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# Global Satellite Launch Projections & Strategic Intelligence, 2026–2035

Launch cadence, deployment volumes, agency plans, and the structural forces driving the orbital buildout — with bear, base, and bull scenarios through 2035.

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Subject Global Satellite Launch Projections, Agency Plans, and Strategic Trends Through 2035

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Scope NASA, ESA, JAXA, ISRO, China (CNSA/CASC), Russia (Roscosmos), CSA, Australia (ASA), UAE (MBRSC), SpaceX, Amazon Leo, and emerging providers

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## Executive Summary

### The Structural Shift

The global satellite industry is in a structural transformation with no historical precedent. Annual orbital launch cadence has more than tripled since 2019. The cost to reach low Earth orbit has fallen 95% from the Space Shuttle era to Falcon 9 today, and is on a trajectory toward a further 20x reduction if Starship achieves operational maturity. The Goldman Sachs base-case satellite market forecast reaches \$108 billion by 2035. Total tracked objects in orbit could reach 150,000 to 285,000 depending on scenario. The industry that required government monopoly capital for six decades is now driven by commercial programs, defense mandates, and geopolitical competition in roughly equal measure.

### 2025: The Baseline Year

2025 was a record-breaking year across every critical metric. 329 orbital launches (321 successes). 4,517 satellites deployed, a 54–58% jump over 2024. US operators accounted for 178 launches (led by SpaceX at 170); China reached 92. Starlink surpassed 10,000 deployed satellites and 9 million subscribers. SpaceX valuation reached approximately \$800 billion in December 2025. Private space investment across all categories reached an estimated \$30–35 billion globally. ABI Research projects global annual launches to exceed 967 per year by 2035. We anticipate these trends to accelerate through 2026 and over the next decade.

### Five Structural Forces Driving the 2026–2035 Decade

- 1 Launch cost deflation.** Falcon 9 reduced the cost to reach LEO from \$54,500/kg (Space Shuttle) to approximately \$2,720/kg. Starship, if it reaches operational commercial cadence, projects \$80–\$150/kg. Every order-of-magnitude cost reduction historically unlocks a new category of space-based application that was previously uneconomical. The addressable market expands non-linearly as costs fall.
- 2 Defense spending acceleration.** The US Space Force could receive up to \$40.2 billion in FY2026 when base budget and reconciliation spending are combined, a potential 40% year-on-year increase. Germany committed €35 billion to space security through 2030. France added €4.2 billion in new military space

funding. European NATO members spent a combined \$559 billion on defense in 2025. Space has moved from a supporting domain to a warfighting domain in all major military doctrines.

**3 Geopolitical competition.** The US–China satellite race is now a sovereign mandate competition, not merely a commercial one. China’s Five-Year Plan 2026–2030 designates satellite internet and reusable launch as national strategic priorities backed by state capital. ITU orbital slot filings operate on a first-come, first-served basis, meaning the race to deploy is structurally irreversible once begun.

**4 Automation and AI integration.** Starlink’s autonomous collision avoidance system executed 144,404 maneuvers in a single six-month period by late 2025, up from 6,873 in early 2022. At scale, human-in-the-loop satellite operations are physically impossible. The transition to autonomous constellation management, AI-driven Earth observation analytics, and on-board edge computing is already underway and will define operational competitiveness through the decade.

**5 Rendezvous, proximity, and the weaponization of orbit.** In December 2025, a satellite launched from China came within 200 meters of a Starlink satellite with no coordination. Russian ‘inspector’ satellites have conducted repeated unannounced close approaches to Western GEO satellites. The US, France, China, and Russia have all demonstrated or are developing co-orbital anti-satellite capabilities. The governance framework for proximity operations does not yet exist in enforceable form.

## Key Metrics

| METRIC                         | 2025 ACTUAL            | 2035 PROJECTION (BASE CASE)                |
|--------------------------------|------------------------|--|
| Annual global orbital launches | 329                    | ~440–480                                   |
| Satellites deployed (annual)   | ~4,530                 | ~10,000–15,000                             |
| Active satellites in orbit     | ~13,000+               | ~50,000–80,000                             |
| Launch cost per kg to LEO      | ~\$2,720 (Falcon 9)    | ~\$100–\$300 (Starship at scale)           |
| US Space Force budget          | ~\$28.9B (FY2025)      | ~\$35–45B+ (est.)                          |
| Global defense space spending  | ~\$50–60B est.         | ~\$100–130B est.                           |
| Global satellite market size   | ~\$630B (all segments) | ~\$1.1–1.5T (Goldman Sachs/Morgan Stanley) |
| SpaceX valuation               | ~\$800B (Dec 2025)     | \$2–3.5T projected (Starlink IPO)          |

## Definitions & Methodology

**Orbital Launch** — A rocket launch intended to place one or more payloads into Earth orbit or beyond. This analysis uses total orbital launch attempts as the primary metric, consistent with BryceTech and FAA AST standards.

Satellite / Spacecraft — Any human-made object intentionally placed into orbit, including operational spacecraft, demonstrators, hosted payloads, and rideshare spacecraft. Debris is excluded unless noted.

Active Satellites (In Orbit) — Estimated satellites in orbit at year-end, including both operational and non-operational spacecraft not yet reentered. Excludes cataloged debris unless stated.

All figures are order-of-magnitude planning inputs. Differences across sources reflect varying inclusion criteria for small payloads (cubesats, femtosats) and non-operational objects.

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## Scenario Analysis: Bear / Base / Bull

### **Bull Case — Accelerated Deployment (~150,000–285,000 tracked objects by 2035)**

A step-change in launch economics beginning ~2027, driven by Starship commercialization and broader reusable launch adoption. Multiple operators deploy large-scale constellations in parallel; satellite production shifts toward mass manufacturing.

May 2026: Starship V3 Flight 12 succeeds — unlocks V3 Starlink deployment from 2027

H2 2026: Starship cadence reaches 10–12 flights/year; multi-pad ops begin

2027 Q1: Starlink V3 commercial deployment begins (60–100 sats/Starship vs. 25–29/Falcon 9)

2027: China reaches 130+ launches/year; reusable rockets approach Falcon 9 cost parity

2027–2028: Amazon Leo hits 1,600+ satellites; global constellation competition forces rapid densification

2028: Starship reaches 80–100 launches/year; three pads operational; US alone exceeds 275–300 launches/yr

2028–2030: Guowang + Qianfan scale to 3,600 sats/year; ~8,000–10,000 new LEO objects by 2030

2029–2030: Space-based compute and defense constellations add 500–2,000 new deployments/yr

2030–2032: Satellite mass manufacturing at industrial scale; 15,000–20,000 annual deployments globally

2033–2035: Orbital density approaches regulatory ceiling; AI-driven space traffic management commercializes

### **Base Case — Steady Expansion (80,000–124,000 tracked objects by 2035)**

Continued expansion in line with 2023–2025 trajectory. Starship becomes commercially operational 2027–2028, enabling moderate payload capacity increases while Falcon 9 remains near its ceiling. China ramps toward ~130–140 launches annually by late 2020s with constellation deployments lagging targets.

2027–2028: Starlink V3 first Starship deployments; ~20–30 Starship flights in 2027

Late 2020s: China reaches ~120 launches/year; Guowang reaches ~500 sats; Qianfan Phase 1 extends to 2028

2028–2029: SDA Tranche 1–2 fully deployed; government LEO missile-tracking constellation operational

2029–2030: Global annual deployments reach 10,000–15,000 satellites/year

2030–2031: FCC/ITU congestion rules tighten; new entrants face higher regulatory barriers

2031–2033: Chinese reusable rockets reach operational cadence; per-launch costs fall ~30–40%

2033–2035: Constellation replenishment cycles dominate; annual deployments stabilize ~10,000–12,000 sats/yr

### **Bear Case — Constrained Growth (~43,000–50,000 tracked objects by 2035)**

Key constraints — regulatory, technical, and financial — bind earlier than projected. Starship timelines slip, China’s ramp slows, and several constellation programs underdeliver. Annual satellite additions grow only modestly above 2025 levels.

2026 Q3: Starship V3 fails or grounded; Falcon 9 ceiling (~145/yr) becomes binding constraint

2026–2027: Amazon Leo misses FCC deadline; scope reduced; ~15–20 planned launches deferred

2026–2028: FCC/ITU spectrum disputes slow deployment authorizations for non-SpaceX operators

2027: China delivers ~100 launches vs. 140 target; Guowang and Qianfan slip 18–24 months

2027–2028: Major debris-generating collision event triggers 6–12 month launch moratorium in affected bands

2028: Starship commercial cadence plateaus at 20–30 flights/year; FAA infrastructure caps bind

2028–2030: Binding deorbit and licensing rules push undercapitalized operators out of market

2029–2031: 2–3 constellation programs enter bankruptcy or consolidation; annual deployments plateau at 4,000–6,000 sats/yr

2030–2032: ITU dispute resolution overwhelmed; new constellation approvals slow to 12–18 month cycle

2033–2035: Global launches stabilize at 350–400/yr; net annual additions fall to 3,000–5,000/yr

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## **Why We Believe in the Bull Case: A Defense of Accelerated Satellite Growth Through 2035**

The bull case projects 150,000 to 285,000 tracked objects and 5,200 to 5,800 cumulative orbital launches by 2035. This is the logical extension of trends already underway, backed by capital commitments and policy

mandates that are largely irreversible. The bear case requires multiple simultaneous failures across independent programs. The bull case requires only that the current trajectory continues.

#### 1 The infrastructure is already being built

SpaceX is constructing five Starship launch pads. LC-39A targets operational status in late 2026; SLC-37 has an FAA EIS in progress for up to 76 launches per year from a single site. The capital has been spent. Meanwhile, SpaceX's Starlink factory is already producing approximately 50 satellites per week before Starship is even operational. When Starship flies at commercial cadence, carrying 60 to 100 satellites per flight versus 25 to 29 on Falcon 9, manufacturing capacity will be the ceiling, not rocket availability.

#### 2 The replenishment cycle creates a structural demand floor

LEO satellites at 500 km have operational lifetimes of approximately five years. Starlink's 7,000-plus satellites in orbit today already require roughly 1,400 replacements per year just to hold constellation size constant. By the early 2030s, when Starlink, Guowang, Qianfan, and Amazon Leo are collectively fielding 20,000 to 30,000 satellites, replenishment demand alone will sustain bull case launch rates. The floor rises every year regardless of new constellation formation.

#### 3 China's Five-Year Plan is a sovereign mandate, not a market forecast

China's 2026 to 2030 Five-Year Plan designates satellite internet and reusable launch as national strategic priorities, backed by state capital and ITU filing deadlines with real geopolitical consequences if missed. Guowang must have 6,500 satellites in orbit by 2032 to protect its orbital slot filings. China logged 92 launches in 2025 with a stated target of 140 in 2026. Even at 60% execution against stated targets, China alone contributes 80 to 90 launches per year through the decade, additive to every US-originated launch.

#### 4 The competitive dynamic is self-reinforcing

Spectrum and orbital slots are finite and can be permanently lost. ITU rules are first-come, first-served: satellites in orbit protect slots; satellites not yet launched do not. This means slowing down is more costly than accelerating, and neither the US nor China will voluntarily accept that outcome. Both programs are therefore structurally resistant to the commercial hesitation that would produce a bear case.

#### 5 Demand is expanding beyond broadband

The bear and base cases treat broadband as the primary demand driver. Three additional categories are now entering the equation:

Direct-to-device: SpaceX's 650+ DTC satellites require different orbital geometry than broadband, generating incremental demand rather than fleet reuse.

Defense constellations: The SDA's Proliferated Warfighter Space Architecture, Golden Dome, and analogous Chinese military programs are each sized in the hundreds to thousands of satellites, funded through defense appropriations insulated from commercial cycles.

Space-based compute: Orbital data center programs from multiple US and European hyperscalers are not yet included in any mainstream launch forecast, making their eventual inclusion a pure bull case differentiator.

**6 The 2025 baseline already exceeded consensus**

Every major forecast entering 2025 underestimated actual deployment. The year closed at 4,517 satellites deployed (roughly 30% above consensus) and 329 launches (25% above the prior year). The analysts behind the bear and base case ranges used models anchored on pre-2025 data. The bull case is, in important respects, the model that correctly predicted 2025 applied forward.

**7 The downside risks are manageable**

The bear case requires compounding failures across Starship timelines, Chinese execution, collision events, and constellation financing simultaneously. The 2025 Qianfan anomaly illustrates why single failures do not define the trajectory: one program paused for months while the broader market hit a record year. Producing a true bear outcome requires correlated failures across independent programs with separate financing, separate geopolitical imperatives, and separate launch vehicles. That is possible but well outside the base rate expectation.

## Historical Launch Record: 2019–2025

The 2025 actuals provide the definitive baseline for the current era of commercial space, marking a 3.5x increase in annual orbital launches (95 to 329) and a roughly 9x increase in satellites deployed per year.

| YEAR          | TOTAL LAUNCHES | SPACEX | CHINA | RUSSIA | OTHER | SATS DEPLOYED |
|---------------|----------------|--------|-------|--------|-------|---------------|
| 2019          | 95             | 21     | 34    | 25     | 15    | ~490          |
| 2020          | 114            | 26     | 39    | 17     | 32    | ~1,280        |
| 2021          | 146            | 31     | 55    | 9      | 51    | ~1,780        |
| 2022          | 186            | 61     | 64    | 21     | 40    | ~2,470        |
| 2023          | 223            | 98     | 67    | 15     | 43    | ~2,950        |
| 2024          | 262            | 136    | 68    | 17     | 41    | ~2,940        |
| 2025 (Actual) | 329            | 170\*  | 92    | 17     | 50    | ~4,530        |

\\* SpaceX 2025: 165 Falcon 9 + 5 Starship test flights. Sources: Jonathan’s Space Report; BryceTech Year in Review 2025; Payload Space 2025 Recap.

Through April 2026, global launch cadence is tracking above 2025’s record pace. China has signaled a target of up to 140 launches for full-year 2026, driven by Guowang, Qianfan, crewed missions, and lunar programs.

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## Satellite Launch Estimates by Agency: 2026–2035

Figures separate government/science satellites (individually planned, well-documented) from commercial mega-constellations (mass-produced, deployment often behind schedule). Constellation figures are projections based on current launch cadence and stated plans.

| AGENCY / PROGRAM   | EST. SATS 2025-2035  | KEY MISSIONS / PROGRAMS   | BUDGET / INVESTMENT  |
|--------------------|--|---|--|
| NASA               | ~30–40 (science & EO)  | SPHEREx + PUNCH (2025), NISAR (2025), Roman (2026), Artemis Gateway, Europa Clipper, NOAA continuity  | ~\$25B/yr; Roman ~\$4B; NISAR ~\$1.5B (joint w/ ISRO)                                      |
| ESA                | ~40–60 incl. IRIS <sup>2</sup> first batch                       | Biomass/Sentinel suite (2025), FLEX (2026), CO2M x3 (2027), Ariel, Harmony, EnVision, LISA (2035), Galileo 2nd Gen, IRIS <sup>2</sup> (2029+) | ~€10.6B/yr; IRIS <sup>2</sup> €10.6B; Galileo 2nd Gen ~€3B                                 |
| China (CNSA/CASC)  | ~250–350 gov/mil (excl. constellations)                          | Tiangong, Tianwen-2 (2026), Tianwen-3 (2028), crewed lunar (~2030), ILRS base (2035), Gaofen/Yaogan/BeiDou series                             | ~\$15B+/yr est.; Five-Year Plan 2026–2030 prioritizes satellite internet & reusable launch |
| China Guowang      | ~1,300 by 2029; realistic 3,000–6,000 by 2035                    | State broadband LEO constellation (13,000 authorized); 163 sats in orbit Mar 2026; dual-use/military confirmed                                | State-funded (CASIC / China Satellite Network Group)                                       |
| China Qianfan      | Phase 1 ~1,296 (slipping to 2027); realistic 1,500–3,000 by 2035 | Commercial LEO broadband (Sailspace brand); 504 sats Apr 2026; anomaly pause lifted Oct 2025  | Shanghai municipal / CAS backing   |
| ISRO               | ~25–35   | NISAR (2025, joint NASA), Gaganyaan crewed (2026), Chandrayaan-4 (2027), Venus Orbiter (2028), Bharatiya Space Station (~2035)                | ₹13,000 Cr/yr (~\$1.6B); Gaganyaan ₹9,023 Cr; space station ₹20,000 Cr committed           |
| Russia (Roscosmos) | ~50–80 (mostly military)   | Luna-26/27, GLONASS-K2, ROSS station first module (~2030–32), Kosmos recon series   | ~\$3–4B/yr (contracted post-2022); timelines highly uncertain                              |
| JAXA               | ~15–20   | ALOS-4 follow-on, MMX Phobos return (2026 dep.), LiteBIRD (2028), HTV-X to Gateway, QZSS expansion to 11 sats                                 | ~¥350B/yr (~\$2.4B); LiteBIRD ~¥30B; Gateway contribution committed                        |
| CSA                | ~5–8   | RADARSAT follow-on (SAR/Arctic), Canadarm3 for Lunar Gateway, Artemis II (Jeremy Hansen, crewed flyby)  | ~CAD \$750M/yr; CAD \$2.05B committed for Canadarm3/Gateway                                |
| Australia (ASA)    | ~3–6   | CUAVA-2/SmartSat CubeSats (2026), Artemis support (AUD \$150M), Gilmour Space Eris sovereign launch (2030+)                                   | ~AUD \$200M/yr (ASA); Gilmour Space privately funded; growing US Space Force partnerships  |
| UAE (MBRSC)        | ~4–7   | Rashid Rover 2 (2026), Emirates Asteroid Belt Mission (2028), Khalifa Sat successors, EO constellation  | ~AED 22B (~\$6B) committed to 2030   |

Global total context: ABI Research projects global annual launches to exceed 967/year by 2035. Goldman Sachs estimates 70,000+ satellites planned for LEO by 2031. The US (NASA + commercial) and China dominate both volume and investment by a wide margin.

## Key Mission Milestones: 2025–2035

| YEAR           | AGENCY      | MISSION / PROGRAM                  | DETAIL   |
|----------------|-------------|------------------------------------|--|
| 2025<br>(done) | NASA        | SPHEREx + PUNCH                    | All-sky IR survey + solar corona constellation, Mar 2025         |
| 2025<br>(done) | NASA / ISRO | NISAR                              | Dual-SAR EO satellite; \$1.5B joint mission; launched Jul 2025   |
| 2025<br>(done) | ESA         | Biomass, Sentinel-1D/4A/5A/6B      | Forest carbon + Copernicus radar/atmosphere suite; all launched  |
| 2025<br>(done) | China       | 92 orbital launches (record)       | Guowang & Qianfan begin ramping; 92 total Chinese launches       |
| 2025<br>(done) | JAXA        | HTV-X1 test flight to ISS          | Next-gen cargo vehicle first flight; ISS docked                  |
| 2025<br>(done) | ESA         | Galileo sats 33–34 on Ariane 6     | First Galileo launch on Ariane 6, Dec 2025                       |
| 2026           | NASA / CSA  | Artemis II crewed lunar flyby      | Wiseman, Glover, Koch (NASA) + Hansen (CSA) around the Moon      |
| 2026           | NASA        | Nancy Grace Roman Space Telescope  | Wide-field IR; dark energy & exoplanets; launch fall 2026; ~\$4B |
| 2026           | ISRO        | Gaganyaan crewed orbital flight    | India's first crewed mission; ₹9,023 Cr program                  |
| 2026           | China       | Tianwen-2 asteroid mission         | Sample return from asteroid Kamo'oalewa; departs 2026            |
| 2026           | ESA         | FLEX (Earth Explorer 8)            | Chlorophyll fluorescence / vegetation biology mission            |
| 2026           | UAE         | Rashid Rover 2                     | Second Emirati lunar surface rover mission                       |
| 2027           | NASA        | Artemis III — crewed lunar landing | First crewed lunar landing since Apollo 17 (1972); Starship HLS  |
| 2027           | ESA         | CO2M (Sentinel-7) — 3 sats         | Anthropogenic CO <sub>2</sub> monitoring constellation           |
| 2027           | ESA         | Ariel exoplanet telescope          | Atmospheric characterisation of ~1,000 exoplanets; ~€600M        |
| 2027           | ISRO        | Chandrayaan-4                      | Indian lunar sample return mission                               |
| 2027           | China       | Tianwen-3 Mars mission departs     | Mars sample return; departure window 2027–2028                   |
| 2028           | JAXA        | MMX Phobos mission departs         | Martian Moons eXploration; sample return ~2031                   |

|          |                |                                     |   |
|----------|----------------|-------------------------------------|---|
| 2028     | JAXA           | LiteBIRD CMB telescope              | CMB B-mode polarisation; cosmic inflation probe; ~¥30B            |
| 2028     | ISRO           | Venus Orbiter Mission               | Indian Venus atmosphere and surface study                         |
| 2028     | Russia         | Luna-27 south polar lander          | Attempted drill-equipped south polar lander                       |
| 2029     | ESA            | IRIS <sup>2</sup> first launches    | EU 290-sat secure comms constellation begins; €10.6B              |
| 2029     | ESA            | EnVision Venus orbiter departs      | Radar mapper; coordinated with NASA VERITAS                       |
| 2029     | ESA            | Harmony Earth Explorer              | Formation-flying SAR pair for surface deformation measurement     |
| ~2030    | China          | Crewed lunar landing attempt        | CNSA target; may slip to 2032; Long March 10 vehicle              |
| ~2030    | NASA           | Lunar Gateway — PPE + HALO          | International lunar station first elements; Canadarm3 (CSA)       |
| ~2030    | NASA           | Europa Clipper arrives at Jupiter   | Assessing habitability of Europa's subsurface ocean               |
| ~2031    | JAXA           | MMX Phobos samples return           | Sample capsule return from Martian moon Phobos                    |
| ~2032    | JAXA / Artemis | Japanese astronaut on Moon          | Part of Artemis framework; JAXA national target                   |
| ~2035    | ESA            | LISA gravitational wave observatory | 3-spacecraft constellation; 2.5M km separation; ~€2B+             |
| ~2035    | ISRO           | Bharatiya Antariksha Station        | India's national space station first module; ₹20,000 Cr committed |
| ~2035    | China          | ILRS robotic lunar base             | International Lunar Research Station robotic phase (with Russia)  |
| ~2030–32 | Russia         | ROSS first module                   | Russian Orbital Station, planned ISS successor                    |
| ~2040    | ISRO           | Crewed lunar landing                | National target announced by Prime Minister Modi                  |

## Commercial Program Feasibility Assessment (Updated April 2026)

TECH = technical maturity. FIN = financial sustainability. REG = regulatory pathway. HIGH (green) = strong position; MOD-H (blue) = moderately high; MOD (amber) = moderate risk; LOW (red) = significant risk. Changes from prior April 2025 edition noted with ↑/↓.

| PROGRAM / OPERATOR                  | STATUS (APR 2026)                                       | TECH  | FIN   | REG   | KEY UPDATE / RISK NOTE   |
|-------------------------------------|---|-------|-------|-------|--|
| SpaceX Starship / Starlink Gen 3    | 11 flights (6 success); Flt 12 targeting May 2026       | MOD   | HIGH  | MOD   | Block 3 first flight May 2026. LC-39A targeting late 2026. Ship recovery 40% success rate (2 of 5 in 2025). Commercial ops ~2027–2028 earliest.                                      |
| Amazon Leo (7,727 sats)             | 231 prod. satellites in orbit; svc. launch mid-2026     | MOD   | HIGH  | MOD   | FCC July 2026 milestone (1,618 sats) will not be met; extension to 2028 filed. FCC approved 4,500 additional sats Jan 2026. Globalstar acquisition (close 2027). ↓ REG downgraded.   |
| China Guowang (12,992 sats)         | ~163 sats in orbit (Mar 2026); 20 missions              | MOD   | HIGH  | MOD-H | 310 sats planned 2026, 900 in 2027, 3,600/yr from 2028. Manufacturing ramp extreme. Five-Year Plan priority. Dual-use/military confirmed.  |
| China Qianfan (15,000 sats)         | ~504 sats in orbit; anomaly pause lifted Oct 2025       | MOD   | MOD-H | MOD-H | Multi-month suspension 2025 (tumbling satellites). Target 648 sats (original: end-2025) slips to 2027. Sailspace brand active in Asia/Africa/LatAm.                                  |
| Eutelsat / OneWeb (648 LEO + Gen 2) | LEO rev +60% H1 FY2026; French state recap €1.5B        | HIGH  | MOD   | HIGH  | French state now largest shareholder. Gen 2: 440 sats total (€2.56B). ↑ FIN upgraded from LOW. Capacity gap vs. Starlink: ~450x and widening.  |
| Blue Origin New Glenn               | 2 flights 2025; booster recovered NG-2; NG-3 Apr 2026   | MOD-H | HIGH  | HIGH  | Reusability demonstrated NG-2 (Nov 2025). Cadence goal: 8 launches/yr. Block 2 upgrades from NG-3. Amazon Leo purchase commitments. ↑ TECH upgraded.                                 |
| Rocket Lab Neutron (13,000 kg)      | First flight slipped to Q4 2026 after tank test failure | MOD   | MOD-H | HIGH  | Stage 1 tank failure pushed debut from H2 2025. Electron: 21 launches 2025 (record). Backlog \$1.1B; 2026 guidance \$908M. Payload upgraded to 13,000 kg.                            |
| Ariane 6 / ArianeGroup              | Inaugural Jul 2024; ramping toward full cadence 2026    | MOD-H | MOD   | HIGH  | ESA/EU IRIS <sup>2</sup> and institutional mandates underwrite baseline cadence. Price gap vs. Falcon 9 persists; European sovereignty rationale primary. Amazon Leo holds capacity. |
| China Reusable (Zhuque-3, LM-12A)   | Zhuque-3 booster landing failed 2025; LM-12A 2026       | MOD   | MOD-H | HIGH  | Zhuque-3 retry planned. Tianlong-3 (CAS Space) failed Apr 3, 2026. LM-12A demo targeted 2026. National priority in 2026–2030 Five-Year Plan.   |

ANALYST NOTE – AMAZON LEO: THE PROGRAM HAS FALLEN ~1,400 SATELLITES SHORT OF ITS FCC JULY 2026 MILESTONE, IS SEEKING AN EXTENSION TO 2028, AND HAS EXPANDED ITS TOTAL CONSTELLATION AUTHORIZATION TO 7,727 SATELLITES. THE GLOBALSTAR ACQUISITION (PENDING 2027) SIGNALS A HYBRID LEO+SPECTRUM STRATEGY RATHER THAN A LAUNCH RACE. AMAZON LEO WILL BE RELEVANT BUT IS NOT A NEAR-TERM COMPETITIVE THREAT TO STARLINK AT SCALE BEFORE 2028-2029.

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## Systemic Risks & Constraining Factors

### Orbital Congestion — Accelerating

With ~13,000+ active satellites in orbit as of early 2026 (up from ~9,500 in 2024), conjunction frequency has worsened materially:

Qianfan anomaly (2025): Multiple satellites failed to raise orbits and were observed tumbling — the first documented case of a megaconstellation’s deployment anomalies creating measurable cascading debris risk, contributing to a multi-month launch suspension.

Starlink debris event (2025): Starlink-35956 sustained an in-orbit breakup under US Space Command assessment. SpaceX actively lowering some V2 Mini satellites to 450–500 km to accelerate reentry.

ITU orbital slot race: China’s Guowang and Qianfan ITU filings create competing spectrum claims with Starlink and Amazon Leo in shared Ka/Ku bands. Interference disputes likely to require ITU adjudication before 2030.

Total tracked objects (est.): ~25,000–30,000 by early 2026; upper-bound scenarios project 150,000–285,000 by 2035. Kessler cascade risk increases in dense altitude shells above 500 km.

### Financial Sustainability

Eutelsat stabilized: French state €1.5B recap reduces near-term existential risk. However, OneWeb’s capacity is ~0.22% of Starlink’s and falling on a relative basis. The 440-satellite Gen 2 order is insufficient to close the competitive gap within the decade.

Amazon Leo re-phased: FCC extension and Globalstar acquisition indicate a longer-timeline, lower-burn approach. The company has \$10B+ committed but is not in a launch-race posture.

Launch startup attrition: April 2026 Tianlong-3 failure and ABL Space’s 2024 closure reinforce that ~60% of launch vehicle startups fail before commercial viability. The current global cohort of 40+ smallsat/medium launch startups will likely consolidate to 8–12 viable providers by 2030.

### Regulatory Environment

FCC Amazon Leo extension: Pending ruling on Amazon’s request to extend its 1,618-satellite milestone from July 2026 to 2028. Precedent-setting for how regulators accommodate megaconstellation deployment

realities.

FAA Starship EIS: Two separate Environmental Impact Statements underway for LC-39A (44 launches/yr) and SLC-37 (76 launches/yr). SpaceX is constructing infrastructure ahead of regulatory clearance, accepting risk that approvals follow.

China ITU filings: Guowang and Qianfan filings create competing spectrum claims. Absent ITU coordination agreement, interference disputes in LEO could become operationally material by 2028–2030.

FCC/ITU congestion rules expected to tighten 2030–2031: Binding STM protocols will slow approvals above 600 km; new entrants will face higher regulatory barriers and financial assurance requirements.

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## Key Technical Drivers

### Payload Miniaturization

Satellites are becoming smaller and lighter, enabling higher density per launch. The shift from large GEO satellites (5–10 tonnes) to small LEO satellites (100–500 kg) has fundamentally changed constellation economics. This trend underpins the feasibility of 10,000+ satellite constellations.

### Launch Vehicle Advancements & Reusability

Reusable first-stage technology (Falcon 9 proven; New Glenn demonstrated on 2nd flight; Zhuque-3 and LM-12A in development) is reducing per-launch costs. Starship's potential to carry 100+ metric tons to LEO represents a step-change: 60–100 V3 Starlink satellites per flight vs. 25–29 per Falcon 9.

### Satellite Manufacturing Scale

Mass production techniques from automotive and consumer electronics are entering the satellite industry. SpaceX's Starlink factory produces ~50 satellites per week. Chinese operators are investing in comparable facilities. The bottleneck is shifting from production to launch cadence and orbital slot availability.

### On-Orbit Lifetime and Replenishment Cycles

LEO satellites at 340–600 km have operational lifetimes of 2–7 years due to atmospheric drag. At steady state, a 10,000-satellite constellation requires replacing ~2,000–3,000 satellites per year. This replenishment demand increasingly dominates annual deployment figures and creates a durable structural demand floor for launch services.

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## National Program Strategic Updates

### China — Five-Year Plan 2026–2030

China's new Five-Year Plan (2026–2030), published in early 2026, explicitly designates satellite internet and reusable launch vehicles as national strategic priorities:

Guowang and Qianfan will receive state manufacturing and launch subsidies to hit the 2032 ITU orbital slot protection deadline (6,500 satellites for Guowang)

Reusable vehicle development at CALT (Long March 12A), LandSpace (Zhuque-3), and CAS Space receives coordinated national funding

China's target of 140 launches in 2026 represents a strategic acceleration; if sustained, China would be near-peer to the US in raw launch volume by 2028–2029

Tiangong space station continues crewed operations; Chinese crewed lunar landing targeted ~2030 with Long March 10 and next-gen crewed spacecraft

### Europe — IRIS<sup>2</sup> and Sovereign Connectivity

IRIS<sup>2</sup> (Infrastructure for Resilience, Interconnectivity and Security by Satellite) is now formally contracted with the SpaceRISE consortium. The €10.6B program will deploy ~290 satellites (18 MEO, 264 LEO-High, 10 LEO-Low) for EU sovereign secure communications. First launches targeted 2029; full operational capacity 2030.

Copernicus Expansion: CO2M (Sentinel-7), Harmony, FORUM, and Wivern missions extend the world's largest EO program through 2032

Galileo 2nd Generation procurement (~€3B) underway for next-gen PRS-capable navigation constellation

Eutelsat's French state recapitalization links IRIS<sup>2</sup> and OneWeb commercial operations as a hybrid public-private European connectivity strategy

### India — IN-SPACe Ecosystem Growth

India's commercial space liberalization continues to accelerate. NISAR, launched July 2025 as a joint NASA-ISRO mission, is the world's most expensive Earth-imaging satellite at ~\$1.5B. ISRO's LVM3 is transitioning commercial operations to NSIL. India's government target: grow global commercial launch revenue to \$13B by 2033.

### US Commercial Sector — SpaceX, Amazon Leo, Blue Origin, and Beyond

The US commercial space sector is not SpaceX. SpaceX dominates launch cadence (~52% of all global launches in 2025) and is by far the largest single operator, but the broader US commercial ecosystem

represents an additional \$20B+ in annual deployment capital and is growing across multiple independent programs.

#### SpaceX / Starlink

Starlink at scale: 10,000+ satellites in orbit by March 2026; 9 million subscribers by end-2025 (adding ~1M per 7 weeks as of Q4 2025); projected revenue \$11.8B in 2025

SpaceX valuation reached ~\$800B in December 2025 (secondary sale at \$421/share), up from \$350B in December 2024; Starlink IPO widely expected 2026–2027

Falcon 9 at practical ceiling of ~165 flights/yr; all further US launch growth is gated on Starship. Five pads under construction (2 Starbase, 1 LC-39A, 2 SLC-37); LC-39A targeting late 2026

Direct-to-Cell: 650+ DTC satellites launched within 18 months; T-Mobile, Rogers, and Optus partnerships active; DTC structurally expands Starlink TAM beyond fixed broadband

#### Amazon Leo (formerly Project Kuiper)

Total program investment estimated \$16–20B across constellation manufacturing, ground infrastructure, and launch contracts (Bank of America / Quilty Space estimates, 2024–2025)

Launch contracts: 92 rockets procured from ULA (38 Vulcan), Arianespace (18 Ariane 6), Blue Origin (12+ New Glenn), and SpaceX (Falcon 9) — the largest commercial launch procurement in history, with contracts valued at approximately \$10.4B to Blue Origin and Arianespace combined

231 production satellites in orbit as of April 2026; factory in Kirkland, WA producing ~5 satellites/day; 80+ planned launches 2025–2028

FCC July 2026 milestone (1,618 sats) will not be met; extension to 2028 filed. FCC separately approved expansion to 7,727 total authorized satellites in January 2026

Verizon, Vodafone, and NTT partnerships secured for distribution; enterprise beta launched November 2025; JetBlue in-flight Wi-Fi deal signed

Acquisition of Globalstar (deal to close 2027) signals a hybrid LEO+spectrum strategy extending beyond pure constellation buildout

#### Blue Origin

New Glenn achieved first orbital success (NG-1, January 2025); booster recovery demonstrated on NG-2 (November 2025); NG-3 targeting April 2026 with Block 2 upgrades

Jeff Bezos has invested approximately \$10B personally to date; cadence goal of 8 flights/year by 2027. Amazon Leo purchase commitments provide baseline revenue

BE-4 engine (also used on ULA Vulcan) is a critical piece of US launch infrastructure; Blue Origin controls engine supply for two major rocket programs

Lunar ambitions: Blue Moon lander under NASA contract for Artemis lunar surface delivery; New Glenn targeting national security launch certification 2026

#### Rocket Lab

21 Electron launches in 2025 (100% success rate, company record); \$1.1B backlog; 2026 revenue guidance \$908M. Stock +522% in the 12 months to early 2026

Neutron (13,000 kg reusable medium-lift) first launch slipped to Q4 2026 after Stage 1 tank test failure; payload capacity upgraded from 8,000 kg to 13,000 kg

Spacecraft manufacturing division growing: supplied spacecraft buses for multiple NASA and national security missions; diversifying beyond pure launch

#### AST SpaceMobile

Direct-to-standard-smartphone satellite connectivity via large-aperture BlueBird satellites; partnerships with AT&T, Verizon, Vodafone, and 45+ carriers globally

First commercial BlueBird satellites demonstrated calls from unmodified smartphones in 2024; constellation buildout accelerating through 2025–2026

Market cap reached ~\$7.5B by early 2026; represents a structurally different revenue model (wholesale to carriers) vs. Starlink (direct consumer)

#### Other notable US commercial operators

Planet Labs (PL): 200+ satellites, daily global imagery; revenue ~\$244M FY2025; primary EO data provider to US government and commercial customers

Intuitive Machines (LUNR): NASA CLPS contractor for lunar surface delivery; stock +798% in 2025 on mission success and contract momentum

Axiom Space / Vast: building the first commercial space station modules; Vast's Haven-1 targeting ISS-compatible docking in 2026; Sierra Space also developing orbital platform

Astranis: GEO broadband microsats; raised \$200M in 2024; signed deals across Latin America and Southeast Asia

Voyager Technologies: defense space infrastructure; IPO filed confidentially at \$2–3B valuation 2025; integrating multiple space-adjacent defense capabilities

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## Launch Cost Trends and Economic Implications

The cost to reach low Earth orbit is the single most important economic variable in the space industry. Its trajectory has been the primary cause of every structural change in the industry over the past decade, and its

continued decline is the central assumption underlying the bull case.

## The Historical Cost Curve

The NASA Space Shuttle operated at approximately \$54,500 per kilogram to LEO, making space the exclusive domain of governments and the largest commercial operators. Early commercial vehicles brought this to roughly \$10,000–12,000/kg through the 1990s and 2000s through efficiency improvements rather than architectural change. SpaceX's Falcon 9 with a reusable first stage, first achieved in December 2015, was the inflection point. Reusability, combined with high launch cadence and streamlined manufacturing, drove the cost per kilogram to LEO below \$3,000 — a roughly 95% reduction from the Space Shuttle era.

## The Starship Step-Change

Starship represents a potential second inflection point of comparable magnitude to Falcon 9. Designed for full reusability of both stages, it targets 100–150 metric tons to LEO per flight versus Falcon 9's 22.8 tons. Cost projections: single-use at approximately \$1,200/kg; partial reusability (6 flights) at \$80–\$95/kg; high reusability (20–70 flights) at \$13–\$32/kg. SpaceX's stated target is under \$100/kg to LEO by 2030. Euroconsult projects a 70% reduction from Falcon 9's current \$2,720/kg within the Starship commercial era.

Single-use Starship: ~\$1,200/kg at \$180M per launch for a 150-ton payload

Partial reusability (6 flights): ~\$80–\$95/kg (Netizen/Anser Press analysis, 2025–2026)

High reusability (20–70 flights): projected \$13–\$32/kg

Aspirational marginal cost (full reuse, high cadence): \$10–\$20/kg

## Market Expansion: Each Cost Tier Unlocks New Applications

Every order-of-magnitude reduction in launch cost historically unlocks a new tier of applications that were previously uneconomical:

At \$54,500/kg: only government science missions and large GEO comms satellites viable. TAM effectively sovereign.

At \$10,000/kg: commercial GEO broadband, weather, GPS. Market grew to ~\$5–10B annually.

At \$2,720/kg (Falcon 9 today): mega-constellations viable for the first time. Starlink at 10,000+ satellites was impossible at 2010 prices. Annual satellite deployments reached 4,530 in 2025.

At \$500–\$1,500/kg (Starship initial): large-aperture EO, LEO manufacturing, commercial stations, orbital compute enter the economic frontier.

At \$100/kg (Starship mature): space-based solar power, large-scale in-orbit assembly, mass prospecting, routine human spaceflight become evaluable.

The current investment wave in defense constellations, space-based compute, and orbital servicing is pricing in the Starship cost trajectory, not today's Falcon 9 costs. Companies building for a \$2,720/kg world will find their economics materially changed when per-kg cost falls below \$500.

## Competitive Pricing Landscape (2026)

Falcon 9: ~\$2,720/kg. 165 flights in 2025; approaching practical ceiling of ~165–175 flights/yr.

Falcon Heavy: ~\$1,400/kg for heavy payloads.

New Glenn: ~\$1,600–\$2,200/kg est. at \$70–\$100M per launch for 45-ton LEO payload. Second credible US provider.

Ariane 6: ~\$4,000–\$5,000/kg est. Price gap vs. Falcon 9 persists; European sovereign mandate provides baseline demand.

Rocket Lab Neutron: ~\$3,000–\$5,000/kg est. Targeting medium-lift responsiveness and vertical integration.

Chinese reusables (Zhuque-3, LM-12A): reaching for Falcon 9 cost parity by 2028–2030. If achieved, removes US cost advantage.

## Structural Implications for Satellite Economics

Shorter design lifetimes become rational: at \$100/kg, replacing a lighter satellite every 5 years with technology refreshes is more attractive than a 15-year design life at high upfront cost. This creates structural ongoing demand.

Mass production economics: satellite manufacturing cost fell ~40% to under \$0.8M per unit from 2018 to 2024 (BryceTech). Further deflation expected. At high volumes, satellite manufacturing resembles automotive production.

New entrants become viable: programs requiring 500 small satellites can be funded and launched at costs accessible to mid-market companies and national agencies previously priced out.

Fixed costs become proportionally larger: as launch costs fall, regulatory compliance, spectrum coordination, and insurance premiums become a larger fraction of mission cost — a moat for established operators with existing authorizations.

Left: Launch cost per kg to LEO 1981–2035. Shuttle era \$54,500/kg; Falcon 9 \$2,720/kg; Starship projected \$80–\$150/kg at maturity. Right: Estimated addressable market at each cost tier. Lower launch costs unlock new application categories non-linearly. Sources: NASA, SpaceX, Euroconsult, BryceTech, Netizen, Anser Press (April 2026).

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## Defense Industry: Funding, Programs, and the Militarization of Space

Space has ceased to be a sanctuary domain. It is now an explicitly contested warfighting environment in the doctrines of all major powers. The US Space Force is on a trajectory to receive approximately \$40 billion in combined FY2026 funding. European nations have committed over €95 billion in space investment by 2030. China's military space budget is growing at rates consistent with its broader defense posture. For the satellite industry, defense is no longer a niche procurement channel — it is one of the two or three primary demand drivers for the decade.

### United States: Space Force and Golden Dome

FY2025 enacted: approximately \$28.9 billion for the Space Force

FY2026 presidential request: \$26.3 billion base (9% reduction in discretionary spending)

FY2026 with reconciliation (One Big Beautiful Bill Act): up to \$40.2 billion — a 40% year-on-year increase. The Aerospace Corporation characterized Golden Dome as the central story of the FY2026 defense space budget.

Reconciliation breakdown: \$7.7B for Long Range Kill Chains, \$5.6B for space-based interceptors, \$7.2B for space-based sensors, \$2B for airborne targeting satellites, \$13.8B broadly for Golden Dome missile defense architecture

Space Development Agency (SDA): PWSA creates a multi-vendor proliferated LEO constellation for missile tracking and data transport procured in iterative tranches. Congress added \$50M above the administration's request, reflecting strong bipartisan support.

Gen. Saltzman (Chief of Space Operations): Space Force will put 300 additional satellites into orbit within two years. Primary concern is China's "kill web" designed to track and target US satellites. Space Force is explicitly shifting from large exquisite satellites to smaller proliferated architectures.

### Europe: From Dependency to Strategic Autonomy

Germany: €35B (\$41B) committed for space security 2026–2030. First National Security Space Strategy published November 2025. OHB, Airbus, and Rheinmetall building national military satellite network. Total defense spending grew 24% to \$114B in 2025, exceeding 2% of GDP for first time since 1990 (SIPRI).

France: €4.2B (\$4.9B) in new military space funding for 2026–2030 (Macron, November 2025). TOUTATIS maneuverable counter-space microsatellites (LEO), YODA patrol nanosatellites (GEO), FLAMHE on-board laser blinding capabilities all active. France–Germany JEWEL initiative launched for joint early warning.

EU-wide: at least €95.46 billion in space capabilities committed by 2030 across EU member states. European Defense Fund 2025 includes €66M for a new LEO ISR constellation. EU Space Shield flagship initiative

launched in 2026.

NATO context: Hague Summit (June 2025) set new 3.5% of GDP defense spending benchmark. McKinsey estimates this could lift European defense spending toward €800B by 2030. European defense tech VC grew from €200M in 2021 to €2.6B in 2025.

## **China and Russia: Adversarial Programs**

China DA-ASAT: kinetic ASAT demonstrated 2007, generating 3,000+ trackable debris objects. Additional DA-ASAT systems presumed operational. Active co-orbital programs documented by CSIS and SWF.

China co-orbital: satellites capable of maneuvering alongside others for inspection, jamming, or physical interference. Chinese satellite came within 200m of Starlink with no coordination (December 2025). Mid-2024 approach to within 1km of Indian military mapping satellite described by India as an aggressive capability test.

Russia Luch / Burevestnik: Russian inspector satellites conducting repeated unexplained close approaches to Western GEO satellites for over a decade. Burevestnik assessed by CSIS/SWF as likely co-orbital ASAT architecture. Russia conducted destructive DA-ASAT test November 2021, generating 1,500+ trackable debris objects.

## **The Commercial-Defense Interface**

Commercial imagery as intelligence: Planet Labs, BlackSky, Satellopic, and Maxar supply real-time imagery used operationally in Ukraine. Space Force TacSRT program (\$30M in FY2026) formalizes this commercial intelligence channel.

Starlink in warfare: operationally used in Ukraine for military communications, drone coordination, and infantry. Demonstrated both military utility of commercial LEO and the geopolitical leverage of the operator. Elon Musk's personal coverage decisions were operationally consequential in a hot conflict.

Dual-use vulnerability: every proliferated LEO constellation with military connectivity capability is a potential target. A conflict beginning on the ground will almost immediately extend to space. This is the primary driver of European interest in IRIS<sup>2</sup> sovereign connectivity independent of US commercial infrastructure.

## **The Militarization of Space: Structural Implications**

Macron (November 2025): "Space is no longer a sanctuary. It has become a battlefield. Today's war is already being fought in space, and tomorrow's war will begin in space."

Targeting risk premium: satellites in the 500–600 km shell are explicitly threatened by co-orbital ASAT, direct-ascent weapons, and electronic warfare. Insurance and hardening costs that did not exist in the pre-2020 era are now emerging in operator economics.

Resilience architecture demand: proliferated smaller satellites are harder to target than single exquisite assets. This doctrinal shift by the Space Force creates structural demand for high-volume small satellite manufacturing and launch.

Escalation risk: absence of binding norms for satellite interference means that kinetic or electronic attacks on commercial infrastructure could escalate without an agreed response ladder. This is the defining governance failure of the current period.

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## **Automation, AI, and the Transformation of Space Operations**

The operational complexity of running a 10,000-satellite constellation at human scale is physically impossible. Starlink's autonomous collision avoidance system executed 144,404 avoidance maneuvers in the six months to May 2025, up from 6,873 in the same period of 2022 — a 21x increase in three years, with no proportional increase in human operators. AI is not an emerging technology in satellite operations; it is already the only viable operating model for mega-constellations.

### **Collision Avoidance: The Forcing Function**

The 2019 near-collision between ESA's Aeolus satellite and Starlink 44 was the catalyst. A bug in SpaceX's manual paging system prevented alerts from reaching operators, forcing ESA to execute avoidance maneuvers via email. SpaceX's current autonomous system operates at a 1-in-1,000,000 collision probability threshold — 100 times stricter than the industry standard of 1 in 10,000. Each Starlink satellite uses krypton ion propulsion for autonomous thruster burns, averaging 14 firings per satellite per six-month period. Zero on-orbit collisions to date despite operating the world's largest constellation.

### **On-Board AI and Edge Computing**

Planet Labs (April 2025): announced integration of Nvidia Jetson-2 on-board processing for in-space image analysis. Cuts time from image capture to intelligence product from hours to minutes.

Bandwidth efficiency: transmitting compressed analytical outputs rather than raw imagery reduces downlink bandwidth requirements by orders of magnitude.

Autonomous tasking: constellations with on-board AI can adapt tasking priorities in real time based on weather, change detection, or surge events without ground intervention per satellite.

### **AI in Manufacturing**

SpaceX Starlink factory: ~50 satellites per week using automotive-scale manufacturing automation. Bottleneck is now launch cadence, not production capacity.

Amazon Leo Kirkland facility: peak production of 5 satellites per day (late 2025), ~1,800/year, using automation that compressed build cycles from months to days.

AI-driven testing: ML models trained on satellite telemetry reduce anomaly diagnosis from days to hours and predict failures before occurrence, reducing on-orbit loss rates.

## **Autonomous Space Traffic Management**

Ground-based STM is becoming computationally infeasible as the primary coordination mechanism. The industry is transitioning toward autonomous on-board conjunction assessment, distributed satellite-to-satellite coordination protocols (CONFERS), and AI-enhanced SSA. SpaceX processes 150,000+ conjunction screening events daily. The US Space Force's Space Fence radar generates millions of observations per day through AI-assisted cataloging.

## **Implications for Portfolio Companies**

Operators without autonomous collision avoidance face regulatory and insurance liability as density increases. FCC and ESA are likely to mandate autonomous avoidance for new constellation authorizations within this decade.

Ground operations efficiency: AI-driven fleet management enables operating thousands of satellites with headcounts an order of magnitude smaller than legacy architectures — a structural cost advantage that compounds over time.

EO intelligence products command higher ARPU: the value in Earth observation is the analytical output, not the raw image. On-board or near-real-time AI processing pipelines are becoming a market requirement.

On-board AI as defense discriminator: US defense procurement is increasingly specifying on-board processing for satellite intelligence programs. Commercially qualified on-board AI positions companies for defense contracts inaccessible to non-AI manufacturers.

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## **Data Centers, Energy Infrastructure, and the Role of Space**

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### **The Convergence Problem**

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**The AI computing boom and the satellite industry are colliding with the same constraint: energy. Global data center power consumption reached**

approximately 415 terawatt-hours in 2024 and is projected to more than double by 2030, driven by the compute demands of large language models and inference infrastructure. Terrestrial power grids in the US, Europe, and Asia are running at or near capacity in the regions where data center demand is highest. New grid interconnection queues in the US now stretch 5 to 7 years. The result is a structural mismatch between where compute needs to be and where power is available — and that mismatch is creating genuine institutional interest in space-based solutions that would have been dismissed as speculative a decade ago. The enabling variable in almost every case is the Starship launch cost trajectory. Neither space-based solar nor orbital compute becomes commercially viable at Falcon 9-era pricing. Both become evaluable below \$500/kg.

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## Space-Based Solar Power

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Space-based solar power (SBSP) places solar arrays in geostationary orbit where they receive sunlight 24 hours a day, uninterrupted by weather or the day-night cycle, then transmit that energy to ground receivers via microwave or laser. A GEO solar array receives approximately 8 times more energy per unit area than a comparable ground installation at mid-latitudes, and the output is effectively

**baseload rather than intermittent — a fundamental economic advantage over terrestrial solar.**

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**The major national programs are further along than most investors appreciate. The UK Space Energy Initiative has published roadmaps targeting a demonstration system in the early 2030s and a 2 gigawatt pilot plant by approximately 2040, with an estimated development cost of £16 billion. ESA's SOLARIS initiative is actively funding photovoltaic efficiency, wireless power transmission, and in-orbit assembly technologies. China's Chongqing Bishan program has built a ground test facility and is targeting a 10-megawatt orbital demonstration by 2030, with a gigawatt-scale system by 2049. The US Naval Research Laboratory successfully demonstrated wireless power transmission at relevant distances in 2023, and the Department of Defense has ongoing funding interest given SBSP's potential to eliminate fuel supply chain vulnerability at forward operating bases.**

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**The binding constraint is launch cost. A 2022 ESA analysis estimated SBSP reaches cost parity with nuclear baseload power at launch costs below approximately \$500/kg — within Starship's mid-range projection range. The secondary constraint is in-orbit assembly: a commercially viable SBSP installation requires structures measured in square kilometers, beyond any single launch. Virtus Solis, Rebeam, and several ESA-funded consortia are actively developing the modular assembly and wireless power transmission technologies to bridge this gap. The**

**development community is explicitly timing commercial roadmaps around Starship.**

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## **Orbital Data Centers**

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**The orbital data center concept is attracting serious early-stage capital, driven by the convergence of AI compute demand, terrestrial energy constraints, and the approaching Starship cost inflection. The engineering rationale is straightforward: orbit offers free thermal management and favorable latency geometry for certain workloads. But the investment activity is what makes this a near-term watch item rather than a long-run thesis.**

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**Lumen Orbit raised \$11 million in seed funding in 2025 and is targeting a demonstration GPU satellite by 2026. Starcloud is developing an orbital AI inference platform with backing from semiconductor supply chain partners. Microsoft, Google, and AWS have all filed patents or made early investments related to orbital computing infrastructure — notable given that the same three entities are simultaneously the largest commercial satellite customers and the operators most acutely affected by terrestrial data center energy constraints. The strategic alignment between their power problem and their existing space investments is not coincidental,**

**and the direction of travel suggests larger commitments as demonstration missions validate the core architecture.**

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**The broader capital context is significant. Global data center infrastructure investment reached approximately \$400 billion in 2024 and is projected to exceed \$1 trillion cumulatively by 2030. Orbital compute is currently capturing a fraction of a percent of that flow, but the absolute dollar figures at even modest penetration are material. If orbital data centers capture 1 to 2 percent of planned data center build-out by 2035, that represents \$10 to \$20 billion in deployment capital — comparable in scale to the Amazon Leo constellation program.**

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## **Rendezvous and Proximity Operations: Strategic Implications and Investment Risks**

Rendezvous and Proximity Operations (RPO) describe maneuvers in which two spacecraft intentionally approach each other in orbit. The enabling technologies — precise propulsion, relative navigation sensors, autonomous guidance, and docking mechanisms — are equally applicable to commercial satellite servicing and to intelligence gathering, electronic warfare, and co-orbital anti-satellite attack. This dual-use character makes RPO one of the most strategically complex and legally ungoverned activities currently occurring in orbit.

### **Commercial Case: Servicing, Life Extension, and Debris Removal**

Life extension: Northrop Grumman MEV-1 and MEV-2 are operational, extending Intelsat GEO satellite lives. Extending a GEO satellite by 5–10 years defers a \$300–\$500M replacement cost. Servicing mission cost: \$50–\$100M. Compelling economics that grow as launch costs fall.

Refueling: Orbit Fab developing in-orbit propellant depots and RAFTI standard refueling interfaces. US Space Force has funded early demonstrations. Commercial refueling targeting operational status 2030–2032 would fundamentally change satellite lifecycle economics.

Active debris removal: ClearSpace (ESA-funded, targeting 2026 first mission) and Astroscale developing capture vehicles for defunct satellites and rocket bodies. Market nascent but regulatory incentive building.

In-orbit assembly: DARPA RSGS and commercial successors targeting large structure assembly and repair of satellites not designed for servicing.

## **Military and Intelligence Dimension**

US GSSAP: over 20 known proximity approaches to GEO satellites, including within 10–15 km. Victus Haze program (operational late 2025) advances rapid-deployment maneuverable RPO. SWF Fact Sheet finds no evidence US RPO missions have been used offensively.

Russia Luch: repeated unexplained close approaches to Western GEO satellites for over a decade. Burevestnik system assessed by CSIS/SWF as likely co-orbital ASAT architecture.

China: satellite came within 200m of Starlink with no coordination (December 2025). Satellite moved to within 1km of Indian military mapping satellite in mid-2024; India characterized this as an aggressive capability test.

France TOUTATIS/YODA: maneuverable counter-space microsats for LEO and GEO. Joint RPO exercise with US under Operation Olympic Defender (December 2025).

## **The Governance Vacuum**

The core governance problem is verification of intent. When a satellite maneuvers to within 200 meters of another satellite, the approaching operator knows the intent; the target does not. There are currently no binding international norms governing minimum approach distances, no mandatory notification requirements for proximity approaches, no agreed escalation ladder for uninvited close approaches, and no ITU or UN mechanism to authorize or prohibit RPO. COPUOS has been discussing RPO norms for over a decade without producing binding rules.

## **Operational and Investment Implications**

Insurance pricing: absence of governance creates actuarial uncertainty. GEO satellites as high-value fixed assets in predictable orbits are most exposed. No historical loss data to anchor probability estimates.

Hardening requirements: defense-connected commercial satellites increasingly procured with electronic hardening, anti-jam capability, and evasive maneuvering propulsion. Adds 15–25% to manufacturing cost but becoming a requirement for national security value chain satellites.

Servicing market inflection: as refueling and life extension become commercially available (targeting 2030–2032), operators with RAFTI-compatible satellites and serviceable architectures will have lower per-year amortization.

Attribution technology as a market: commercial RPO attribution capability at GEO remains limited. Companies that solve high-fidelity attribution will have significant defense procurement opportunities (LeoLabs, ExoAnalytic, Space Fence currently lead).

Repositioning and responsive launch: Victus Haze and analogous programs reflect military requirements for rapid satellite repositioning in response to threats. This creates demand for satellites designed for rapid launch and repositioning — a materially different design constraint from traditional long-lifecycle architectures.

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## Data Visualizations

The following charts summarise the key quantitative findings from this memo. All figures reflect publicly available data as of April 2026. Note: throughout this document, USA launch figures include all US operators (SpaceX, NASA, ULA, Rocket Lab, and other US commercial providers). SpaceX is not equated with the US in any aggregated figure.

### Chart 1 — Global orbital launches by country (USA = all operators), 2019–2025

USA bucket includes all US operators: SpaceX (170 launches), NASA, ULA, Rocket Lab (US pad), and other US commercial providers. † SpaceX alone = 165 Falcon 9 + 5 Starship. Sources: Jonathan’s Space Report; BryceTech Year in Review 2025; Payload Space 2025 Recap.

### Chart 2 — Estimated government and science satellites by agency, 2025–2035

Sorted descending by midpoint estimate. Excludes commercial mega-constellations (Starlink, Guowang, Qianfan, Amazon Leo). Bars show low–high range. Sources: agency budget documents, mission manifests, and analyst estimates compiled April 2026.

### Chart 3 — Mega-constellation deployment trajectories (base case)

Starlink based on confirmed in-orbit counts and SpaceX manifest. Guowang and Qianfan reflect realistic deployment at 60–70% of stated targets. Amazon Leo reflects FCC extension to 2028. ESA IRIS<sup>2</sup> per programme documentation (first launch 2029, FOC 2030).

### Chart 4 — Cumulative global orbital launches by scenario, 2025–2035

Bull, base, and bear cases per this memo’s analytical framework. Shaded band represents the full range of outcomes. Annual launch estimates incorporate all US operators, China, and rest-of-world trajectories under each scenario.

### Chart 5 — Civil space agency budgets with dynamic growth projections, 2026–2035

Top: Stacked area shows combined civil budgets totaled at key years. Bottom: Individual agency trajectories on log scale with explicit growth assumptions labeled. NASA modeled at 1–3%/yr with acceleration post-

2028 reflecting US-China competitive pressure. China at 8%/yr per Five-Year Plan mandate. All figures USD at constant 2025 FX rates. Defense/intelligence budgets excluded.

### Chart 6 — Satellite projection model with key mission milestones, 2026–2035

Data sourced from the projection model Output tab. Milestone annotations mark confirmed events likely to influence trajectory in each scenario. Shaded band represents the full bull–bear range.

### Chart 7 — Private space investment by category and key company valuations, 2019–2035

Top: Annual private investment by category (historical 2019–2025; projected 2026–2035). Satellite comms includes Amazon Leo (\$16–20B total program), OneWeb, Telesat, and AST SpaceMobile. Launch infrastructure includes SpaceX secondary sales, Blue Origin, Rocket Lab, and commercial launch startups. Defense-adjacent includes Palantir Space, Voyager Technologies, and government-adjacent programs. In-space services includes commercial stations (Axiom, Vast), orbital compute, and debris removal. Bottom: Key company valuation trajectories on log scale. SpaceX milestones from confirmed secondary transactions (\$350B Dec 2024, \$800B Dec 2025). Amazon Leo = cumulative program investment. Rocket Lab and AST SpaceMobile = public market cap. All projections are analytical estimates.

## Data Archive

| METRIC                        | 2022   | 2023   | 2024   | 2025 ACTUAL | 2030 PROJ.     | 2035 PROJ.     |
|-------------------------------|--------|--------|--------|-------------|----------------|----------------|
| Annual Orbital Launches       | ~186   | ~223   | ~262   | 329         | ~420–500       | ~500–650       |
| Satellites Deployed (annual)  | ~2,470 | ~2,950 | ~2,940 | ~4,530      | ~7,000–10,000  | ~10,000–15,000 |
| Active Satellites in Orbit    | ~5,500 | ~7,500 | ~9,500 | ~13,000+    | ~30,000–45,000 | ~50,000–80,000 |
| Commercial Share of Launches  | ~70%   | ~75%   | ~80%   | ~87%        | ~88–92%        | ~90%+          |
| SpaceX Share of All Launches* | ~33%   | ~44%   | ~51%   | ~52%        | ~40–50%        | ~35–45%        |
| USA (all operators) Share     | ~26%   | ~32%   | ~38%   | ~52%+       | ~52–58%        | ~45–55%        |
| Starlink Subscribers          | ~1M    | ~2.3M  | ~4.6M  | ~9M         | ~23M (est.)    | ~32M (est.)    |

Sources: BryceTech Global Orbital Activity 2025; Jonathan’s Space Report via Aviation Week (Jan 2026); Payload Space 2025 Year in Review; Wikipedia 2025 in Spaceflight; SpaceX/Starlink subscriber data per company reports.

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## Sources & Documentation

### Primary Industry Research & Launch Data

| SOURCE                             | TITLE / PUBLICATION  | DATE              | KEY DATA  |
|------------------------------------|--|-------------------|---|
| BryceTech                          | Global Orbital Activity / Year in Review 2025                        | Jan 2026          | Launch counts, deployment, commercial share     |
| Jonathan's Space Report (McDowell) | Annual Orbital Launch Analysis                                       | Jan 2026          | 329 launches, vehicle breakdown                 |
| Payload Space                      | 2025 Orbital Launch Attempts by Country                              | Jan 7, 2026       | Country-level breakdown                         |
| Aviation Week / SpaceOps           | Global Orbital Launch Rate Jumped 25% in 2025                        | Jan 7, 2026       | 165 Falcon 9, China 92                          |
| Goldman Sachs                      | The Global Satellite Market is Forecast to Become Seven Times Bigger | Mar 2025          | \$108B market by 2035                           |
| ABI Research                       | Number of Orbital Space Launches by Operator: 2025 to 2035           | Feb 2026          | 967+ launches/yr by 2035                        |
| The Lee Co.                        | How the Space Industry Ramps Up to Launch 58,000 Satellites by 2030  | Feb 2026          | GAO 58,000 projection                           |
| China in Space (Jack C.)           | Guowang/Qianfan Mega-Constellations Mega-Article                     | Updated Apr 2026  | Real-time satellite counts                      |
| KeepTrack.space                    | Inside China's Secretive Megaconstellation — Guowang                 | Mar 2026          | 163 Guowang sats; military context              |
| ESA / Copernicus                   | IRIS <sup>2</sup> Programme Documentation                            | 2024–2026         | 290-sat architecture; €10.6B; 2029 first launch |
| ESA                                | List of ESA Programmes and Missions                                  | Accessed Apr 2026 | Full Sentinel, Science, Explorer missions       |
| Wikipedia                          | 2025 in Spaceflight  | Accessed Apr 2026 | Mission events and milestones                   |
| Qianfan Wikipedia                  | Qianfan Constellation  | Accessed Apr 2026 | 504 sats as of Apr 2026; Phase 1 architecture   |

## Regulatory & Government Documents

| SOURCE             | DOCUMENT  | DATE         |
|--------------------|---|--------------|
| FCC                | Amazon Leo — License Extension Request Filing (milestone: 1,618 sats to 2028) | Jan 2026     |
| FCC                | Amazon Leo Authorization for 4,500 Additional Satellites (7,727 total)        | Jan 2026     |
| FAA                | Environmental Impact Statement — Starship at LC-39A (up to 44 launches/yr)    | Ongoing      |
| FAA                | Environmental Impact Statement — Starship at SLC-37 (up to 76 launches/yr)    | 2024–ongoing |
| Chinese Government | 14th/15th Five-Year Plans — Satellite Internet and Reusable Launch Priorities | 2021 / 2026  |
| ITU                | Guowang (GW-A59, GW-2) and Qianfan Coordination Filings                       | 2020–present |
| ESA / EU           | IRIS <sup>2</sup> Constellation — ESA Procurement Framework                   | 2023–2025    |
| NASA               | 2025 Year in Review — Launches, Milestones, Program Updates                   | Dec 2025     |

## Caveats & Data Limitations

This memorandum reflects publicly available data as of April 26, 2026. Chinese program data is drawn from ITU filings, state media, and independent analysis; internal timelines, budgets, and capability specifications are not independently verifiable. Starship operational cadence projections beyond 2027 carry very high uncertainty. Amazon Leo FCC extension outcome is pending. All figures are order-of-magnitude planning inputs and should be verified against primary sources before use in financial modeling or acquisition decisions.

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