



Data Centers in Space

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Space-based data centers – The Next Broligarch Obsession?

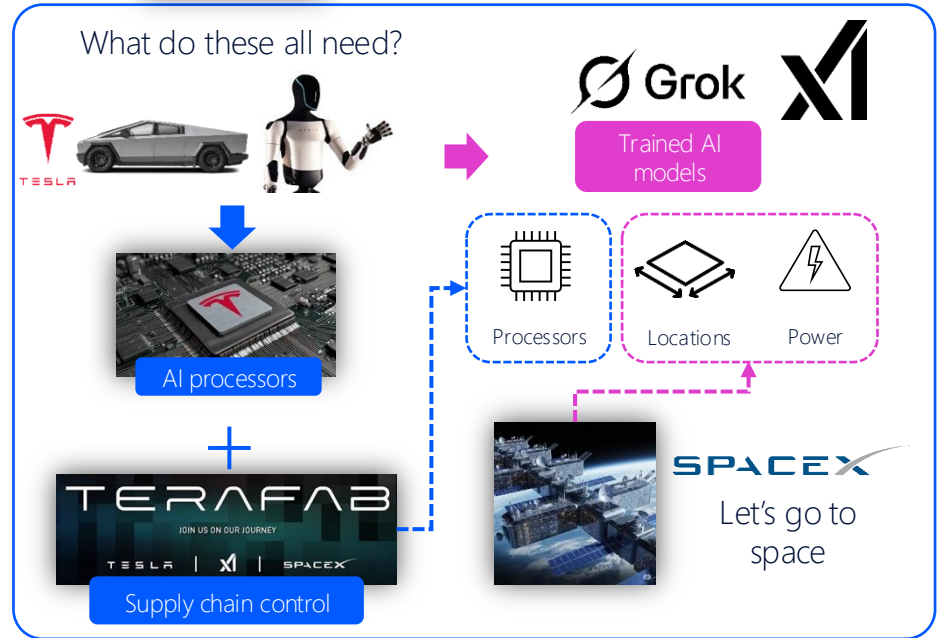


Assorted startups

Currently focused on power



Elon Musk's holistic vision for vertical integration
 January 2026: Applies to launch "millions" of satellites for data centers
 March 2026: Launches Terafab



What's the problem they're trying to solve?

To build gigawatt-scale data centers...

On Earth

vs

In Low Earth Orbit

Hard to find locations

They don't call it "space" for nothing 🪐

Hard to find power

Lots of "free", 24/7/365 solar power! ☀️

Pouring heat into the atmosphere

Space is really cold! ❄️

Increasing demand for regulation

The final frontier 🖐️

Also on Earth...

“The carbon footprint of AI systems alone could be between 32.6 and 79.7 million tons of CO₂ emissions in 2025, while the water footprint could reach 312.5–764.6 billion L.”*

Source: [The carbon and water footprints of data centers and what this could mean for artificial intelligence](#)

*Note – this paper clearly stresses the difficulty in estimating the *specific* impact of AI data centers

Recent drone strike on data centers have raised security concerns – would they be safer in space?

Growing public backlash

US datacenters face slew of problems amid grassroots protests against AI

New constructions delayed or cancelled, raising questions about US's ability to expand infrastructure to support boom



The AI Data-Center Rebellion Is Growing Fast and Getting Violent – What Investors Need to Know



Artificial
Intelligence
Index Report

2
0
2
6

[Download report](#)

Stanford University
Human-Centered
Artificial Intelligence

“AI experts and the public have very different perspectives on the technology’s future, and global trust in institutions to manage AI is fragmented.”

NOKIA

Are space-based data centers
a practical option?

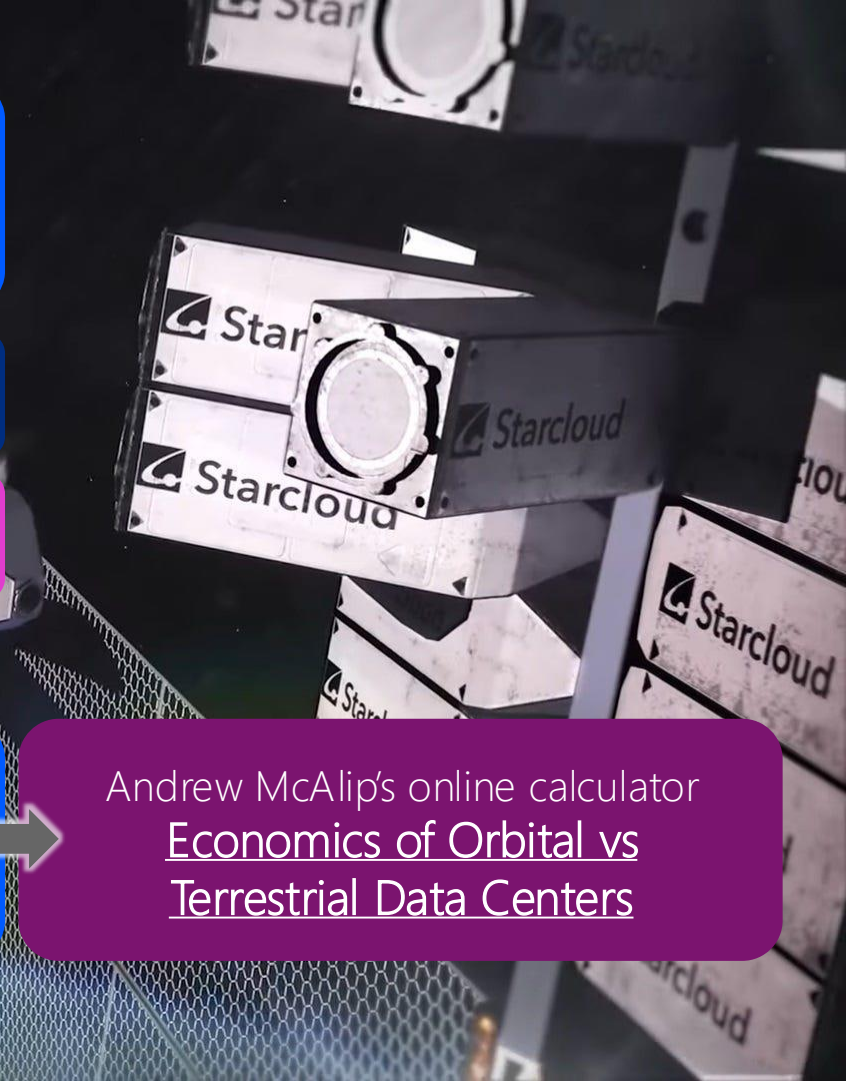
Part 1: Engineering challenges

Part 2: Problems of scale

Note: There are many variables and best-guess estimates for these engineering challenges

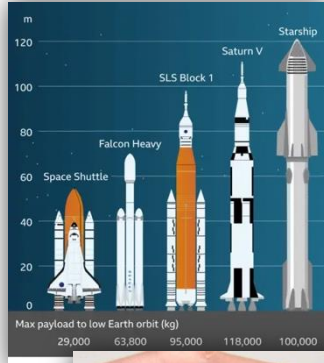


Andrew McAlip's online calculator
[Economics of Orbital vs
Terrestrial Data Centers](#)



Part 1: Engineering Challenges

- Payload cost to LEO
- Generating power
- Cooling
- Component hardening
- Maintenance issues
- Comms data rates
- Orbital orchestration

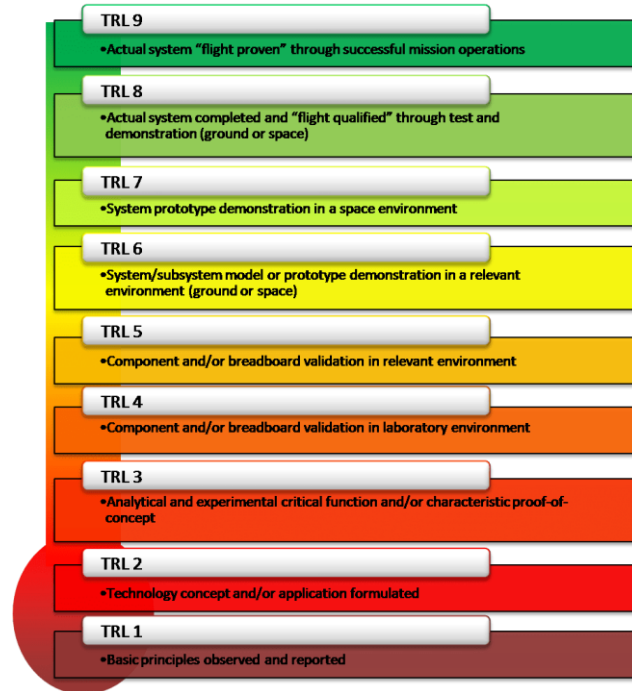


A word on feasibility scoring...

As I review the various technologies I will assign a score to indicate how difficult this particular issue seems to be using NASA's Technology Readiness Level (TRL) scale...

But I need to add a second metric that indicates a *gap analysis* between the technology capability today and the difficulty of achieving the necessary capability for space-based data centers

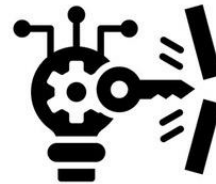
Example: *Solar panels have been used in space missions for decades...but not on the scale needed for space-based data centers. So what needs to change, and how hard will that be to achieve?*



Simple gap analysis metric



Technology evolution should produce the required capability

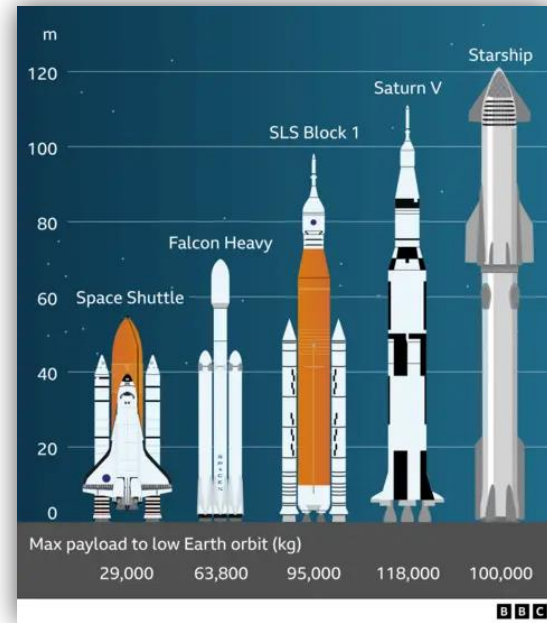


Breakthrough needed to reach required capability



No obvious technology solution

1.1: Payload Cost to LEO



Evolution of orbital payload cost efficiency

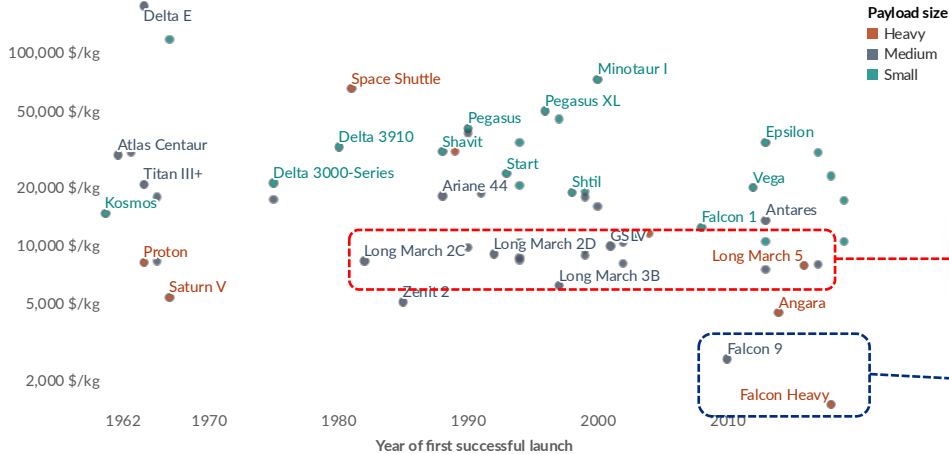
Cost of space launches to low Earth orbit

Source: [Our World in Data](#)



Cost to launch one kilogram of payload mass to low Earth orbit¹ as part of a dedicated launch. This data is adjusted for inflation.

Launch cost per kilogram of payload (constant 2021 US\$ per kilogram; plotted on a logarithmic axis)



The "magic number" seems to be \$200 per kg to LEO by the mid 2030s



China has much higher launch costs



- SpaceX has a significant lead in low cost
- Internal cost is thought to be 20% of the 3rd party cost

Data source: CSIS Aerospace Security Project (2022)

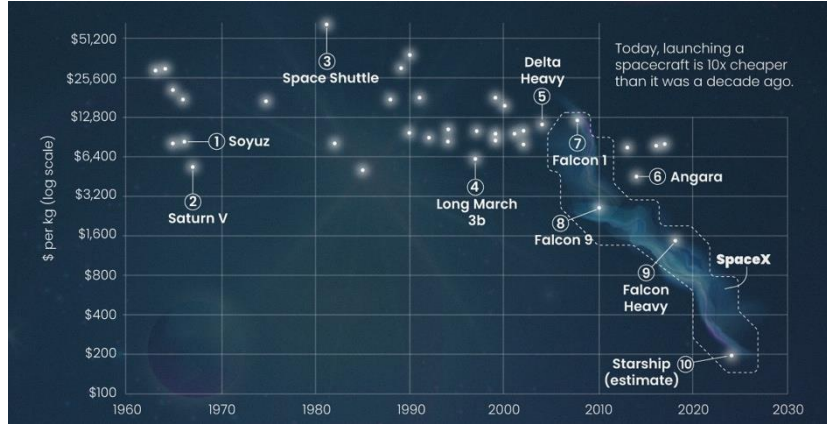
OurWorldinData.org/space-exploration-satellites | CC BY

Note: Small vehicles carry up to 2,000 kg to low Earth orbit¹, medium ones between 2,000 and 20,000 kg, and heavy ones more than 20,000 kg. This data is expressed in constant 2021 US\$.

1. **Low Earth orbit** A low Earth orbit (LEO) is an Earth-centered orbit with an altitude of 2,000 kilometers or less (approximately one-third of Earth's radius). This is the orbit where most artificial objects in outer space live. LEOs are often used for satellites, including those for communication, Earth observation, and space stations due to their proximity to Earth's surface, facilitating shorter communication times and detailed surface imaging.

How do we lower launch costs?

1 Optimized Reusability



Visual Capitalist: "The Cost of Space Flight Before and After SpaceX"



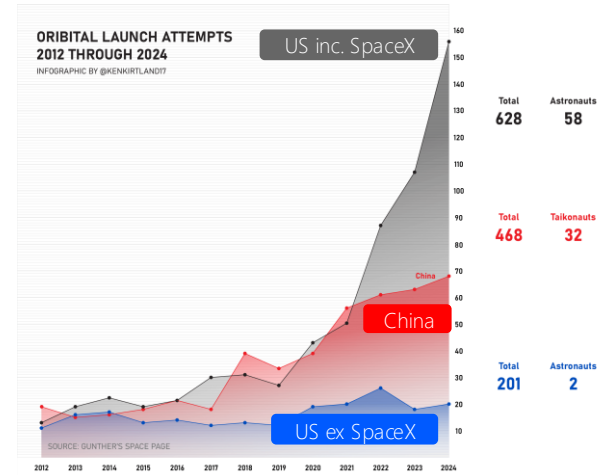
The Space Shuttle was reusable, but was over-engineered

- Crew & Payload
- Two-Way Capable
- Orbital repair and retrieval
- ISS assembly

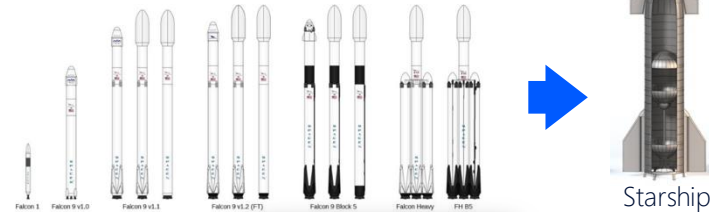


SpaceX rockets are more limited in function, but far more cost-effective

2 Scale



3 Rate of innovation

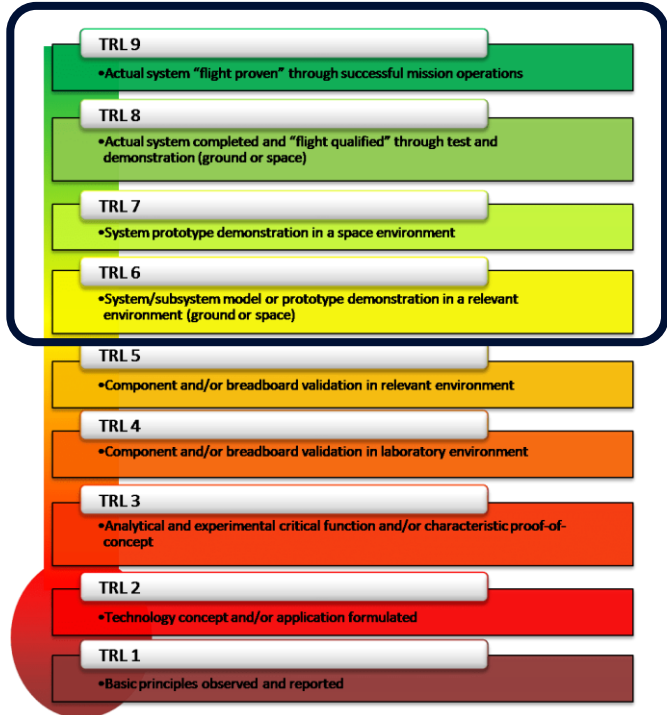


SpaceX Merlin vs Raptor



Scoring launch costs

Note: Continued reduction in cost-to-LEO would actually mitigate many of the other SPDC challenges...but not all



TRL 6-9

Cost reduction technologies are well advanced and scaling will produce further economies

~~USA~~ SpaceX has a significant lead



Technology evolution should produce the required capability

SpaceX is already well within reach of economic launch costs for SBDCs* and there are no obvious technology barriers to further cost reduction

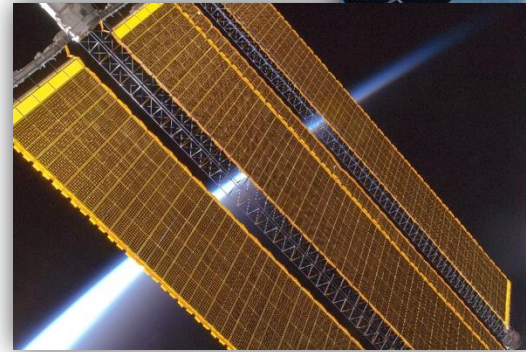
*It is thought that SpaceX internal cost is around 20% of the price it charges to customers – which is already \$1,000-\$2,000

1.2: Generating power

Disclaimer – Orbital AI data centers are a *very different* topic from space-based solar power



Source: NASA, "[Space-based solar power](#)"



Plenty of solar power – right?

Yes:

In heliosynchronous orbit



These orbits are used for:

- Weather satellites
- Reconnaissance satellites
- Electronic intelligence satellites

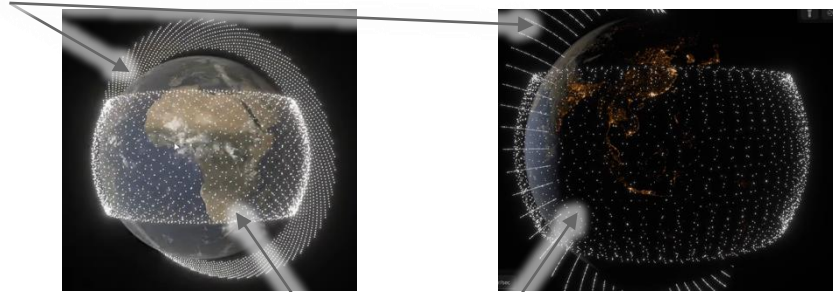
Data Centers may need something else...

These satellites are in heliosynchronous orbit

Or maybe:

Musk DC mega constella

Many are in regular LEO orbits



But these "belt" satellites are 50/50 sunlight and darkness

They will need batteries as well as solar panels

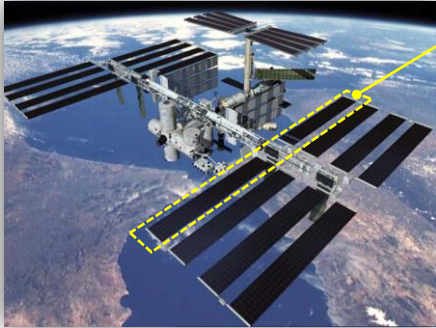
They are positioned to be over population centers → lower latency

Or just shut down when they're in the dark

Source: Scott Manley: ["What would SpaceX's space data center plans look like?"](#)

Solar panels are a mature technology for space operations

Wikipedia: [Electrical system of the International Space Station](#)



The ISS Solar Array Wing (SAW)

- Each SAW can generate 31 kW
- Uses glass-coated silicon (Starlink also uses silicon)
- Weighs 1,088 kg (33W per kg)
- Efficiency drops by 0.45% per year
- 60% of the power is used to charge banks of lightweight Li-ion batteries
- Batteries designed for 60,000 charge cycles or 10 years of operation

26 years of solar panel experience on the ISS



The ISS solar panels need to fold...

- Initial storage at launch
- To protect panels against extreme solar events (e.g. solar storms)

Panel efficiency degradation caused by:

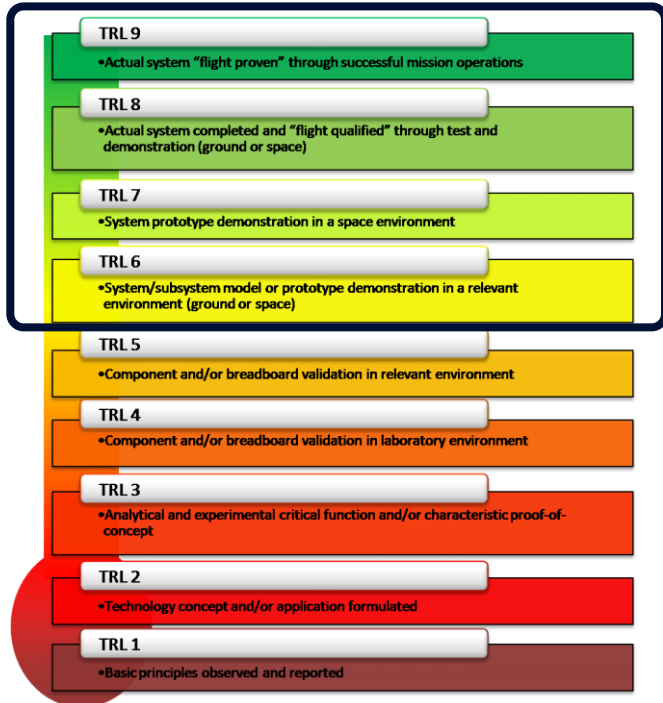
- Micrometeoroid and Orbital Debris
- High energy radiation
- Thermal Cycling
- Orbital thruster plume contamination

Many other space operators use multi-junction GaAs/Ge solar cells

- Higher efficiency (30%–40% vs 20-25% for silicon)
- More resistant to radiation damage

For the 5 year mission times of SBDCs, silicon is probably perfectly adequate

Scoring solar power generation



TRL 6-9

Solar power has been used in space for decades – but not on the scale required by SBDCs

Multiple new solar cell designs exist in the lab, or as proven terrestrial technology

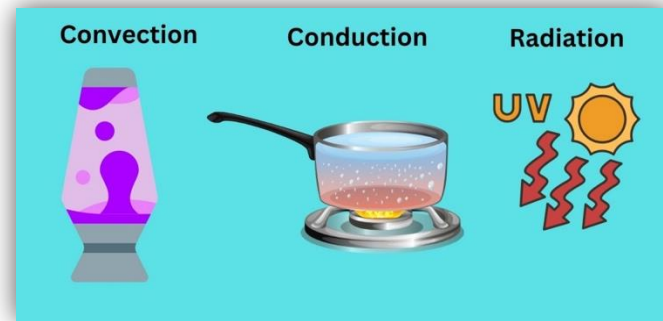


Technology evolution should produce the required capability

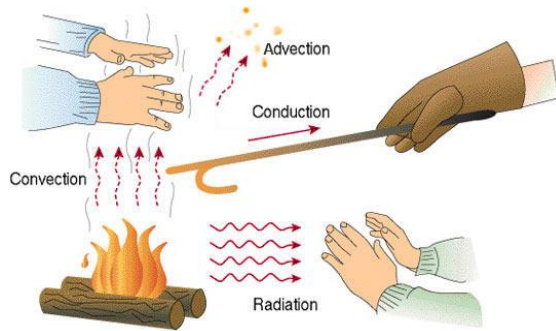
Both solar panels and batteries are heavy

See my comment that lowering launch costs mitigates other challenges

1.3: Cooling



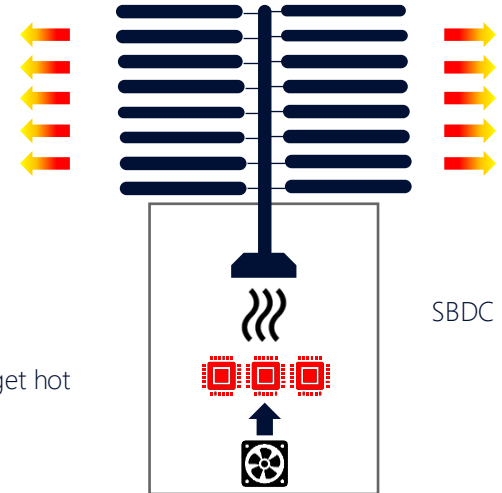
Four Types of Heat Transfer



- Advection
 - The *horizontal transfer* of heat by external forces (e.g. engine water cooling system)
- Convection
 - The *vertical transfer* of heat, driven by density changes in the medium (e.g. "hot air rises")
- Conduction
 - Heat transfer *through a medium* (e.g. where heat travels through metal bar)
- Radiation
 - Heat transfer through *electromagnetic radiation* (e.g. the heat from an electric fire)

Some estimates indicate the weight of radiators will be more than the rest of the satellite combined (assumes 100 MW power)

But to remove the heat from the satellite we can only use *radiative cooling*



Zero G – so need fan-driven gas or liquid *advection* cooling

Technologies in play...

The amount of energy we can radiate is given by the *Stefan-Boltzmann* equation

$$P = \epsilon \sigma AT^4$$

Power (Watts) → P Surface area of emitter(m²) → A Absolute temperature (K) → T
 Emissivity ($\epsilon = 1$ for a perfect black body) → ϵ
 Stefan-Boltzmann constant 5.67×10^{-8} Watts/m².K⁴ → σ

e.g.. ■ Back body (matt) 1.00 ■ Aluminium foil 0.04 ■ Concrete 0.85

Hotter radiator → more radiation

At room temp (293K)

417 Wm⁻²

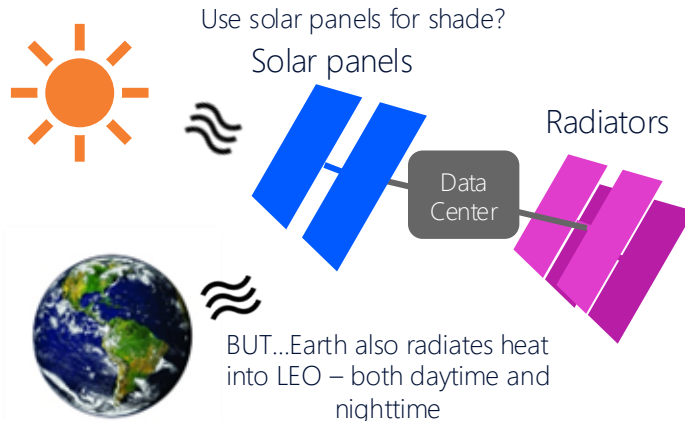
At 80C (353K)

880 Wm⁻²

Nvidia GPU typically operates at 60-85C

Can we go even hotter without thermal throttling?

Other factors



Special coatings



The ISS uses AZ-93, a nonspecular white coating that provides superior thermal control / protection by allowing only 13-17% of the solar radiation impinging on the spacecraft external surface to be absorbed through to the interior systems while emitting 89-93% of the heat generated

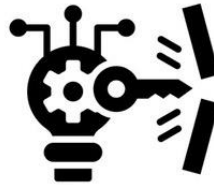
Scoring cooling technologies

TRL 5-9

Radiator technology has been widely used in spacecraft – *but for very limited heat sources*

Multi-megawatt scale heat dissipation very different

Larger radiator area more vulnerable to debris damage.
Resilience and/or shielding techniques *adds weight*.

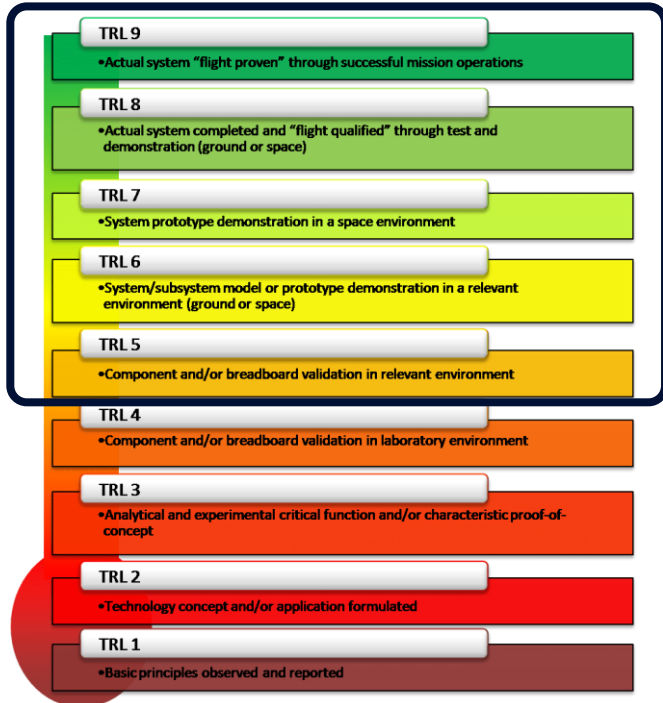


Technology breakthrough in processor heat tolerance, coating materials or cooling materials capabilities needed in order to avoid significant radiator weight penalties

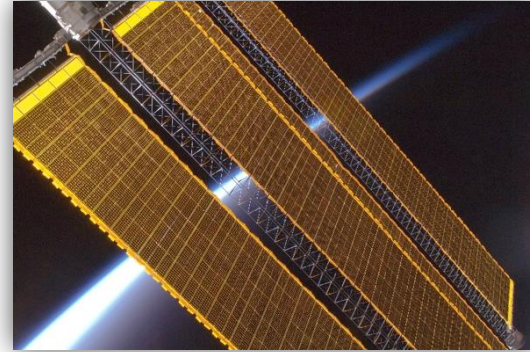
However...



A dramatic technology evolution to lower launch costs would also help solve these problems



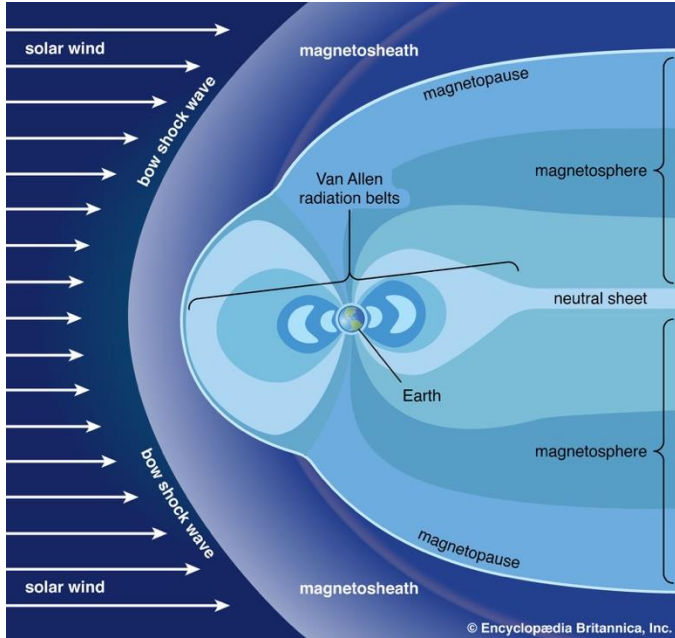
1.4: Component Hardening



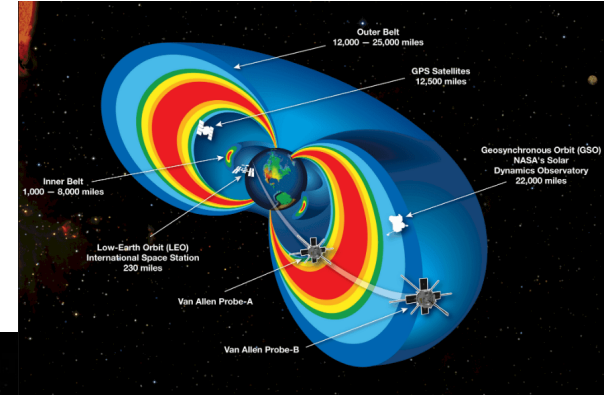
NVIDIA Rubin Platform
Six new chips. One AI supercomputer.

 <p>Vera CPU 88 Olympus Cores LPDDR5</p>	 <p>Rubin GPU 50PF HBM4</p>	 <p>NVLink 6 Switch Single Hop 3,600 GB/s</p>	 <p>ConnectX-9 800 Gb/s per port</p>	 <p>BlueField-4 DPU 64C Grace CPU + CX-9 800 Gb/s</p>	 <p>Spectrum-6 Ethernet Switch 102.4 Tb/s, CPO</p>
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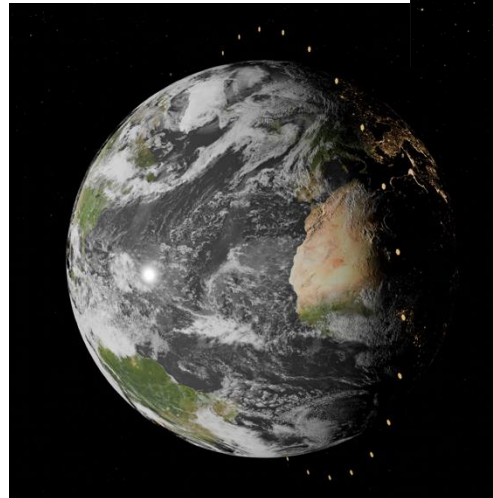
Why do we need to protect electronic devices?



- Low Earth Orbit (LEO) lies *below* the inner belt
- GPS satellites orbit *between* the inner and outer belts
- Geosynchronous (GEO) orbits are *towards the edge* of the outer belt



Source: [Nuclear-power.com](https://www.nuclear-power.com)



A *heliosynchronous* orbit is a type of polar orbit that remains in sunlight 24/7

Often used by weather, mapping and spy satellites

600-800 km

Van Allen radiation belts are formed from the interaction between the solar wind and the Earth's magnetic field

Source: <https://www.britannica.com/science/Van-Allen-radiation-belt>

Hardened Electronics

GPUs, RAM, Storage



GPU: NVIDIA positioning Vera Rubin architecture as “suitable for LEO”

Radiation problems for chips

Moderate level

Radiation causes single “bit flip” errors

High level

Life-shortening or even permanent damage to components

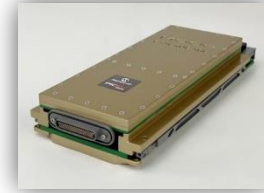
Radiation hardening strategies historically

Use silicon on insulator (SoI) designs

Choose semiconductors with larger bandgaps

In the past rad-hard chips lagged ~10 years behind commercial systems

Recent breakthroughs



- MicroChip PIC64-HPSC
 - 12 nm FinFET process
- AMD Versal family
 - 7 nm FinFET process

What if we only need 5 years?



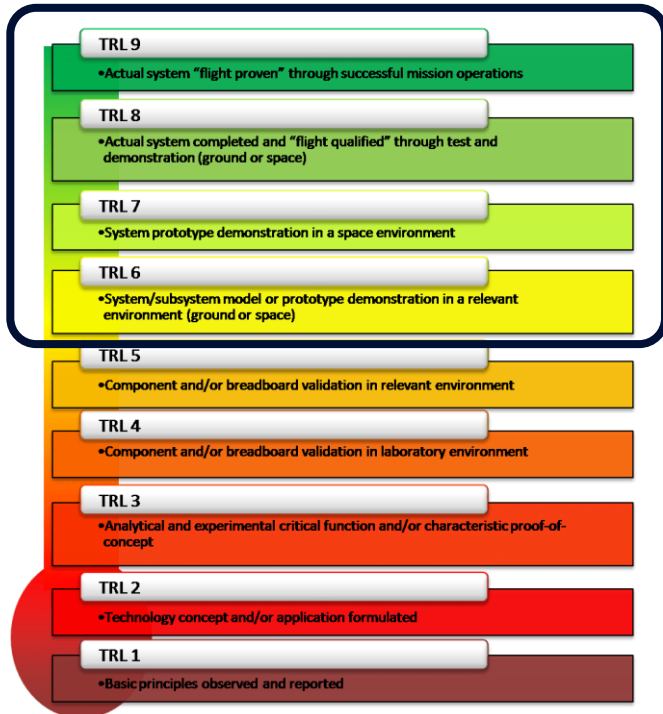
Elon Musk’s Terafab would produce hardened electronics for his satellite DCs

Evidence is emerging that COTS components can survive for at least 5 years without significant problems

Source: [“Towards a future space-based, highly scalable AI infrastructure system design”](#)



Scoring component hardening



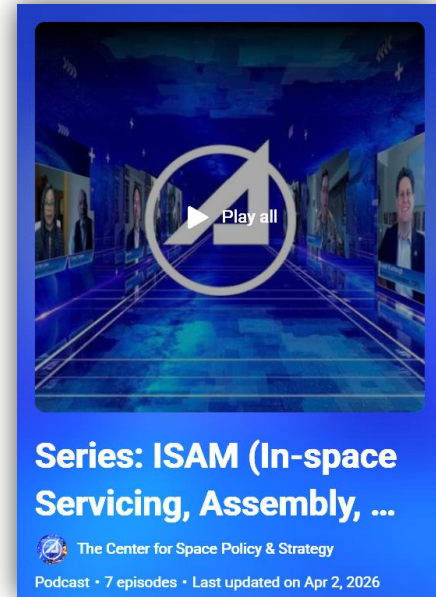
TRL 6-9



Technology evolution should produce any *additional* required capability

- Component hardening techniques are well understood
- But...for a 5 year projected life span, COTS components seem to be sufficient
 - *Based on ground testing*
- For more extreme requirements, technology evolution seems to be on track to deliver reliable solutions
 - Longer lifespan
 - More exposed equipment (e.g. robotic service modules)

1.5: Maintenance issues

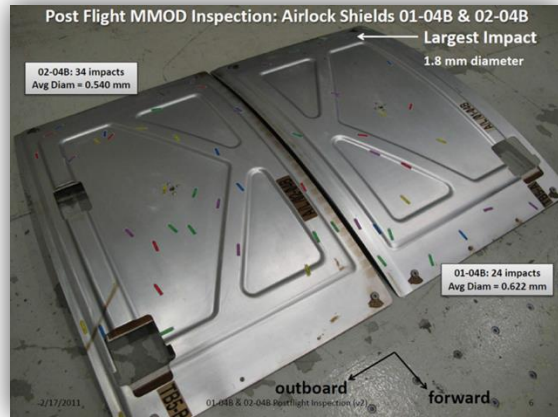


Highly recommended: [YouTube link](#)

Why is in-orbit reliability such a challenge?

Orbital debris

[Find out more about the dangers of orbital debris](#)

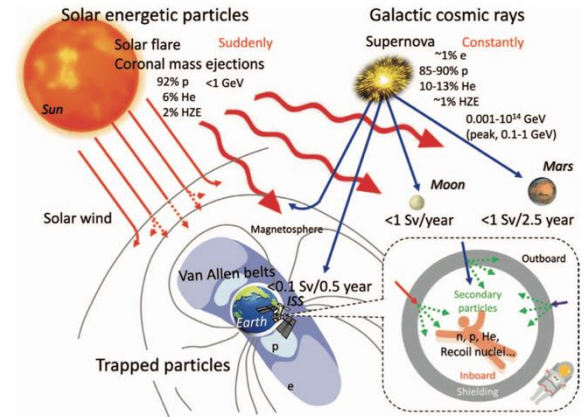


58 debris impact points marked on airlock panel from ISS



Largest impact point was 1.8 mm

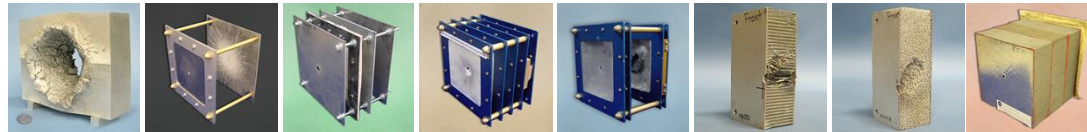
Radiation hazards



Solid aluminium shield

1940s

Mars mission



Shielding always adds weight and cost – and can never be totally effective

Multiple approaches to the challenge of maintenance...

Option 1

- Launch a human mission for each satellite repair



Unlikely to be practical unless we build "one big data center"

Option 2

- Service depot in orbit



- Spare parts
- Robotic workers

Option 3

- Build in resilience

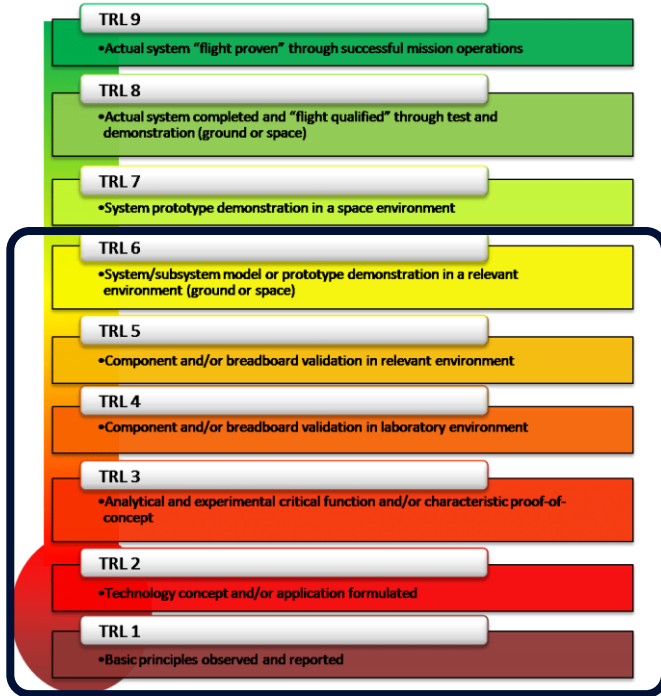


- Resilient to certain levels of failure



- If damage is too bad, just replace the DC element

Scoring orbital maintenance



TRL 1-6

NASA and ESA have been considering in-orbit manufacturing, assembly and maintenance for several years

Feasibility is linked to lower launch costs and advances in robotics



Technology evolution *should* produce the required capability for both launch cost reduction and robotic capability

BUT...ultimately the cost-effectiveness will be limited by the frequency of failure



See Kessler Syndrome



1.6: Comms data rates

Comms for SBDCs

Two distinct models...

Monolithic data center model



- Gigawatt scale power
- Comms will be primarily DC to ground

Distributed data center model

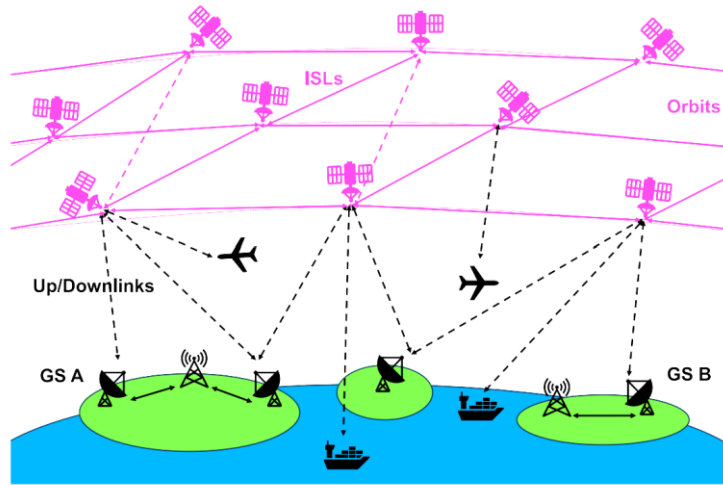


- Thousands of satellites
- Tens of megawatt scale power each
- Comms will be
 - DC to ground
 - DC to DC

Communications in space is easy, unless...

...you want high data rates

Source: [Inter-satellite link technologies and applications in Low Earth Orbit satellite networks](#)



Satellite comms is significantly more complex than terrestrial fiber networks

Massive body of work required for resilient routing technologies

State of the market
ISL data rates

amazon LEO

100 Gb/s



STARLINK

200 Gb/s

TELESAT LIGHTSPEED™

10 Gb/s

State of the market
downlink data rates



STARLINK

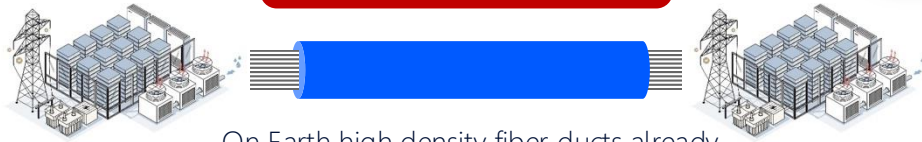
Stationary internet ~1Gb/s
Mobile data rates drop dramatically



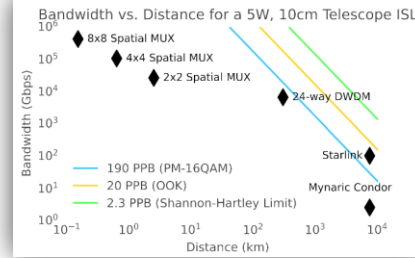
Satellite to ground station comms is in transition from radio (~10Gb/s) to optical (up to terabit rates)

There is a huge bandwidth gap...

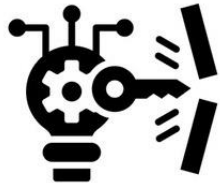
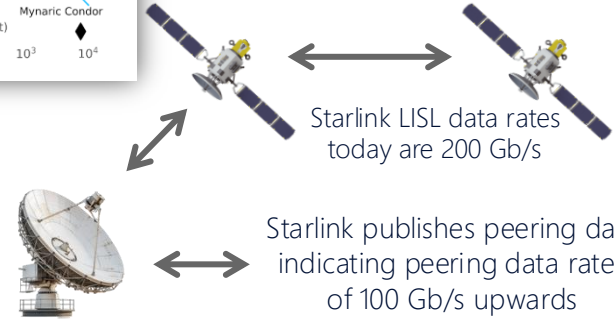
And this *still* may not be enough in 10 years



On Earth high density fiber ducts already support 3,456 fiber pairs – with higher fiber counts coming
Potentially 345,600 Tbps



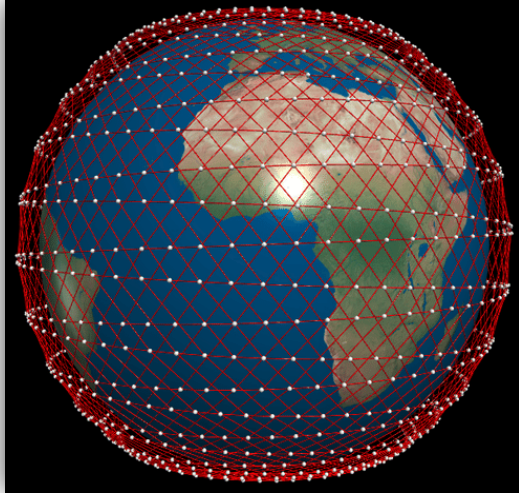
1 Tb/s may be possible if inter-satellite distances are reduced to 10 km (vs 80-100 km today)



We need a technology breakthrough to get to the *same data rates* as terrestrial data centers today...and by then terrestrial data centers will have many time more capacity than they do today



Or...we evolve the notion of an SBDC so that it works in a bandwidth-constrained architecture



1.7: Orbital orchestration

Who regulates *space launches* ?

There will be a different agency (e.g.) for comms (ITU-R)

All countries have an agency to regulate *aviation*...and some countries have a specialized *space agency*

In the UK



For example

In the EU



Coordinates with national agencies

In the USA



In Russia



In China

Commercial (vs government) space activity is very recent



Many examples of international cooperation in space

There is currently no "United Nations" for space activity

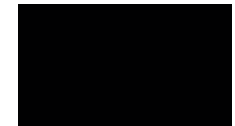
But there is a UN office...

United Nations Office for Outer Space Affairs
International Space Exploration Coordination Group



1975
Apollo-Soyuz
First international
manned mission

Hundreds of
international
unmanned missions



2000
ISS
First international
manned mission

Why satellites have to continually manoeuvre

Wikipedia: [Collision avoidance \(spacecraft\)](#)

- Counteract orbital decay
- Avoid collisions
- Maintain position
- As the satellite reaches a low level of fuel, it **must** de-orbit

Starlink satellites have manoeuvred 50,000 times since the first satellite was launched

[Starlink interactive map](#)

Actually...that equates to one manoeuvre per satellite, per month – not so dramatic!



Critical need for centralized coordination of information

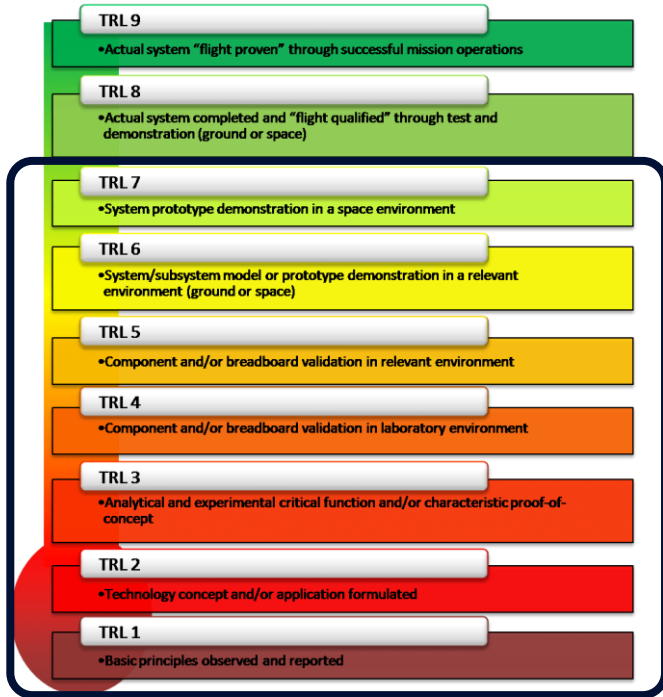
The Traffic Coordination System for Space is freely available to US and international satellite operators

- Lists location of unclassified objects
- Provides real time alerts for possible collisions



[Link: Google and Aerospace collaboration for AI constellation orchestration](#)

Scoring multi-vendor constellation orchestration



TRL 1-7

Shared information and alerts via TRACSS (TRL-7)
Potential for AI-driven orchestration (TRL-5?)
But...how does this work *between* vendors? (TRL-1)



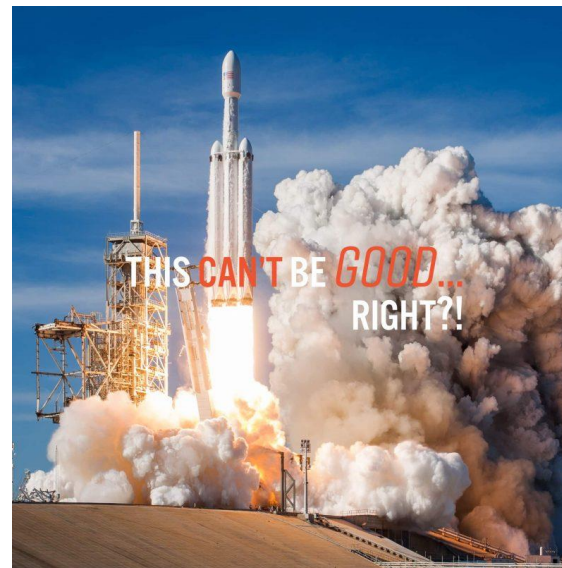
Technology evolution *should* produce the required capability for multivendor collaborative orchestration



Collaboration is well proven in other areas (e.g. internet backbones). But can it work in space?

Part 2

Things that are going to get
really bad with scale



What about "The environment"?

AKA "Have we found a new way to wreck the planet?"

De-orbiting considerations

AKA "What goes up must come down"

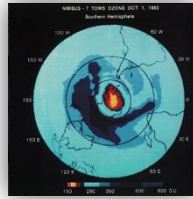
The Kessler Syndrome

AKA "Some idiot always has to ruin it for everyone else"

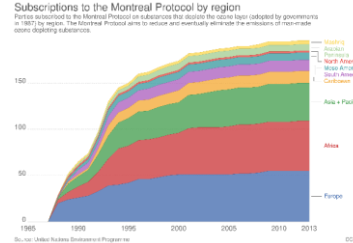
A reminder about the success of the Montreal Protocol



1974
Rowland and Molina at UCI publish the first warnings of the impact of CFCs on the ozone layer [Source](#)

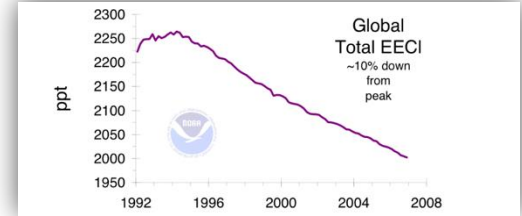


1983
TOMS satellite shows "ozone hole" over the Antarctic



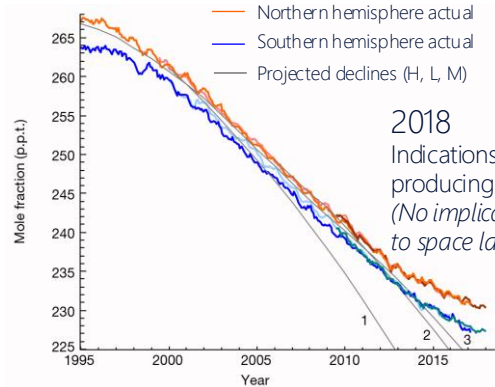
1987 →
Montreal Protocol gains worldwide support to ban multiple ODS

Source: Wikipedia [Montreal Protocol](#)



Until 2018
Montreal Protocol gains worldwide support to ban multiple atmospheric pollutants

But then...



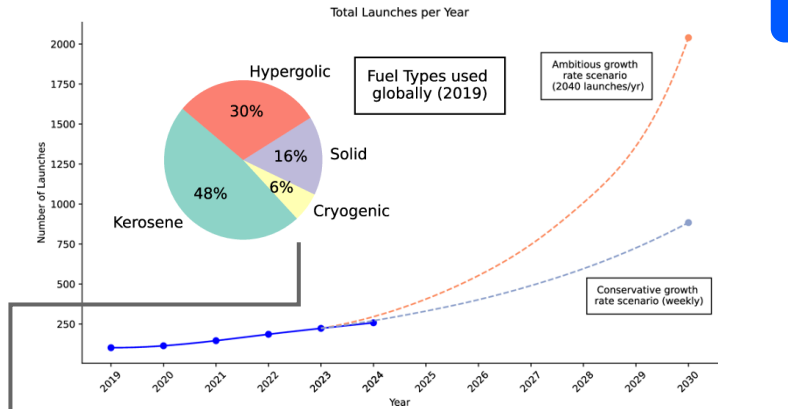
2018
Indications that somebody is producing "illegal" CFC-11s.
(No implication that this is related to space launches)

We really don't need another way to deplete the ozone layer!

Source: ["A Mystery Source Is Producing Banned Ozone-Destroying Chemicals, Shocking Scientists"](#)

Pollution from rocket *launches*...but which fuel are they using?

Source: [Near-future rocket launches could slow ozone recovery](#)



	Kerosene	Hypergolic*	Solid	Cryogenic (Hydrogen)	Cryogenic (Methane)
CO ₂	Yes	Yes	Yes		Yes
H ₂ O	Yes	Yes		Yes	Yes
Soot	Yes	Yes	Yes		
Cl _x			Yes		
Al ₂ O ₃			Yes		
NO _x	Yes	Yes	Yes	Yes	Yes
SO _x	Yes	Yes			
CO	Yes				

Lots of polluting chemicals, but methane seems the best option

More research needed, but this study concludes...

1. Chlorine and soot cause ozone depletion
2. Soot also causes atmospheric warming
3. Increasing the launch emissions inputs creates bigger impacts
4. Impact is location-dependent
5. Launches from a single site can have global impacts.



Separately an analysis of a Falcon 9 launch indicates only emits about the same amount of CO₂ as a single transatlantic flight



Launches are putting large amounts of soot and other chemicals into the "chemically sensitive" stratosphere and upwards

Methane



Starship



New Glenn



Vulcan Centaur

Kerosene



Falcon 9, Falcon Heavy

Soyuz



Multiple



Long March family uses Kerosene or H₂ (5, 6, 7, 8, 10), Methane (9) and hypergolic fuels ((2, 3, 4)

Solid



Vulcan Centaur Boosters

Lockheed Martin/Boeing JV



Risks from re-entry

Sources:

- [Global 3D rocket launch and re-entry air pollutant and CO2 emissions at the onset of the megaconstellation era](#)
- [Unnecessary risks created by uncontrolled rocket reentries](#)
- [AAS Statement on the Atmospheric Impacts of Spacecraft Reentries and Launches](#)
- [ESA Environmental Impact of Propellants](#)



What goes up must come down?

More atmospheric pollution

From Russia with love



Courtesy of SpaceX



10-40% of a spacecraft mass will survive re-entry
Source: [ESA](#)

This time it's from *alumina*

Al_2O_3
is a catalyst for ozone depletion



These are made from aluminum-lithium alloys

What happens if there's too much "stuff" in LEO?

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Collision Frequency of Artificial Satellites: The Creation of a Debris Belt

DONALD J. KESSLER AND BURTON G. COUR-PALAIS

NASA Johnson Space Center, Houston, Texas 77058

As the number of artificial satellites in earth orbit increases, the probability of collisions between satellites also increases. Satellite collisions would produce orbiting fragments, each of which would increase the probability of further collisions, leading to the growth of a belt of debris around the earth. This process parallels certain theories concerning the growth of the asteroid belt. The debris flux in such an earth-orbiting belt could exceed the natural meteoroid flux, affecting future spacecraft designs. A mathematical model was used to predict the rate at which such a belt might form. Under certain conditions the belt could begin to form within this century and could be a significant problem during the next century. The possibility that numerous unobserved fragments already exist from spacecraft explosions would decrease this time interval. However, early implementation of specialized launch constraints and operational procedures could significantly delay the formation of the belt.

A quick overview of the Kessler Syndrome

From the movie "Gravity" © 2013 Warner Bros.



Could this really happen?

Some background...

- 1978** Donald Kessler and Burton Cour-Palais publish seminal paper on collision cascading effect
- 1985** US military carries out ASM-135 ASAT test
- 2007** China destroys one of its FY-1C weather satellites in kinetic test. Debris at 865km will likely remain a threat for “decades or centuries”.
- 2009** 1st satellite-satellite collision when Iridium 33 collided with Kosmos 2251 at 11.7 km/s at 789 km altitude over Siberia, creating massive debris field
- 2021** Russian ASAT test kills Kosmos 1408 in polar orbit – debris stretches over 300-1,000km band and is threat to all LEO orbits, including ISS and Tiangong.
- 2024** Chinese Long March 6A rocket explodes in LEO, releasing >700 fragments. Substantial risk to orbits below 800 km. [Source](#).

Source: [Wikipedia – Kessler Syndrome](#)

Preventable debris



China does not have deorbiting capability for some models of Long March launcher



Since 2000 China has accumulated more long-lived rocket mass debris in LEO **than the rest of the world combined.** ([Source](#))

Proliferation of new constellations

Source: Wikipedia

- *GPS, Galileo and GLONASS have 24 each*
- Starlink has 10,000 in LEO, up to 14,000 planned
- OneWeb has 655 in LEO more are planned
- Amazon Leo 302 in LEO with up to 3,236 planned
- China's Guowang with 6,000 planned in LEO and 7,000 in MEO
- China's Qianfan (Thousand sails) 501 in LEO and 15,000 planned

*If China does not add a de-orbit feature to **all** of its Long March launchers then LEO is going to get very dangerous, very quickly*

Yeah...but could Kessler *really* happen?

And what would the consequences be?

CRITICAL NUMBER OF SPACECRAFT IN LOW EARTH ORBIT: A NEW ASSESSMENT OF THE STABILITY OF THE ORBITAL DEBRIS ENVIRONMENT

Hugh G. Lewis⁽¹⁾ and Donald J. Kessler⁽²⁾

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⁽²⁾ Consultant, Asheville, North Carolina, United States of America

- *Let's be clear – this is all about probabilities*
- This 2025 update by Kessler and Lewis indicates:
 - We have *already exceeded* the “instability threshold” for orbits between 420 and 1,000 km
 - We are close to...or have exceeded the “runaway environment” threshold between 520 and 1,000 km

“...after some period of time – perhaps shorter than previously anticipated – the **intact population*** would be difficult to maintain because the **fragment population**** would become too hazardous to continue space operations in low Earth orbit.”

* ie. Operating satellites

** ie. Space debris

Source: [Critical number of spacecraft in low earth orbit: A new assessment of the stability of the orbital debris environment](#)

Source: [ESA ClearSpace-1](#)

Heliosynchronous orbits at 600-800 km may *already be too dangerous* without extensive shielding or active debris removal

Could we just wait for it to clear naturally?

Source: NASA

LEO (< 600 km): Several years
Moderate LEO (800 km): 100 years
High-Earth Orbit (> 1,000 km): >100 years
Geostationary Orbit (GEO): Millions of years

Could we clean up the mess ourselves?



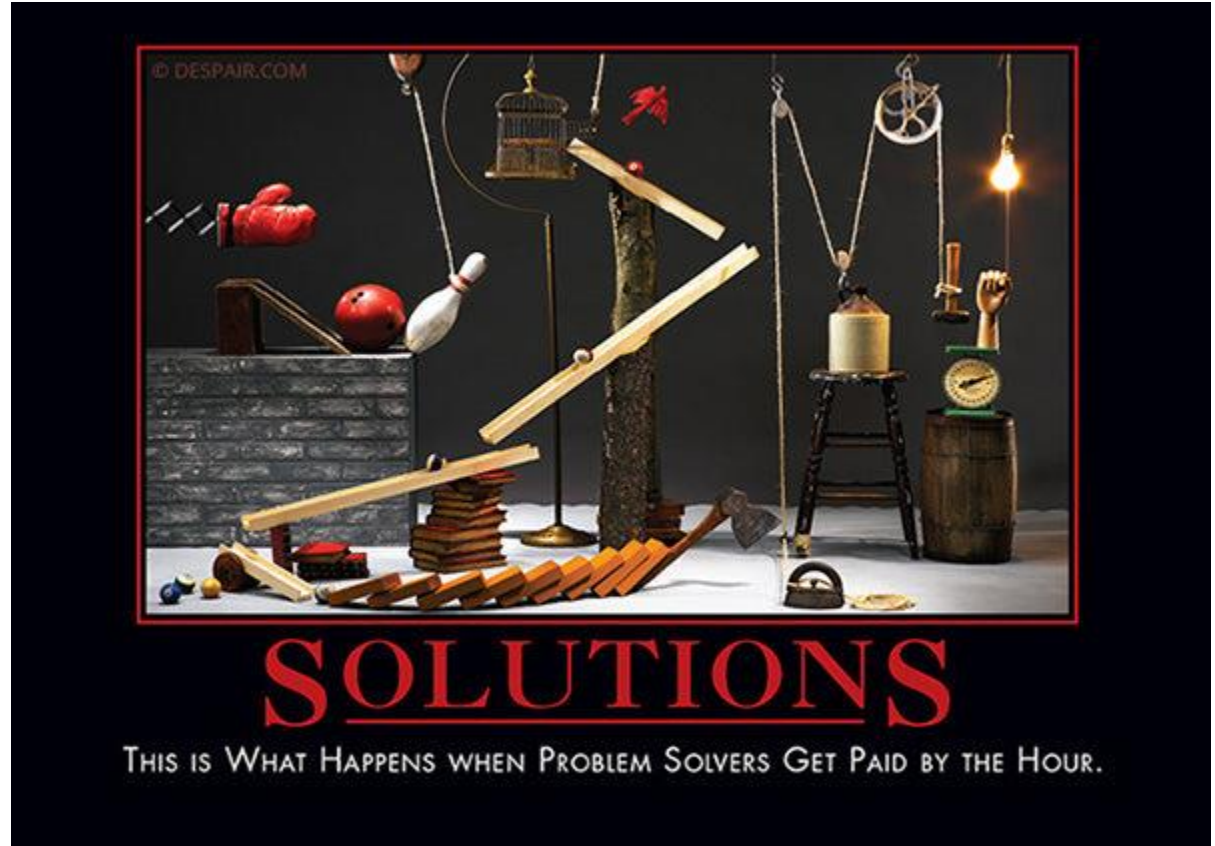
ESA's ClearSpace-1 will be the first active debris clearance mission...but at what cost, and who pays for it?

\$130M

[ESA Zero Debris Approach](#)

NOKIA

Let's see if we can
sum up!



Space-based data centers – a good idea or a bad idea?



The problems of AI data centers on earth are very real, and very serious



Humans are good at solving the kind of *engineering problems* posed by *space-based data centers*

- Payload cost to LEO
- Generating power
- Cooling
- Component hardening
- Maintenance issues
- Comms data rates
- Orbital orchestration

BUT...how do we solve the "other problems"? In particular because they are all *problems of scale*

Historically the Broligarchs have shown little or no concern over environmental damage vs short-term financial gains

Just another "tragedy of the commons"



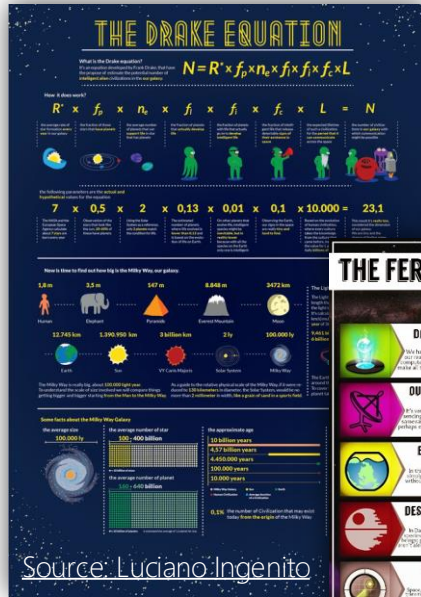
But Kessler could be the "unsolvable problem"

Timeframe: >10 years

Could Kessler be one solution to the Fermi Paradox?

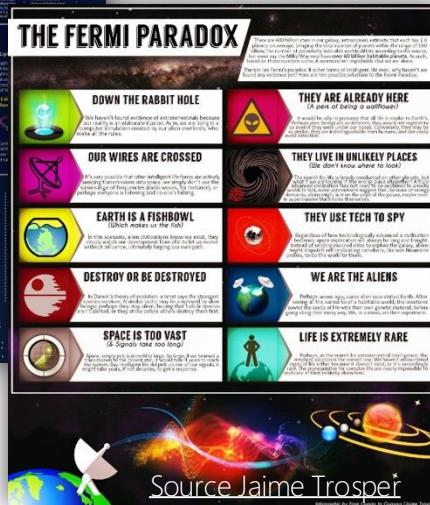
Note: Somewhat fanciful speculation

A good explanation of the Fermi Paradox by James Schombert at U of Oregon

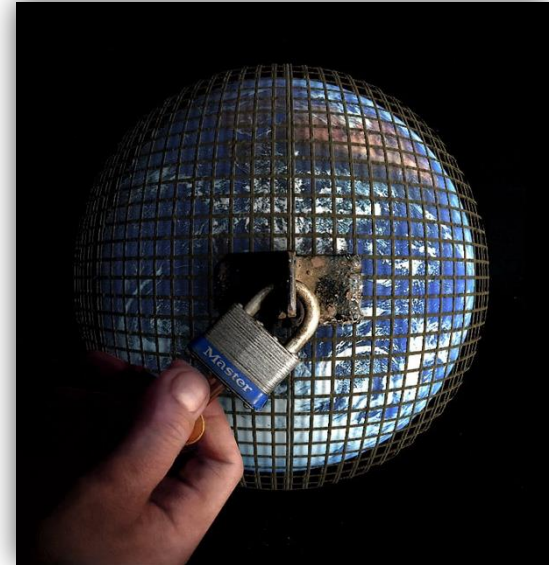


If intelligent life is "inevitable"...

Where is everyone?



Or maybe...



Advanced civilizations just get "locked in"?

And on behalf of cat videos, however they may be created...

Geoff Bennett
Geoff.bennett@nokia.com

