NASA SPACE APPS CHALLENGE 2026 · SPACE MISSION DESIGN GAME



AegisSat: Interactive Zero-SRAM CubeSat Mission Design Game

An interactive solo & 4-player co-op spacecraft design game uniting **KÜPSAT-01** TRL-7 heritage, **IAC 2026** shielding, and **WERR 24-Byte Zero-SRAM** physics across Launch, Space, Ground & User segments.

Interactive Game & Twin

https://aegissat.space
4-Player MDL Co-Op + Mission Viz 3D

Flight Heritage

KÜPSAT-01 TRL-7 (7 Aug 2026) & IAC-26-C2.IPB.29
Antalya

Team AegisSat

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01 · DEEP-SPACE CHALLENGE

Why Standard CubeSats Die Beyond Low Earth Orbit

Radiation-Induced SEUs Corrupt AI Weights

234.0 flips/day

Under Mars Deep-Space GCR + X-Class Solar Proton Storms, 64 MB volatile AI weight SRAM on unshielded Al-6061 suffers 234 flips/day, silently corrupting attitude & fault control.

Thermomechanical & Detumbling Shocks

3,647.58 °/s · -150.0 °C

KÜPSAT-01 recorded ~20 G separation shock and 3,647.58 °/s tumble. Standard Al-6061/COTS buses freeze down to -141.5 °C internal temp and lose 64 Hz modal margin under 14.1 Grms.

02 · VERIFIED HARDWARE & FLIGHT PROOF

KÜPSAT-01 Stratospheric Heritage + IAC 2026 Composite Chassis

KÜPSAT-01 Flight (421 Samples)

25,636 m

7 Aug 2026 mission: 22.51 hPa min pressure, -54.50 °C exterior vs -17.27 °C internal (+37.23 °C passive thermal differential).

IAC-26-C2.IPB.29 Structure

-81.7% Stress

Al7075-T6 / CFRP + Hexagonal Honeycomb sandwich: 18.49 MPa von Mises, 0.254 mm deflection, Mode 1 = 100.76 Hz (GEVS 14.1 Grms), FS = 27.20.

1U Mass & Cost Advantage

345 g / $8,300

Complete WERR Hybrid bus is 373 g (957 g payload margin out of 1,330 g 1U limit) at $8,300 total vs $42,800 for heavy 775 g Rad-Hard TMR avionics.

03 · CORE INNOVATION

WERR 24-Byte Zero-SRAM PROM + MLI Active Thermal Control

Immutable 24-Byte (192-bit) Mathematical Seed

- **0 Bytes mutable weight SRAM** (0.0 weight flips/day, **0.35 W** ultra-low compute)
- Deterministic arithmetic replaces 64 MB volatile neural matrices
- Dual-byte hardware **CRC-16/CCITT-FALSE** catches **192 / 192** single-bit SEU corruptions at 100% accuracy

```
02 02 03 03 bf3ed46f 3de770bd 3fcccccd 445861ed ff0b f1
46
```

Dual-Stage Deep-Space Thermal Envelope

-24.5 °C

IAC passive MLI/honeycomb insulation (+37.23 °C gain) paired with a thermostatically regulated **0.50 W survival heater** (**0.85 W** total bus in deep space) keeps internal electronics ≥ -24.5 °C (safe above -30 °C limit) at -150.0 °C ambient.

04 · CONTROL THEORY & PATENTS

3-Axis Euler ADCS (94.37% Damped) + Patent 2 & 3 Safety Gates

Schwarzian + Koenigs ADCS

94.37%

Negative Schwarzian $S(f)(0) = -6.919 < 0$ & Koenig multiplier $\mu = 0.75$ damp 3,647.58 °/s energy by 94.37% in 10 cycles vs PID 63.15% or SEU-degraded ARM 29.97%.

Patent 2 · Julia Watchdog

TR 2026/016633 hardware gate strictly vetoes unstable controller gains ($|r| \geq 2.4046$) and locks $\mu = 0.75$ before actuator saturation.

Patent 3 · Spoofing Barrier

TR 2026/020266 Collatz Parity Lyapunov barrier isolates injected spoofing bursts whenever $\gamma = n_{odd} / n_{even} > 0.58496$.

05 · GAME ARCHITECTURE & OFFICIAL NASA RESOURCES

4-Player NASA MDL Co-Op, Mission Viz 3D & Live Data Feeds

Space Mission Design Game Loop (CML 1–4)

- **4-Player Co-Op (GSFC MDL):** Commander, Structures, Avionics & Science leads sign off mass (1,330 g), solar EPS, link & budget gates
- **3 Difficulty Scenarios + Sandbox:** Cadet (Balloon), Engineer (Artemis Moon), Mars PI (+ Cyber Spoof) & Shareable `#design=` Links
- **NASA Mission Viz + CubeSat 101:** Dual 3D Hardware / Orbit view, random in-flight events, CML 1–4 badge & Leaderboard

Live Space Weather & Global Offers Utilized

- **NOAA SWPC & NASA DONKI GST (`/api/space-weather`):** GOES ≥10 MeV proton flux, Planetary Kp & SPENVIS/OMNIWeb radiation
- **Microsoft Planetary Computer STAC:** Sentinel-2 L2A scenes over KÜPSAT-01 Arslanköy–Ermenek recovery corridor
- **Meteomatics Weather API:** 100 m wind shear & surface meteorology for stratospheric balloon launch windows

06 · MISSION TRADE STUDY & IMPACT

Mars Transit (Solar Storm + Spoofing Attack): 2.0% vs 100.0%

Architecture	Weight SRAM	SEU Flips/Day	10-Cycle ADCS	Min Temp	Power / Cost	1U Margin	Game Score / CML
Al-6061 + 64 MB ARM SRAM	64 MB	234.0	29.97% (SEU)	-141.5 °C (Freeze)	4.20 W / $3,600	730 g	**20 pts · CML-1 FAIL**
CFRP + Rad-Hard TMR CPU	16 MB	0.0	63.15% (PID)	-129.0 °C (Freeze)	8.50 W / $42,800	555 g	**262 pts · CML-2 FAIL**
AegisSat Hybrid + WERR 24B	**0 B PROM**	**0.0**	**94.37% (μ=0.75)**	**-24.5 °C (OK)**	**0.85 W / $8,300**	**957 g**	**776 pts · CML-4 (100%)**

Open-source Mission Design Game, Python/JS bit-exact core, KÜPSAT-01 replay & patents live at **https://aegissat.space** · **github.com/bdagli-web/aegissat**