UNP

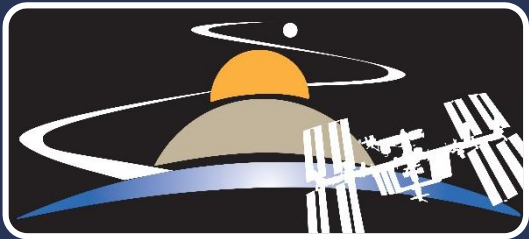# The Manifest and Launch Process

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NASA LAUNCH SERVICES PROGRAM
CSLI
CUBESAT LAUNCH INITIATIVE

Agenda

- Launch manifest process
- Between manifest and delivery
- Delivery and launch
- Design for manifest/launch
  - Available launchers/orbits
  - GSE, inhibits, and other considerations
- University Options
  - The CSLI approach
  - The UNP approach

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Launch Manifest

- Many options
  - Buy your own Launch Vehicle (LV): Costs $50M+
    - **Pros:** Control the schedule and orbital parameters of the launch and better able to negotiate mission unique requirements
    - **Cons:** Expensive
  - Buy your own rideshare slot: Costs $300k+
    - **Pros:** Cheaper price
    - **Cons:** At the mercy of the Launch Vehicle Provider, little pushback available to LV requirements, little to no licensing assistance, no signed ICD with the LV and little insight into their processes, no mission specific requirements including often times orbital parameters
  - Apply to a program (CSLI, UNP, etc.) that takes care of it for you
    - **Pros:** Cover the launch and integration cost (up to a point), better able to negotiate specific requirements, licensing assistance available, signed ICD, more insight into verification and launch vehicle processes
    - **Cons:** You forfeit the ability to say what launch vehicle you want to go on

- University CubeSats
  - Will be rideshare
  - Will almost definitely go through a 3rd party (CSLI, UNP, or others)
  - Will have to accept what you are offered

- Apply to program that provides launches
  - Carefully analyze and understand your request
  - Determine orbit ranges that work and those that don't
    - Understanding the ideal can be helpful, but this should not be all you request
    - Provide acceptable ranges and keep options as open as possible.
    - Be flexible with your orbital parameters
- Get accepted
- Submit all required paperwork promptly
  - Ask questions if you don't understand it
  - Be realistic, not optimistic. Regularly shifting dates due to delays causes confusion and adds difficulty
  - Spacecraft schedule should be neither aspirational nor inspirational

Example: If your ideal orbit is 45° inclination at 500 km but you can accept anything from 400 – 550 km and inclination from 40° -90° you could list in your request:
- Inclination: 45° +45/-5
- Altitude: 500 km +50/-100

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- Manifest program matches launch slots to missions
  - Most LVs have CubeSat availability
  - Some missions are dedicated rideshares
  - U.S. programs (NASA and DoD) almost exclusively use U.S. launch vehicles due to ITAR and Commercial Space Launch Act.
  - All Government programs have access to others
    - CSLI has access to DoD launch slots
    - UNP has access to NASA launch slots, including ISS

- If offered a slot, don't turn down good in hopes of perfect, but…
  - Only accept if timeline is realistic
  - It's better to say no now if you won't make it
    - Nobody will hold it against you if you need more time
    - 6-12 months before launch it will be too late for the slot to be given to a new mission

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Behind the Scenes

- Once accepted, CSLI or UNP will begin meeting with integrator
  - Launch vehicle provider may manage their own CubeSat integration, or pass it off to a 3rd party like Spaceflight, Maverick, or Parsons
  - Integrator holds regular meetings with all satellite teams on the launch starting 1-2 years prior to launch
    - CSLI and UNP attend these meetings on behalf of the missions
    - Experience varies
      - Experienced companies and integrators know what they need ahead of time
      - Launch vehicle startups don't always know what they're doing, and the meetings can be chaotic
      - Provide answers or deliverables promptly as requested
  - Meetings cover topics such as
    - Deliverables needed for range/launch safety
    - Environmental test expectations
    - Delivery and integration schedules to the launch vehicle
    - Satellite needs from the launch vehicle
      - Note this rarely applies to CubeSats

UNP Delivery

- University will deliver satellite to UNP, integrator, or someone else.
  - UNP provides environmental testing before launch
  - CSLI will work with the integrator to help teams find environmental testing options
- CubeSats likely delivered to LV integrator already in deployer
  - CubeSat team will likely not be involved with LV integration directly
  - CubeSat team may not even deliver directly to launch site
  - CubeSat team may sometimes travel to LV integrator site on their own dime, however this is rare.
- Timeline
  - Typically must be delivered to integrator 45-90 days prior to launch
  - UNP requires additional ~3 months for environmental test
- Behind the scenes
  - Integrator and LV provider work together to integrate CubeSat deployers onto rocket
  - Integration meetings during preceding ~12-18 months have worked out
    - Agenda
    - Delivery dates/times
    - Equipment/space needed at launch site for ground tests, GSE, final closeout activities (uncommon for CubeSats)

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Design Considerations

- Be flexible to optimize manifesting options (and reduce launch cost)
  - Be compatible with many dispensers and avoid tabbed designs
    - Comply with the CubeSat Design Specification (CDS) and be able to call out possible exceptions if where you don't
    - Comply with LSP-REQ 317.01 whenever possible
  - Be flexible with orbit requirements
    - Unique orbits drive costs and reduce launch opportunities (i.e. if the bus is going to Pittsburgh it can't take you to Cleveland)
    - Avoid overly congested orbits
- Design for Demise – avoid large pieces of high melting point materials, if unsure ask
- *Choose a UNIQUE name for your CubeSat and BE CONSISTENT! Avoid names that are a single common work ("Chart," "Press," "Hello 5"*
- International Space Station Battery testing is unique and can be a bit of a pain – plan accordingly and talk to NASA LSP early
- Plan ahead for skill and knowledge transfer, you will eventually graduate and move on. Plan for your project to live on without you.

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Design Considerations

- Avoid hazardous materials and systems whenever possible.
  - If needed, communicate early and often with UNP/CSLI about any hazardous materials or "provocative features"
  - UNP requirements exist to help you avoid these

- If your SC can alter its orbit (ex., propulsion system or drag device)
  - Use GPS and reflectors to assist in tracking
  - Consider cybersecurity
  - Don't plan on jettisoning parts on orbit or breaking off into smaller pieces without clearly thinking through how to track

- Design to passivate your SC at end of mission (ex., deplete batteries, disconnect solar panels, vent stored pressure)

- Have a solid RF plan in place as early as possible (type of license(s) needed, frequency flexibility, ground station strategy etc.)

- Think through any sensitives to Helium, humidity, hydrocarbons, magnetic fields and whether you can live with less than perfect

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CSLI Manifesting Approach

1. Submission Process

- NASA releases the CSLI Announcement of Partnership Opportunity

- Eligible Organizations secure spacecraft funding commitment and submit proposals in response
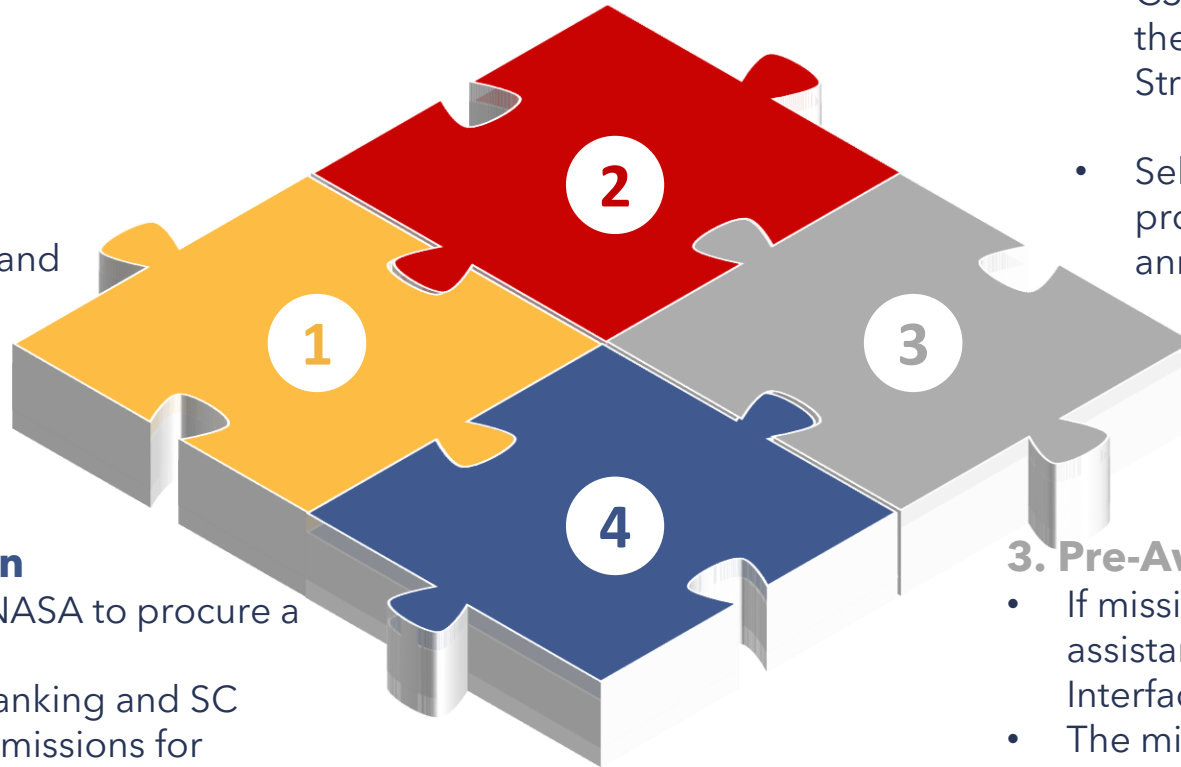
2. Selection Process

- CSLI Board Reviews Proposals and scores them based on alignment with NASA Strategic goals and objectives

- Selection Committee selects missions and provides priority ranking and NASA announces the selectees

4. Manifesting and Integration

- SC team signs agreement with NASA to procure a Launch
- Based on selection committee ranking and SC readiness, NASA CSLI identifies missions for manifesting
- CSLI holds a Pre-Procurement Readiness Review for teams to determine readiness for manifesting and/or launch service procurement

3. Pre-Award*

- If mission passes PPRR, CSLI with SC assistance, CSLI drafts a Launch Services Interface Requirements document
- The mission goes out for Launch Service bid among eligible LV providers
- Mission is Awarded and Integration Telecons begin

Assumes that a US government rideshare opportunity is not available.

CSLI Pre-Procurement Readiness Review

- Prior to going out for Launch Service Procurement, your team will have to successfully pass a Pre-Procurement Readiness Review

- This is to ensure that your team is ready for a launch service, that you will make your launch and that you have the technical ability and knowhow to show up and be ready for integration

- To enter a PPRR a team will have to have shown that they have completed the following steps:
  - Have a SC handover readiness < 24months
  - Submitted a Launch Service Integration Requirements Document Questionnaire to CSLI
  - NASA CSLI has completed the draft LSIRD prior to the PPRR and Shared it with the CubeSat team
  - Signed a Cooperative Research and Development Agreement (CRADA)

- Required Attendees Include:
  - LSP CSLI Mission Managers
  - CubeSat Project and Technical Leads
  - CubeSat Faculty Advisors
  - Additional Student attendance is encouraged.

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Pre-Procurement Readiness Review Components

1 — **Mission Overview**
Brief Explanation of S/C CONOPS and objectives

2 — **CRADA Acknowledgement**
State that you have read the CRADA and understand your obligations if you don't deliver

3 — **Orbital Insertion Requirements**
Identify and justify all constraints and preferences on orbital selection and request

4 — **CubeSat Spec Compliance**
Identify specification document and revision number that SC is designed to. Point out non-compliances

5 — **CubeSat Images/Renderings**
Images detailing S/C Stowed, Operation states, expanded and dimensioned orthogonal views of S/C

6 — **Communications Architecture**
S/C transmitters, receivers and frequencies, ground station receivers and frequencies and identifying any amateur frequencies used.

7 — **Safety and Orbital Debris**
Detail propulsion, high voltage systems, subsystems with stored energy and whether CubeSat power source can be disconnected

8 — **Sensitives**
Identify spacecraft sensitives to helium, humidity, hydrocarbons and cleanliness level

9 — **Project Schedule/Budget**
Project Gantt Chart, with a critical path identified, major risks and schedule margin. Detail Project budget with adequate margin.

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The CSLI Launch Triangle

International Space Station Launches

Utilize the existing Contract mechanisms within the Agency to deploy payloads on the International Space Station and CRS missions

Government Rideshare Launches

Launch via government Rideshare opportunities, utilizing excess launch capability from previously procured launches from other government agencies
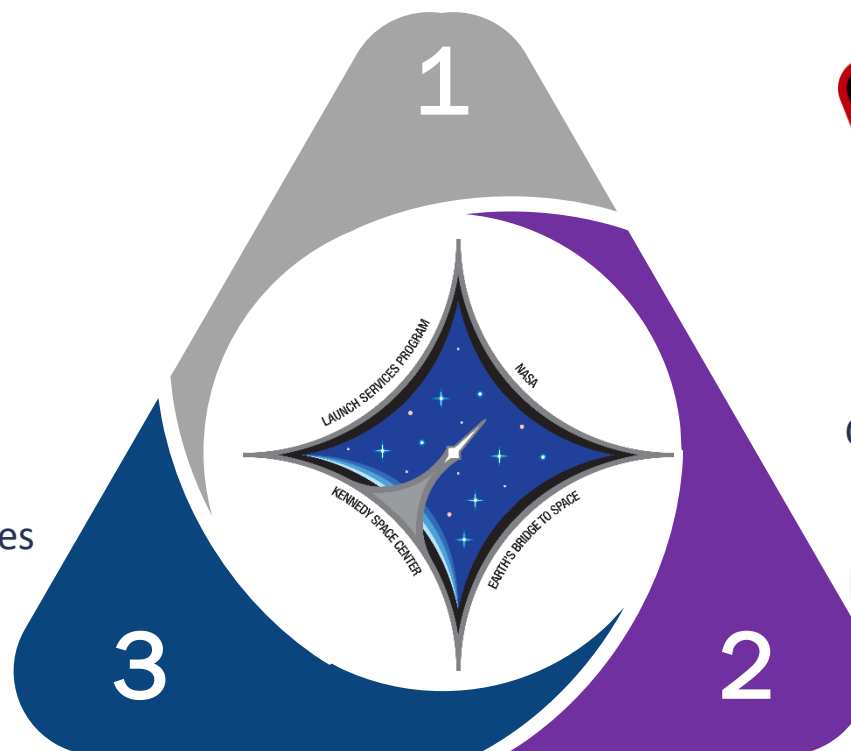
Venture Acquisition Dedicate Rideshare Procured (VADR) Launches

CSLI Aggressively procures missions through the VADR contract, utilizing competition between 13 different launch providers balancing schedule, costs and performance. CubeSat missions launched as rideshares

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CSLI Post Launch Vehicle Award Process

1. Testing and Orbital Debris Compliance Review

Spacecraft must show compliance with all Launch Vehicle, range and orbital debris requirements

2. CubeSat Integrated into Dispenser

CubeSat integrated into dispenser either at LV processing site or shipped integrated to LV.

3. Dispenser is integrated onto the Launch Vehicle

Process will occur at Launch Site, however teams may be able to view.

4. Mission Launches

Plan to attend, on your own dime.

5. CubeSat Deployed

Specified time after launch, signal sent to deployer and CubeSat deployed.

6. Organization operates CubeSat using Ground Station

Using state-vectors provided by LV, organization makes contact with SC.

7. CubeSat completes Mission

Mission complete CubeSat burns up upon reentry.

8. Technical Report Submitted

Organizations analyze data, write technical papers and provide results to NASA

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Launch Services Program (LSP) and CSLI

- LSP finds the ride and sees it through…
  - Serves as technical advisor during CSLI selection process
  - Identifies launch opportunities and manifests CSLI selectees (as ELaNa missions)
  - Implements the business mechanism (contract or agreement with government agency) for that ride
  - Produces Flight Certification Orbital Debris Assessment Report (ODAR) for compliance
  - Delivers launch integration and management insight/oversight through launch
  - Continues to Educate the next generation of CubeSat developers

LSP Manifests Selected CSLI CubeSats → **LSP Initiates and Manages CubeSat Launch Service and Integration Contracts** →

Space Operations Mission Directorate

LSP is the recognized NASA expert for CubeSat launches

- Teams apply, get accepted, and participate in UNP Nanosatellite Cycle Phase A
  - After 2 years, UNP down selects 2-4 for Phase B
- Phase B teams entered in DoD Space Experiments Review Board (SERB) process
- DoD Space Test Program (STP) purchases/finds launches for experimental DoD missions
  - Missions sponsored by U.S. Department of Defense (DoD) entities may participate
    - Missions primarily government owned/developed
    - Range from UNP CubeSats to $300M+ Gov Satellites
  - UNP teams present at Space Experiment Review Boards (SERBs)
    - AFRL, AF, and DoD SERB
    - Missions ranked by flight priority at each SERB level – DoD relevance matters
  - STP matches launch opportunities to satellite needs and timelines
    - In regular contact with UNP to discuss university missions
    - Since UNP missions are CubeSats, they don't need to rank highly to receive launches – most launch vehicles have capacity to add them on
- UNP commits to launch once university passes Pre-Integration Review

Questions?

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