

Ideation activities are external to the Brinson Hub and can take place within many existing Caltech and JPL organizations. The Brinson Hub will not ideate in-house, but will instead leverage prior investments on Campus (Caltech) and at JPL for early concept proposals. However, the Brinson Hub will actively engage with others to advertise capabilities and advise on concept suitability. This may also include hosting informational gathering workshops to connect communities of interest and expertise.

Existing sources of project concepts include but are not limited to: (a) The joint Caltech-JPL Keck Institute for Space Studies (KISS) which is recognized globally for its high-impact think-tank workshop approach for developing Earth, planetary, and astrophysics mission concepts, (b) The Resnick Sustainability Institute (RSI) which provides an arena for developing a process-based understanding of key environmental systems as well as suites of new tools in support of developing a more sustainable and resilient society, and (c) The Innovation Foundry at JPL which regularly guides teams to find pathways to solve complex technical problems in support of JPL’s scientific ambitions.

## Merit Assessment

Potential Brinson Hub projects must undergo a period of rapid Merit Assessment before entering a Feasibility Assessment phase. This evaluation will be triggered by submitting a Merit Form. This questionnaire asks broad questions that assess whether the concept fits within the pillars of the Brinson Hub, and that the Brinson Hub is the most appropriate avenue for the concept to succeed. It is the first step in assessing the potential value and feasibility of the concept. To assist individual Project Leads or small teams, the Brinson Hub Leadership Team will be available to discuss early concepts, assist in guiding teams to appropriate resources, or provide feedback. The Brinson Exploration Hub will intentionally embrace a broad suite of project concepts that cover a range of complexity. Some projects will focus on developing and demonstrating cutting-edge technology or measurement capability that would form the underpinnings of a larger future science mission, while others would lead to immediate science discovery. Some of the projects will be smaller in scope and lower in risk (e.g., exploration from ground-based or suborbital platforms), while others will embrace higher-risk and potentially larger scope.

## Feasibility Assessment

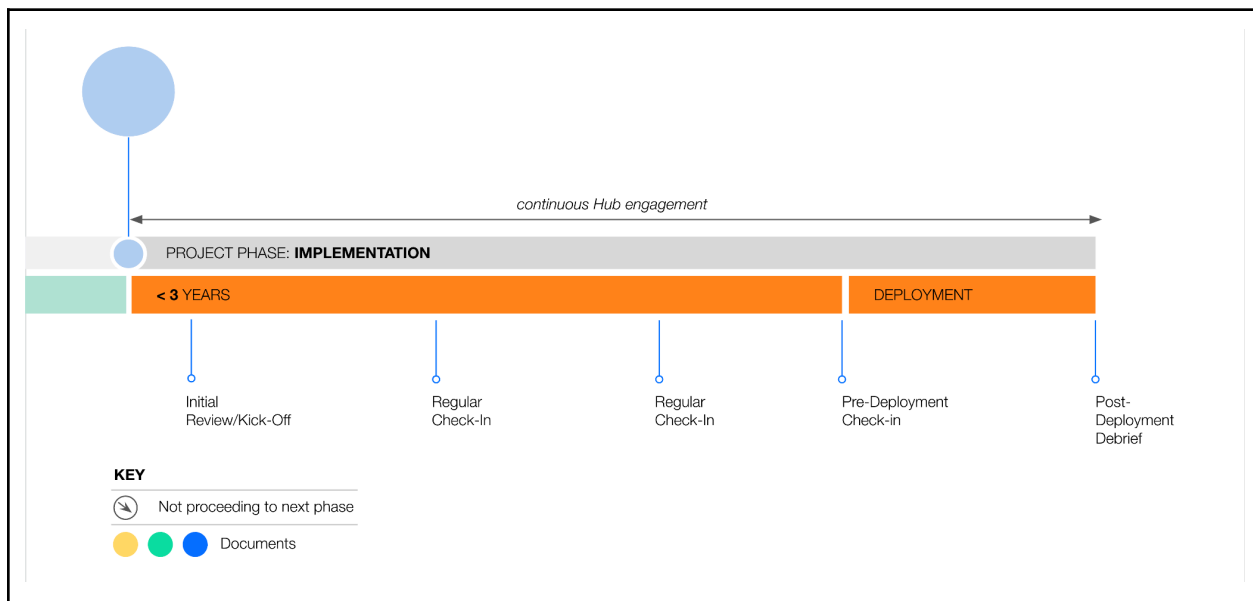
Concepts that move forward in the Brinson Hub project lifecycle after successful completion of the Merit Assessment will be invited to fill out a Feasibility Form and undergo a Feasibility Assessment before moving forward to the Implementation Phase. This step will ascertain a concept's technical and programmatic approach, as well as its schedule and maturity level in major areas. It also seeks to identify and inform the Brinson Hub of key resources the project may be missing such as partnerships/funding, technology, personnel, etc. and whether there is a viable path forward in those areas. Concepts will be assisted by the Brinson Hub for further evaluation of the scientific, technical, and partnership aspects, as well as the development of a maturation plan if needed.

The Brinson Exploration Hub will intentionally embrace a broad suite of project concepts that cover a range of maturity. Some projects may be low-maturity, rapid turnaround exploratory endeavors, while some may be higher-maturity, higher cost, higher-impact efforts. The selection of projects to move into Implementation may modulate depending on the capacity and/or number/size/complexity of the Brinson Hub's portfolio of projects at any given time. A review board will identify and recommend concepts to become projects, with the Brinson Hub Director making final selections, and the Oversight Council providing concurrence.

## Maturation

After completion of the Feasibility Assessment process, some concepts may graduate to Implementation, while some may require maturation or be directed to alternate venues. The further maturation of selected concepts may be absorbed by the Brinson Hub on a case-by-case basis. Concepts identified to have potential but lack crucial pieces may be further developed through a Maturation process that evolves their concept and defines next steps. This process will affirm and/or evolve the responses to the Feasibility Form and define the necessary next steps for the concept to continue to either another full Feasibility Assessment phase or an alternate venue for Implementation, or further Maturation. Some areas of maturation that concepts will need to address include technical, partnerships/funding, and schedule approaches. Sufficiently mature concepts may advance directly into Implementation.

## Implementation Phase



*Figure 3: The Brinson Exploration Hub project implementation phase model: A project moves from Merit Assessment (Figure 2) to Feasibility Assessment (Figure 2) to an Implementation Phase. A schematic of the expected implementation phase in a project's life cycle. If at any point in the cycle it is understood that the concept will not converge, it will be off-ramped to alternative pathways and will not move forward in the Brinson Hub.*

Once concepts enter the Implementation Phase, they are a part of the Brinson Hub's portfolio of projects, and the Brinson Hub is committed to executing the concept to fail fast or deploy. Though each project will be different and require flexibility, common features of the Implementation Phase will include an initial review, a self check-in point (dependent on what is appropriate for each individual project), and pre-/post-

expedition activities. Projects will use an iterative process to rapidly and continuously design, build, and test their concept. If at any point in the cycle it is understood that the concept will not converge, it will be off-ramped to alternative pathways and will not move forward in the Brinson Hub.

The initial review is scheduled between the project team, the Brinson Hub Executive Director of Operations, and some combination of advisors (science, technical, business) appointed by the Brinson Hub soon after the Implementation begins. This review kicks off the project and may impose adjustments to schedule, approaches, or team. A future “point-in-time” check-in will be scheduled to allow the team & advisors an opportunity to assess progress in multiple areas of the project and make key decisions about future work. Rather than serving as a gate, the check-in is an opportunity for feedback and discussion with the entire team, advisors, and relevant Brinson Hub personnel. Projects may elect to commit to multiple self check-in dates during the initial review; these should be scheduled at a cadence appropriate to the project.

The Brinson Hub’s process deliberately limits project reviews so the project teams can focus on execution. The iterative process is supported by science, technical, and business advisors leveraged from Caltech and JPL; teams, on both an individual and team level, are encouraged to engage with these advisors directly on an informal and ongoing basis. Projects will often rely on the design-build-and-test philosophy as a key process, where early prototyping and testing may reveal insights (or misunderstandings) faster than analyses. These builds may, for example, come in the form of 3D-printing models, bench testing simple electronics & software, or performing low-cost tests (such as flying a payload on a high-altitude balloon to 100,000 ft before launching it to space). Rapid testing of key parts of the design supports the “fail-fast” mentality of identifying problems early and addressing them.

In the time leading up to deployment, each project team will engage in a short pre-expedition discussion, where they may make final assessments and correct small issues. In the time immediately following deployment, teams will engage in post-expedition reviews where they reflect on successes and failures, and deliver documentation of lessons learned.

Project teams are encouraged to learn from each other, exchange ideas, and engage in regular informal discussions with the Brinson Hub, Caltech, and JPL personnel, as well

as present their experiences and findings to their larger communities in the form of special seminars, talks, and updates. Brinson Hub leadership (including the Oversight Council and Navigation Council) are encouraged to attend the seminars and engage in discussions that keep the Brinson Hub evolving in a productive direction. Additionally, each project will provide at least one campus-wide seminar both on Campus and at JPL, covering project overview, major challenges, unique processes or solutions, results, and lessons-learned. Brinson Hub projects will also participate in the annual JPL research poster fair and hold an open house for the Campus community.

## Partnerships and Funding Model

The Brinson Exploration Hub is designed to provide opportunities to synergize the knowledge and innovation of the Caltech/JPL community with new approaches to exploration. It leverages philanthropic and commercial partners to accelerate impactful science. These partnerships extend to individual projects as well as strategic alliances, among other types of sponsorship or contributions. Partnerships with industry may consist of access to autonomous vehicles, platforms to host payloads, routine access to space, or turn-key services such as integration and test, communications, data acquisition, and operations. Partnerships with other academic or research organizations may entail joint science data processing or take advantage of other facilities.

## Partnership Engagement

The reach of the Brinson Hub's partnerships portfolio will grow through regular interaction with a number of organizations and connection to new and future projects entering the Brinson Hub. General partnership agreements may be maintained or even be elevated above the specific project they initially supported. Some partners may be involved in multiple Brinson Hub projects, and therefore take on more of a strategic nature with the partner having a vested interest in the overall success of the Brinson Hub. Other partnerships may be through general funds, Brinson Hub enhancement, or specific projects. An advocate of a project (scientist/investigator) may initiate a conversation with potential partners, however, they will not be required to have these relationships a priori.

## Partnership Types

The Brinson Hub seeks partners in a number of areas which include:

- *Funding* - Partners could provide funding to either enable the Brinson Hub to advance rapid exploration and scientific endeavors, or to provide directed funding to enable or accelerate specific areas. In the former, partners will provide funds to the Brinson Hub to develop capabilities in hardware, software, or facilities, as well as know-how capability to enable Brinson Hub missions. The funding can also subsidize Brinson Hub projects in specific areas of need. This type of funding could also support student growth and development.
- *Facilities* - Examples include assembly or test facilities such as clean rooms, thermal vacuum & environmental test facilities, electromagnetic interference / compatibility, optical benches, test optics, machine shops, and other advanced manufacturing. Developing exploration systems may require the use of a number of specialized facilities and capabilities. For instance, for space missions, the Brinson Hub will develop partnerships with organizations (governmental, educational and private) to utilize the needed facilities to develop, build, test, and launch missions. This will include partnerships in design, manufacturing, testing, certification, launch, and operations.
- *Services* - Examples include launch, hosting on space assets with available size, weight and power, turn-key services including specific data acquisitions as well as build, build/test services, etc.). Similarly, ocean expeditions have available berths and facilities to accommodate secondary exploration missions, just as rockets may have room for secondary payloads.
- *Hardware* - Examples include spacecraft buses, subsystems, instruments, test equipment, simulation/support equipment, etc. The Brinson Hub will need to develop hardware to accomplish the exploration and scientific discovery missions it takes on. These partnerships could be in the form of acquiring a spacecraft bus from a commercial vendor, or governmental/educational organization. It could also be in the form of acquiring subsystems or instruments, as well as test and simulation equipment to enable the accelerated development of the hardware. An example of this would be to acquire a propulsion subsystem to be integrated into a Brinson Hub-developed spacecraft bus.
- *Software* - Examples include guidance and control software, autonomy, onboard (science) data processing, computational power, test and simulation software,

etc. The exploration systems of today and the future will rely on complex software to accomplish their missions. Software development is a complicated and time consuming process. In an effort to accelerate this development process, the Brinson Hub will develop partnerships to acquire software modules or complete software packages. An example of this type of partnership can be the acquisition of Guidance and Navigation software modules to effect the accelerated development schedule of Brinson Hub missions. The software then would be integrated into the system in collaboration with the provider.

- *Talent* - Examples include interns and advisors. The educational pillar of the Brinson Exploration Hub will be a dimension of partnership. Caltech students may receive internships with government labs or industry partners, working on specific projects that align with their interests and those of the partners. This may result in a regular pipeline of talent and allow Caltech students to receive hands-on practical experience that will benefit Caltech and their individual careers as scientists and engineers.

## Educational Component

At its core, Caltech is an educational institution focused on fundamental research in science, technology, and engineering. JPL brings the added ambition of formulating and implementing missions that others would find nearly impossible to accomplish. As a division of Caltech and NASA's FFRDC, JPL has an recognized interest in education and each year hosts over 800 interns in addition to graduate researchers, postdocs, and visiting faculty. Both institutions educate the next generation of scientists and engineers, as well as expand the experience-base of current personnel. The Brinson Exploration Hub builds on Caltech and JPL traditions of academic excellence, fundamental research, and mission development expertise. Our purpose is to bridge academia, industry, government, and all those with a common goal of driving exploration forward for the benefit of society.

The Brinson Hub will provide a unique training environment realized through its innovative projects, structures, and approaches that provide hands-on learning opportunities for not only early-career scientists and engineers, but experienced scientists, researchers, and engineers engaging in new skills or activities. With multiple projects of different scales and maturity extant at any time, students will be able to participate in multiple phases of implementation and operation. Real problems will



constantly need to be solved, and these can provide the basis for interactive classroom learning modules and an innovative curriculum.

#### Caltech Student Involvement Opportunities

Students will be involved in research projects supported by the Brinson Exploration Hub, as proposed by the Caltech and JPL Co-Leads, who are full-time employees. Students can be a part of a project team, but cannot be a lead. Participation may include academic credit, pay, or course involvement, depending on the student's academic option. Additional opportunities are anticipated, such as:

- Graduate internships at JPL and industry partners, which will be supported by the Brinson Hub or the industry partner to develop student-led exploration-oriented initiatives both related to and independent of projects in development at the Brinson Hub. Internships will follow the existing procedures outlined by the Graduate Studies Office.
- Summer opportunities for undergrad students from campus and other institutions which will be supported by the Brinson Hub in coordination with the campus Student-Faculty Programs Office, initially through SURF, SURF@JPL, and WAVE programs. The Brinson Hub will also work with students to seek out external internships that may be relevant to an ongoing project (e.g., working CubeSat operations at another university lab to fold-in lessons to an ongoing CubeSat project at the Brinson Hub).
- Short workshops that may be sponsored by the Brinson Hub to cover particular areas of interest if they are relevant to multiple projects (e.g., rapid mechanical prototyping, high-altitude ballooning, Low-Earth-Orbit spacecraft operations, etc). These workshops will be restricted to a small number of Brinson Hub-affiliated personnel and students to allow for direct hands-on experience.

An important aspect of the Brinson Hub will be the interaction of students and researchers, not only within a single project, but across all Brinson Hub projects. Regular short seminars will be offered to allow project teams a forum to discuss ongoing challenges within a wider forum of Brinson Hub-affiliated personnel. Broader yet, each project will provide at least one campus-wide seminar both on Campus and at JPL, will participate in the annual JPL research poster fair, and hold an open house for the Campus community.

The Brinson Hub will also serve as a “storefront” on campus for students pursuing JPL and NASA opportunities, serving to connect students to apply for such programs as the NASA Science Mission Design Schools, the Caltech Space Challenge, and other NASA internships. Each Winter term, the Brinson Hub will host an “Opportunities” day to provide seminars on relevant programs, internships, and related items for students to consider for the summer months.

#### Educational Opportunities for JPL

Personnel from JPL participating in the Brinson Hub’s projects may additionally seek to expand their experience-base by auditing relevant campus classes. Personnel may also use Brinson Hub projects to jumpstart other collaborations, such as through JPL-Researchers-On-Campus (JROC), recruitment of SURP students, or President’s and Director’s Research & Development Fund (PDRDF).

#### Curriculum Opportunities

Developments to the curriculum will be intertwined both with the overall exploration goals of the Brinson Hub and with supported projects. There will be a need for both general courses that support the Brinson Hub effort, for example in mission planning and design, and the introduction of new courses, which would educate students in the specialized science and technology needs of the projects.

The Brinson Hub is not an instructional unit within Caltech, but will work with the academic divisions to maintain a list of courses that are relevant to the Brinson Hub and its projects to encourage students to pursue cross-disciplinary opportunities. After successful development and demonstration, the intent is that the Brinson Hub can work with the academic divisions to catalyze new graduate and undergraduate minors in “Exploration Science and Technology,” to be administered by a cross-divisional committee of interested faculty. These new minors would consist of a selection of formal coursework and capstone projects. Students would be exposed to the end-to-end process from development of science requirements to working in mission implementation teams. Courses would be taught by a combination of JPL staff and Caltech faculty. Existing courses that support the goals of the Brinson Hub exploration projects will be discussed for inclusion in the new minors.

# Appendices

## Appendix A: The Pillars of the Brinson Exploration Hub

The fundamental “pillars” that support the strategic vision of the Brinson Exploration Hub are to:

***I. Implement breakthrough exploration projects that drive scientific and societal benefit.***

Projects at the Brinson Hub will test fundamental theories, explore areas few have ever ventured, and demonstrate critical new technologies. Results should be revolutionary and awe-inspiring to both the scientific community and broad society.

***II. Produce a new generation of “space savvy” alumni.***

Education is at the core of our mission, with a thriving community of students, postdocs, and visiting researchers. The Brinson Hub will provide end-to-end hands-on opportunities, producing alumni who have had deep experience with exploration missions.

***III. Execute with speed, agility, and risk tolerance.***

The Brinson Hub projects will be accepting of risk, both in implementation and objective. It is expected that some projects will fail to meet their objectives due to audacious challenges - if everything is successful, the Brinson Hub may not be pushing hard enough at boundaries. A core practice at the Brinson Hub will be to “fail fast” to allow for rapid iteration.

***IV. Seize emerging opportunities in the broader ecosystem of Earth and space exploration.***

The Brinson Hub seeks to embrace and benefit from rapid advancement in technology and novel exploration opportunities driven by the commercial sector. To this end, the Brinson Hub will seek to identify and facilitate non-traditional opportunities for partnership.

***V. Respond to the strategic ambitions of both Caltech and JPL.***

Projects at the Brinson Hub should significantly advance the interests of Caltech, JPL, and society at large. Post-project debriefs will focus on lessons that raise the capability of these institutions.

## Appendix B: Acronyms

HD	Hub Director
HAD	Hub Associate Director (System Engineering)
HED	Hub Executive Director of Operations
EAC	External Advisory Council
OC	Oversight Council
PC	Partnerships Council
IC	Implementation Council
NC	Navigation Council
KISS	Keck Institute for Space Studies
ADSI	Associate Director for Strategic Integration (JPL)
CS	Chief Scientist (JPL)
CT	Chief Technologist (JPL)
SME	Subject-Matter Expert

## Appendix C: Ontology

**Hub Activities:** All initiatives organized by the Brinson Hub, including Exploration Projects, educational endeavors, community-building efforts, etc.

**Hub Exploration Projects:** The highest profile subclass of Brinson Hub Activities, involving significant expeditions or exploration efforts.

**Merit Assessment:** An initial, rapid evaluation process conducted by a review board. This step serves as a preliminary filter and only a select few submissions will advance to the more detailed Feasibility Assessment.

**Feasibility Assessment:** A comprehensive evaluation that examines scientific and technical aspects, engineering, programmatic elements, financial considerations, partnerships, and scheduling. This assessment may be repeated after a Maturation Cycle if necessary.

**Maturation Cycle:** A support period, typically less than one year, before a Hub Exploration Project progresses to the Implementation Phase.

**Implementation Phase:** The phase focused on the construction and deployment of the project.

**Partnerships:** Collaborations with the Brinson Hub involving entities outside of Caltech and JPL on any Hub Activities.