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# ***The Global Positioning System (GPS) Resiliency through Redundancy***



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12 September 2023

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- **Two satellites transmitting inaccurate data in the same view**

- Never happened in history of GPS

- **OCX concerns documented**

- **SSC fully prioritizing this effort**

- **SpOC will not operate any active satellites without successful resolution of this issue**



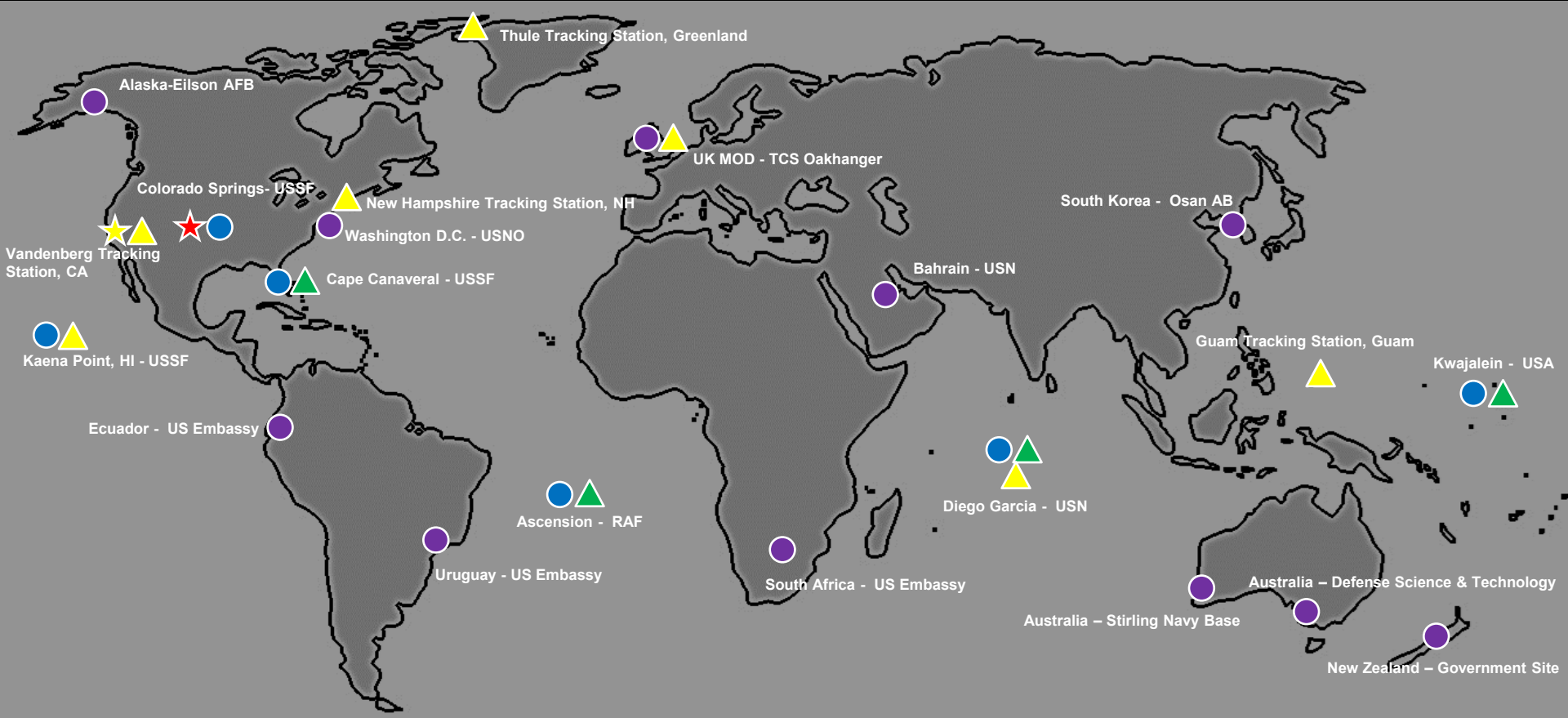
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# Global Architecture & Mission Partners

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- ★ Master Control Station (MCS)
- ★ Alternate Master Control Station (AMCS)
- ▲ Ground Antenna
- ▲ Satellite Control Network (SCN) Remote Tracking Station
- National Geospatial Agency (NGA) Monitor Stations
- Space Force Monitor Station

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# Control Stations

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Master Control Station, Schriever SFB, CO

- The Master Control Station (MCS) is located at Schriever Space Force Base, Colorado. GPS is controlled 24/7 from this one site.
- The Alternate Master Control Station (AMCS) is located at Vandenberg Space Force Base, California, enabling continuity of operations in the event of ground system failure at the MCS.





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# Operating Locations

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**Ascension Island – 2 SOPS OL-A**



**Kwajalein Atoll – 2 SOPS OL-B**



**Cape Cod, FL – 2 SOPS OL-C**



**Diego Garcia Island – 2 SOPS OL-D**



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# Vehicle Autonomy

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- **All satellite vehicles can operate for an extensive period of time before human interaction is required.**
- **The Bus System can operate indefinitely barring major anomalies.**
  - All Bus System commanding done currently is preventative to ensure longevity of the satellite lifespan.
- **The Navigation Payload can operate until the satellite reaches the end of navigation prediction data, barring major anomalies.**
  - The navigation signal will degrade over time until the navigation data held on the satellite runs out.
  - Each satellite block type (IIR, IIR-M, IIF, III) presents different symptoms of old data, and the satellite will often transmit Nonstandard Code (a signal to receivers that the specific satellite should be ignored) if the satellite's navigation data is too old.

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# Redundant Sensors/Subsystem

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**This table contains examples of specific redundant components but is not all inclusive:**

Subsystems	NDS Payload	Navigation Payload
Redundancy Management	Optical Sensor	Atomic Frequency Standard (AFS)
Spacecraft Processor Unit (SPU)	EMP Sensor	L-band Subsystem
Power Control Software	Combined X-Ray & Dosimeter	Voltage Control Crystal Oscillator (VCXO)
Solar Array Drives	Burst Detector Processor	
Heaters	Burst Detector Analysis Box	

**Average >20 years for all elements of any redundant subsystem to fail**

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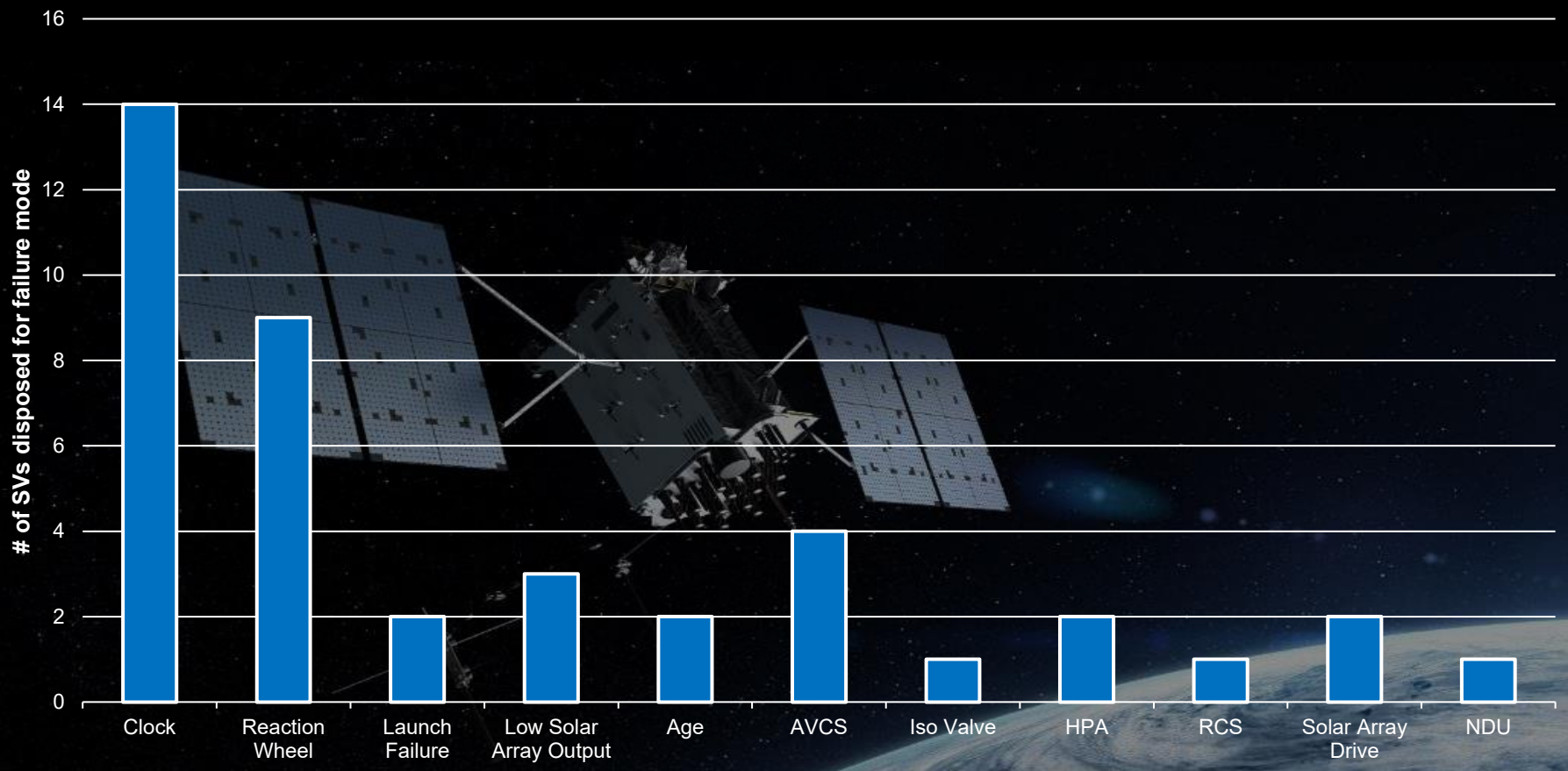




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# Reasons for Satellite Disposal

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# Procedural Redundancy

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- **Two-person verification**
- **Multiple engineering calculations**
- **Pre-planned engineering activities**
- **CSAT – Command Level Oversight**
- **NANU dissemination**



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A satellite with two large solar panel arrays is shown in space. The Earth's horizon is visible in the lower right corner, showing blue oceans and white clouds. The background is a dark, starry space.

# Questions?

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