



Designing for Launchability:

Aligning Satellites and Launch Vehicles for Mission Success

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Session: Designing for Launchability – Aligning Satellites and Launch Vehicles for Mission Success

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A B S T R A C T

The success of a space mission depends not only on innovative satellite technology or a powerful rocket—it hinges on the seamless integration between payload and launch vehicle. This paper explores "launchability" from both sides: what satellite developers must consider to ensure successful, cost-effective access to space, and what emerging launch vehicle providers need to understand to design offerings that truly meet customer needs. Drawing on real-world experience and lessons learned from both sides of the integration aisle, this paper offers practical guidance for designing with mutual success in mind.



1. Introduction

Access to space has never been more in-demand, more innovative, or more consequential. The proliferation of small satellites, the emergence of new launch vehicle providers, and the growing global commercial, government, and education institutional demand for specific orbits have created an ecosystem of extraordinary opportunity—and equally significant complexity.

Yet for all this dynamism, a fundamental challenge persists: the gap between how satellites are designed and what launch vehicles actually need—and vice versa. Satellite developers frequently discover late in their programs that their chosen form factor is poorly suited to available launch vehicles, that their loads sensitivities preclude certain options, or that export compliance and logistics add months to their timeline. Launch vehicle providers, meanwhile, sometimes build rockets without fully understanding what their customers need, resulting in offerings that are technically capable but commercially unattractive.

"Launchability" is the discipline of closing this gap. It is a way of thinking—and a way of designing—that considers the satellite-launch vehicle interface as a system, not an afterthought. This whitepaper explores launchability from both sides of that interface, drawing on practical experience supporting missions from 0.25U CubeSats to 700 kg spacecraft across twelve discrete launch vehicles.

Key Insight

Launchability is not a checkbox at the end of a development program. It is a design philosophy that, when adopted early, reduces cost, expands options, and improves the probability of mission and business success.

2. The Launchability Framework

At its core, launchability is defined by the intersection of five dimensions that must be evaluated together, not in isolation:

For Satellite Developers

- Mass and volume optimization
- Structural loads compatibility
- Orbital flexibility and trajectory coverage
- Integration and separation system selection
- Export compliance, insurance, and logistics planning

For Launch Vehicle Providers

- Demand-driven orbit and schedule offerings
- Transparent and competitive pricing
- Generous, usable mass/volume envelopes
- Streamlined campaign timelines
- Customer-centric payload processing

These two sets of considerations are deeply interdependent. A satellite optimized for mass efficiency is only valuable if the launch vehicle's pricing model reflects that optimization. A launch vehicle offering flexible rideshare is only commercially successful if satellite customers can actually integrate into it. Launchability is, ultimately, about designing for the other side of the interface.

3. The Satellite Developer's Perspective

For satellite teams, launchability begins with a straightforward question: can this design be safely launched to the desired orbit, on time and on budget? The answer depends on decisions made throughout the design process - many of which have significant downstream consequences if launchability is not considered from the start.

3.1 Mass and Volume: The Primary Cost Drivers

Launch pricing is ultimately a function of mass and volume, though the relationship is more nuanced than it first appears. A launch vehicle provider is not simply selling kilograms—they are selling a fraction of a fairing volume that happens to have a mass capacity. Satellite developers who understand this distinction can structure their designs to maximize value.

- Design to fairing volume, not just mass budget.
- Minimize protrusions and irregular geometries that reduce stacking efficiency and complicate integration with separation systems.
- Consider stackable form factors where constellation architectures allow - designs that tile efficiently into a fairing maximize the number of payloads a launch vehicle can manifest, which in turn drives down per-unit launch cost.
- Consider allowable volumes of smaller emerging launch vehicles to unlock launch capacity options
- Evaluate structural mass with the same rigor as payload mass—every kilogram of bus structure that is not performing a function is a kilogram of launch cost.

Case Example: Designing for Mass Efficiency

DiskSats offer an innovative example of launchability-first design. DiskSats are designed to be stackable and optimize the use of payload fairing volume.

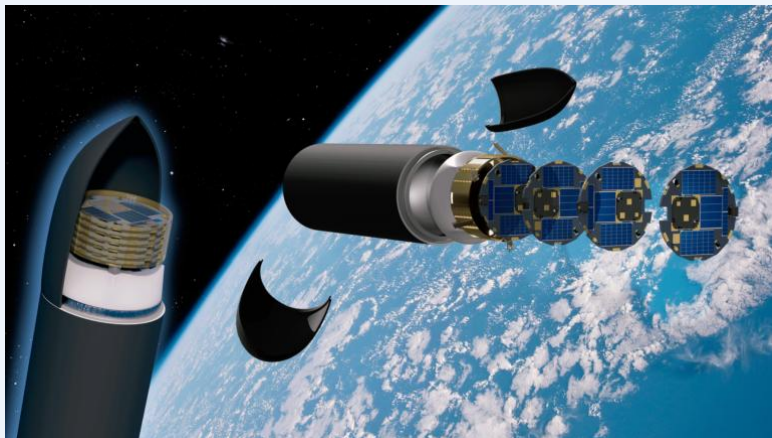
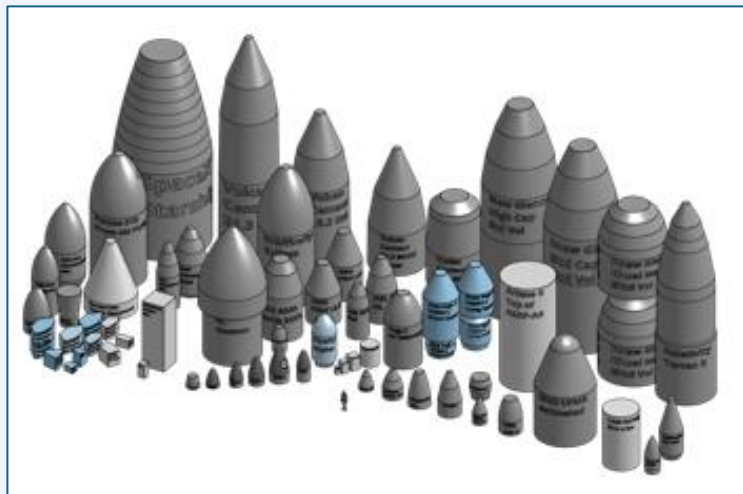
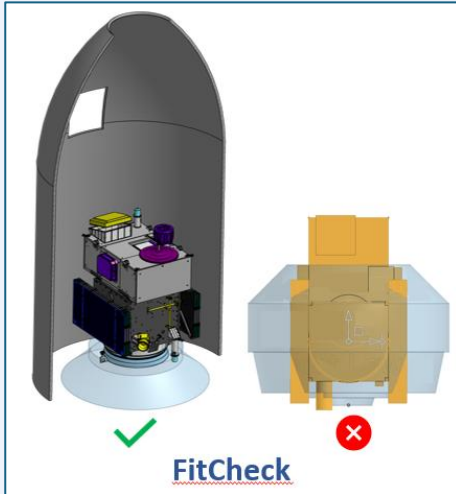


Illustration of DiskSat deployment. Credit: NASA

Example: Assessing Spacecraft Fit within LV Fairing & Payload Adapter Offerings

SpaceLaunch's FitCheck tool verifies which fairings & adapter configurations a spacecraft will fit in and outputs technically viable LV options or identifies where unique orientations or adapters could accommodate the spacecraft geometry. This example shows two outputs from FitCheck showing an example of a compatibility & an incompatibility for a spacecraft.



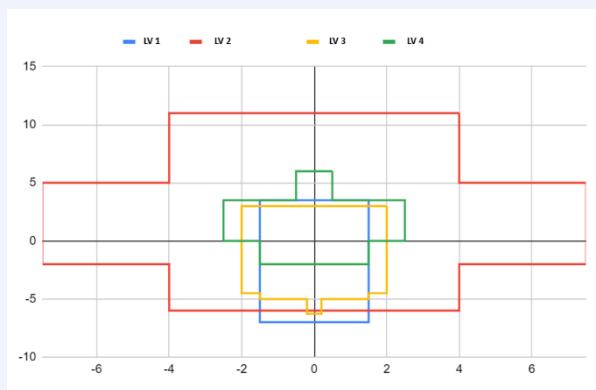
3.2 Structural Loads: The Hidden Compatibility Filter

One of the most common—and most avoidable—late-stage surprises in launch integration is loads incompatibility. Launch vehicles impose quasi-static acceleration loads, sinusoidal vibration, random vibration, shock, and acoustic environments on payloads. Each launch vehicle has a distinct environment profile, and each satellite has different sensitivities.

In practice, loads compatibility eliminates some candidate launch vehicles before cost or schedule are even considered. SpaceLaunch systematically evaluates compatibility across LVs with in-house developed tools that plot the loads environments of all launch vehicles in their portfolio—quasi-static loads, sine vibration, shock levels, acoustic profiles, and fundamental frequency requirements—so that a satellite's sensitivities can be quickly cross-referenced against available options.

Example: Designing for Multiple Launch Vehicle Loads

SpaceLaunch's EnvCheck tool overlay structural loads of multiple launch vehicles, input customer payload structural loads requirements, and output technically viable LV options. This example shows an overlay of quasi-static loads across four different LVs.





When incompatibilities exist, they are not always disqualifying. Options include:

- Test notching
- Structural redesign
- Frequency shifting or stiffness tuning
- Addition of vibration isolation systems between the separation system and the spacecraft
- Negotiating launch conditions (e.g., wind constraints)

The key is identifying these issues early - before the structural design is frozen—when the cost of accommodation is low.

3.3 Orbit Requirements and the "Bus Stop" Problem

Rideshare launch services have democratized access to space for small satellite operators. However, rideshare introduces a fundamental trade-off: the satellite developer surrenders control of orbit and schedule in exchange for a lower sticker price. This trade-off can be described as the "bus stop" problem—the satellite developer gets on the bus and goes where the bus goes, not where they need to go.

The opportunity cost of this trade-off is frequently underestimated. Consider a mission where the desired operational orbit is 550 km, 53° inclination, but the rideshare manifest goes to 500 km Sun-Synchronous Orbit (SSO). The satellite developer now faces:

- Propellant expenditure (and associated mass budget impact) to reach the desired orbit from the drop-off point if the spacecraft has propulsion – typically only a realistic option for minor plane changes.
- Reduced operational lifetime if propellant must be expended for orbit adjustment rather than station-keeping.
- Delay in beginning revenue-generating operations while the spacecraft maneuvers to its operational position.
- In some cases, inability to reach the desired orbit at all if the spacecraft is not propulsive.

When these factors are accounted for, the apparent cost advantage of rideshare can erode significantly. Smaller dedicated launch vehicles—which are emerging in significant numbers—may offer a more cost-effective solution when opportunity cost is properly modeled, even if their per-kilogram pricing appears higher.

3.4 Designing for Multiple Launch Environments

Perhaps the most powerful launchability strategy available to satellite developers is designing for compatibility with multiple launch vehicles from the outset. This launch vehicle-agnostic approach provides several significant benefits:

- Competitive leverage: the ability to solicit bids from multiple providers and choose the most advantageous terms.
- Risk mitigation: the ability to remanifest to an alternative vehicle if the primary vehicle experiences a failure, significant schedule delay, or commercial failure.
- Schedule flexibility: the ability to take advantage of earlier manifest openings on alternative vehicles.



- Constellation scalability: the ability to distribute deployments across multiple vehicles and launch sites to achieve desired orbital plane coverage and launch-risk mitigation.

Achieving launch vehicle agnosticism requires early attention to the broadest common envelope of mass, volume, loads, and interface requirements across the candidate vehicle set. This is a more demanding design challenge, but the commercial and programmatic benefits can justify the investment.

3.5 Separation Systems: An Underappreciated Design Driver

The separation system - the mechanical and electrical interface between the spacecraft and the launch vehicle - is a frequently underappreciated driver of both cost and schedule. Separation system selection should be evaluated against several criteria beyond the obvious technical compatibility:

- Mass: separation systems range from a few hundred grams for CubeSat deployers to several kilograms for larger mechanical systems—mass that comes directly out of the payload allocation.
- Hardware and integration cost: some separation systems require significant non-recurring engineering for custom interfaces.
- Testing requirements: some launch vehicle providers require integrated testing of the separation system and spacecraft prior to launch campaign, driving additional cost, schedule, and technical risk.
- Protrusion compatibility: separation systems that require interface features (mounting flanges, bolt circles, electrical connectors) in specific locations may conflict with preferred spacecraft architecture and integration envelopes.

The selection of a separation system is also a factor in launch vehicle down-selection, since not all separation systems are compatible with all vehicles. Early engagement with candidate separation system suppliers - and with the launch service provider who will be integrating the system - is essential.

3.6 Qualification Strategy: Protoflight vs. Dedicated Qual Model

Satellite developers building single spacecraft or small constellations must make an early decision about qualification strategy: build and test a dedicated qualification model or qualify each flight unit through protoflight testing. This decision has direct implications for launchability.

A dedicated qualification model tested to qualification levels enables acceptance testing of flight units at lower acceptance levels, reducing the structural loads applied to flight hardware. This can increase the population of launch vehicles for which the spacecraft is loads-compatible, since the flight unit has not been subjected to the full qualification environment.

Protoflight qualification, while reducing non-recurring hardware cost, subjects each flight unit to full qualification levels—which may limit compatibility with some launch vehicles whose environments approach or exceed protoflight acceptance levels.

3.7 Export Compliance and Logistics: The Often-Overlooked Timeline Killers

For US-based satellite developers, and for non-US developers working with US-origin technology or launch vehicles, export compliance is a mission-critical planning factor that is systematically underestimated. The International Traffic in Arms Regulations (ITAR) and Export



Administration Regulations (EAR) impose licensing requirements, deemed export controls, and nationality restrictions that can add months to program timelines if not addressed proactively.

- For US customers using foreign launch vehicles, an export license is typically required—and license processing times can range from 30 days to 6 months depending on the destination country, the technology classification of the spacecraft, and the caseload of the licensing authority.
- For non-US customers, working with US-origin launch vehicles or components requires careful classification of all hardware and software to determine whether ITAR or EAR licensing applies.
- Campaign logistics—shipping spacecraft, ground support equipment, and personnel to launch sites in foreign countries—involves additional licensing, hazardous materials handling permits, and customs considerations that must be planned months in advance.

The practical implication is that export compliance should be initiated as soon as the launch capacity contract is signed. Retroactive compliance efforts are costly and disruptive.

3.8 Insurance Costs

While access to space has become more routine in recent years, launch failures do and will still occur. Satellite developers should understand the risks of launch failure, orbital debris, and issues that can occur during transport & integration to both the spacecraft and to GSE. Insurance covering transport, pre-launch, launch, and on-orbit phases should be considered. When to bind an insurance policy can significantly impact the cost. Factors such as LV flight heritage (the number of successful launches, number of consecutive successful launches, first flight items) and if recent failures in the space industry were insured greatly impact insurance pricing.

4. The Launch Vehicle Provider's Perspective

The global launch market has never had more providers, and the competition for customer payloads has never been more intense. Yet some launch vehicle providers - particularly new entrants - may approach market development with a technology-first rather than customer-first orientation. The result is vehicles that are technically impressive but commercially misaligned with what their target customers actually need.

The fundamental reframe required of launch vehicle providers is this: you are not in the rocket business. You are in the payload delivery business. Every design decision - from fairing diameter to pricing structure to payload processing facility layout - should be evaluated through the lens of customer attractiveness.

4.1 The Orbit Portfolio: Serving Demand, Not Capability

The orbits a launch vehicle can access are determined by the laws of orbital mechanics, the location of the launch site, and public safety considerations. But the orbits a launch vehicle should offer are determined by market demand. These are not always the same thing.

The current commercial small satellite market is concentrated in a relatively small number of orbital regimes: 500-600 km SSO, 450-600 km LEO at mid-inclinations (45-55°), and a small but growing segment in Very Low Earth Orbit (VLEO) below 450 km. Launch vehicle providers who



can offer these orbits reliably and on a predictable cadence have a significant commercial advantage over those who offer technically achievable but commercially marginal trajectories.

Launch site selection is a major determinant of orbit accessibility. A vehicle launching from a high-latitude site (such as Andøya in Norway or Saxavord in Scotland) has natural access to SSO and polar orbits but faces inclination constraints for mid-inclination LEO. A vehicle launching from a near-equatorial site has access to low-inclination orbits and GTO, but SSO may require a dog-leg maneuver that penalizes payload capacity. Launch vehicle providers should make explicit, evidence-based choices about which orbits to serve and size their vehicle and launch site accordingly.

4.2 Mass and Volume Envelopes: Generosity as a Competitive Differentiator

The mass and volume envelope offered to customers—the payload fairing diameter, the usable length, and the mass-to-orbit at the target altitude and inclination—is one of the most important commercial specifications a launch vehicle provider publishes. Customers use these parameters to determine whether their spacecraft can physically fit on the vehicle and whether the vehicle can deliver sufficient mass to achieve the desired orbit.

Several principles apply:

- Publish honest, conservative numbers. Customers who design to published performance specifications and later discover that the vehicle cannot meet them are not repeat customers. It is far better to publish conservative specifications and occasionally exceed them than to publish optimistic specifications and fall short.
- Fairing diameter is often the binding constraint, not mass capacity. Many small satellite constellations are volume-limited rather than mass-limited. A vehicle with a larger fairing diameter—even if its mass capacity is similar to a competitor—may be able to manifest significantly more revenue-generating payloads per flight.
- Communicate the full volume envelope clearly. The usable volume within a fairing is not simply a cylinder—it is shaped by the fairing ogive, the payload adapter, the keep-out zones for separation systems, and any constraints imposed by co-manifested payloads. Customers need to understand the actual usable volume, not just the maximum fairing diameter.
- Develop novel, flexible adapters to maximize the use of fairing volume.

4.3 Pricing: Transparency and True Cost of Delivery

Launch vehicle pricing is an area of persistent confusion and frustration for satellite customers. Published per-kilogram pricing is rarely the whole story - it may exclude separation system costs, may assume a specific orbit that is not the customer's desired orbit, come with significant restrictions that add undue burden on the spacecraft manufacturer, and may not reflect the actual negotiated price for a given mission configuration.

New entrant launch vehicles need to be realistic in their pricing. Payload customers will not pay a premium for a ride on a LV that has limited flight heritage.

Launch vehicle providers who offer transparent, predictable pricing - including all-in costs for a defined mission configuration - have a significant commercial advantage. This means:

- Publishing pricing that includes common separation system options, not just the launch vehicle itself



- Clearly communicating how pricing scales with mass, volume, and orbit—including the cost impact of non-standard orbits or dedicated versus rideshare configurations.
- Offering multi-launch agreements with defined pricing for constellation customers—predictable pricing over a multi-year horizon is enormously valuable to operators planning large deployments.
- Being explicit about what is not included - insurance, export compliance support, range fees, launch campaign fees for extended processing time - so that customers can make accurate total cost of ownership comparisons.

4.4 Campaign Timeline: Simplicity as a Feature

The launch campaign - the period from spacecraft delivery to the launch site through launch - is a significant driver of customer cost and risk. Every day spent at the launch site is a day of hotel, travel, and personnel cost for the customer's integration team. Every unexpected delay is a disruption to a customer's production schedule and delays the start of their on-orbit operations.

Launch vehicle providers who invest in streamlining the campaign experience can differentiate themselves meaningfully from those who treat the campaign as an afterthought. Specific areas of focus should include:

- Clearly defined and consistently honored Payload Processing Facility (PPF) access schedules - customers need to know how many days they have for integration, what equipment they can bring, and what facility support (cranes, clean room access, electrical power, hazmat disposal) will be available.
- Well-documented Interface Control Documents (ICDs) that accurately reflect the as-built vehicle configuration - surprises during integration are expensive for both parties.
- A single, experienced customer integration team point of contact who has decision-making authority and can resolve issues without escalation delays.
- A willingness to support the customer with unplanned issues that arise during the launch campaign – offering flexibility with personnel support, PPF access, and tooling access as needed.
- Support of the customer in launch campaign travel planning & local information (recommendations for lodging, food, & activities)

4.5 Building a Customer-Centric Experience

Beyond the technical and commercial specifics, the most durable competitive differentiator for launch vehicle providers is the quality of the customer experience - the ease of working together across the entire mission lifecycle, from initial inquiry through post-launch mission operations.

Every launch vehicle provider and every satellite developer is a unique organization with unique priorities, communication styles, and operational cadences. The providers who invest in deeply understanding their customers - their technical constraints, their schedule pressures, their organizational decision-making processes—build relationships that generate repeat business and referrals in a market where reputation travels quickly.

Practically, this means:

- Early and regular communication with potential customers, including pre-proposal technical exchanges that help customers determine fit before committing to a procurement process.



- Offering flexible contract structures that accommodate the realities of satellite development schedules—including launch slot adjustments, remanifest options, and defined processes for managing customer delays without punitive consequences.
- Providing launch slot availability and pricing information in a format that supports customer business case development—not requiring months of negotiation to get to a number.
- Treating customer payloads as the purpose of the vehicle, not as passengers on a test flight

5. The Global Launch Landscape

The global launch vehicle market has undergone a structural transformation over the past decade. The emergence of numerous new entrant launch vehicle providers—spanning a wide range of payload capacities, launch sites, and target markets—has dramatically expanded the options available to satellite developers while simultaneously complicating the process of selecting the right vehicle for a given mission.

This landscape is evolving rapidly. The next two to three years are likely to see significant changes in which vehicles reach operational status, which achieve commercial viability, and which consolidate or exit the market. Satellite developers building programs with five-to-ten-year launch dependencies should plan for remanifest contingencies.

6. Practical Guidance: Designing for Mutual Success

The following recommendations synthesize the preceding analysis into actionable guidance for both satellite developers and launch vehicle providers.

For Satellite Developers

- **Early action:** Incorporate launchability into your design requirements from PDR onward.
- **Maintain options:** Develop a launch vehicle compatibility matrix early and update it at each major design milestone.
- **Total cost modeling:** Model the full cost of launch options, including opportunity cost of non-optimal orbits, schedule delays, and export compliance timelines.
- **Early engagement:** Engage launch service providers early - before CDR - to identify potential interface issues while they can still be addressed at low cost.
- **Separation system flexibility:** Design separation system interfaces to accommodate multiple separation system types where possible.
- **Export compliance:** Begin export compliance analysis as soon as the launch vehicle is selected.
- **Contract structure:** Negotiate contract terms that include remanifest provisions and defined processes for schedule changes.

For Launch Vehicle Providers

- **Customer-first design:** Design your payload interface and campaign processes around customer needs, not vehicle convenience.



- **Transparent pricing:** Publish conservative, honest, all-in pricing that enables accurate customer business case development.
- **ICD quality:** Invest in the quality and completeness of your Interface Control Documents.
- **Multi-launch agreements:** Offer multi-launch agreements with defined pricing for constellation operators - this creates revenue visibility and customer loyalty.
- **Customer integration team:** Build a dedicated customer integration team with authority to resolve issues in real time.
- **Export compliance fluency:** Understand the export compliance implications of your vehicle and launch site for your target customer base.
- **Remanifest provisions:** Treat remanifest planning as a feature, not a concession - customers who know they have options are more willing to commit.

7. Conclusion

Launchability is not a constraint - it is an opportunity. Satellite developers who design for launchability from the outset have more options, lower costs, and greater resilience to the inevitable uncertainties of launch vehicle development. Launch vehicle providers who build with customer launchability in mind have more attractive offerings, more loyal customers, and a stronger competitive position in an increasingly crowded market.

The path to reliable, affordable, and scalable access to space runs through early alignment between what satellites need and what launch vehicles offer. The organizations that internalize this principle—and design accordingly—will be the ones that succeed in the next era of the space economy.

The fundamental message is simple: design for the interface, not just the mission. Whether you are building a satellite or a rocket, your counterpart on the other side of that interface is your most important customer—and understanding what they need is the most valuable investment you can make.

About the Author

Marcy Mabry is CEO and Co-Founder of SpaceLaunch, providing primary & dedicated launch procurement, mission management, and satellite integration services for payloads that benefit our planet and its inhabitants. She brings a career spanning military aviation, human spaceflight, and commercial launch — beginning as an F-15 avionics technician in the U.S. Air Force, followed by systems engineering on the Space Shuttle program, and as Director of Mission Management at Firefly Space and Spaceflight. She founded SpaceLaunch to bring deep technical expertise and relentless customer focus to every mission.

This whitepaper was developed in conjunction with the SmallSat Europe 2025 presentation "Designing for Launchability: Aligning Satellites and Launch Vehicles for Mission Success." It draws on the SpaceLaunch team's direct experience supporting more than 150 payload launches across 0.25U cubesats to 700 kg spacecraft across 12 discrete launch vehicles, and providing end-to-end mission services, including launch integration, mission management, and launch procurement for Primary & Dedicated missions.