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Space In-Orbit Sustainability

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Space Sustainability

- Space is a critical infrastructure
  - Our everyday lives are reliant on space infrastructure
- Safety and security of operating in space is paramount
- Space is becoming more:
  - Congested
  - Contested
  - Competed

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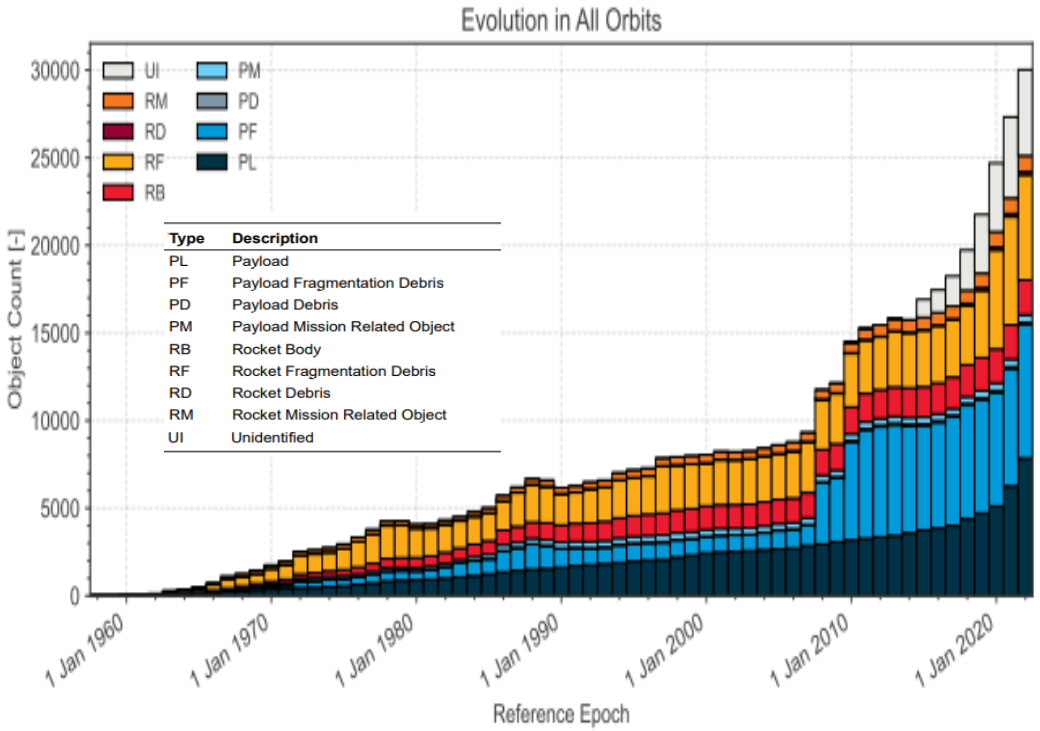
Image Source: ESA

Current State of Low Earth Orbit

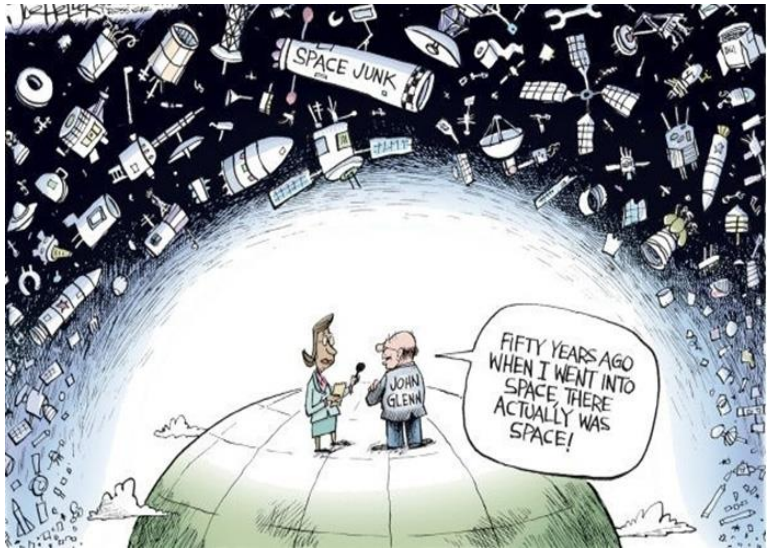


Source: ESA'S ANNUAL SPACE ENVIRONMENT REPORT

- Plus lots of non trackable objects. Estimated number based on ESA MASTER 8 model and NASA ORDEM model:
  - **1,000,000** objects between 1cm and 10cm
  - **130,000,000** objects between 1mm and 1cm

- **36,000** objects > 10 cm (30,000 actually tracked)

- Dramatic increase in the last 10 years of the number of objects (Active Satellites and Debris) mostly in LEO due to:
  - Increasing launch activity with lots of smallsats orbited including (e.g. Starlink 12,000 planned) mega-constellation
  - Debris resulting from fragmentation events



Collision Risk

Mean Time To Collision(MTTC) = f (orbit spatial density, decay time per orbit, cross-section area)

- **Orbit spatial density**

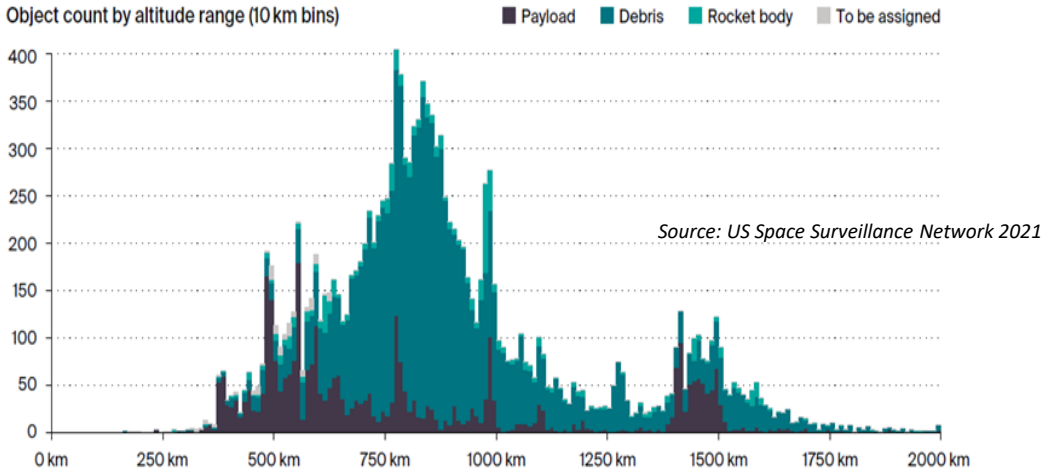


Figure 3: Publicly available catalogue of space objects tracked by the US SSN as of 22 May 2020 (Combined Force Space Component Command, 2021). The 'Payload' category comprises both operational and non-operational objects.

- **Cross-section area**

	CATEGORY	WEIGHT	ANALOGY
Traditional GEOs LEOs	LARGE	LEO> 1000 kg GEO>4000 kg	
	MEDIUM	500 - 1000 kg	
	MINI	200-500 kg	
Newspace Smallsats	MICRO	20-200 kg	
	NANO	1-20 kg	

- **Decay time per orbit** for an object with an average Area/mass = 0,015 m2/kg

Satellite Altitude	Lifetime
200 km	1 day
300 km	1 month
400 km	1 year
500 km	10 years
700 km	100 years
900 km	1000 years

Source: US National Research Council

- For the purposes of this calculation, we have taken objects larger than 1cm only

Object size	Number of debris (*)
1mm< object <1cm	130,000,000
1cm< object <10cm	1,000,000
> 10 cm	36,000

(*) *NASA ORDEM model*

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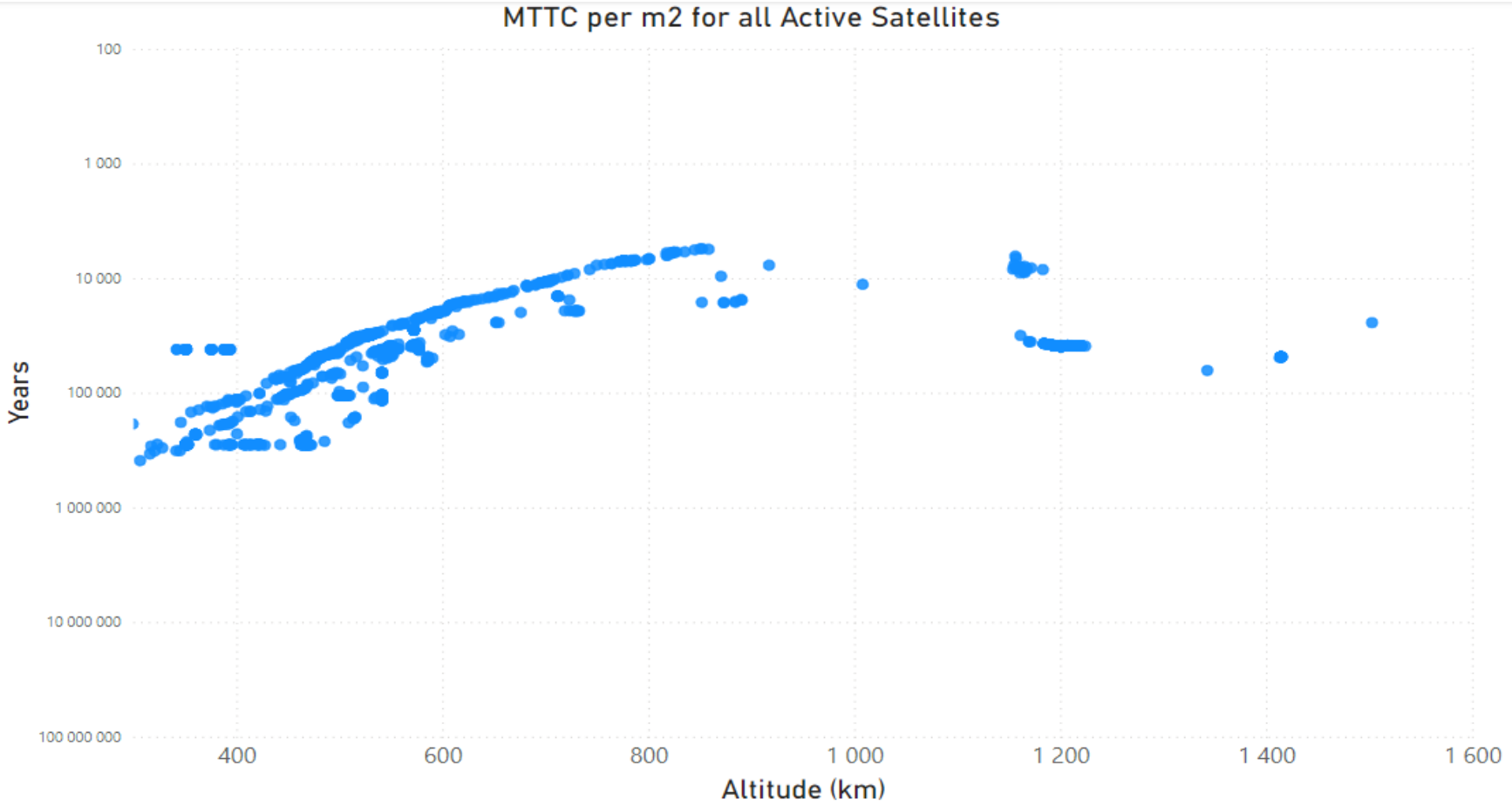
Normalised MTTC for All Active Satellites



Significant impact of the orbit

- 500-600 km:

20,000 years<MTTC<200,000 years

- 700-900 km:

5,000 years<MTTC<10,000 years

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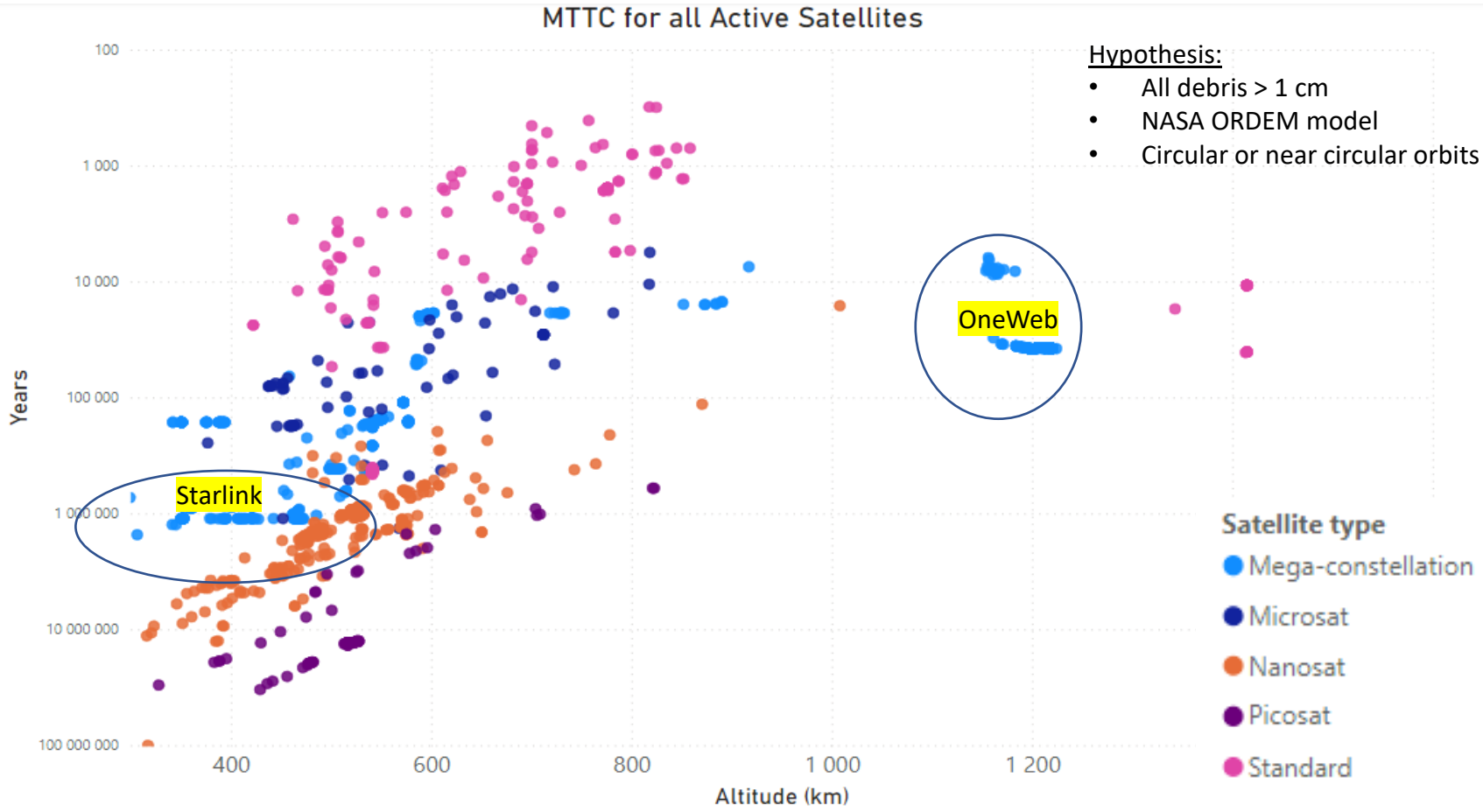
Source Seradata

***As computed by SCOR** as of 16/05/2021*

MTTC for all Active Satellites



Hypothesis:

- All debris > 1 cm
- NASA ORDEM model
- Circular or near circular orbits

MTTC largely inhomogeneous:

- MTTC of 300 years for large standard satellites at 850 km altitude
- MTTC of 10's of million years for Picosat at 400 km altitude

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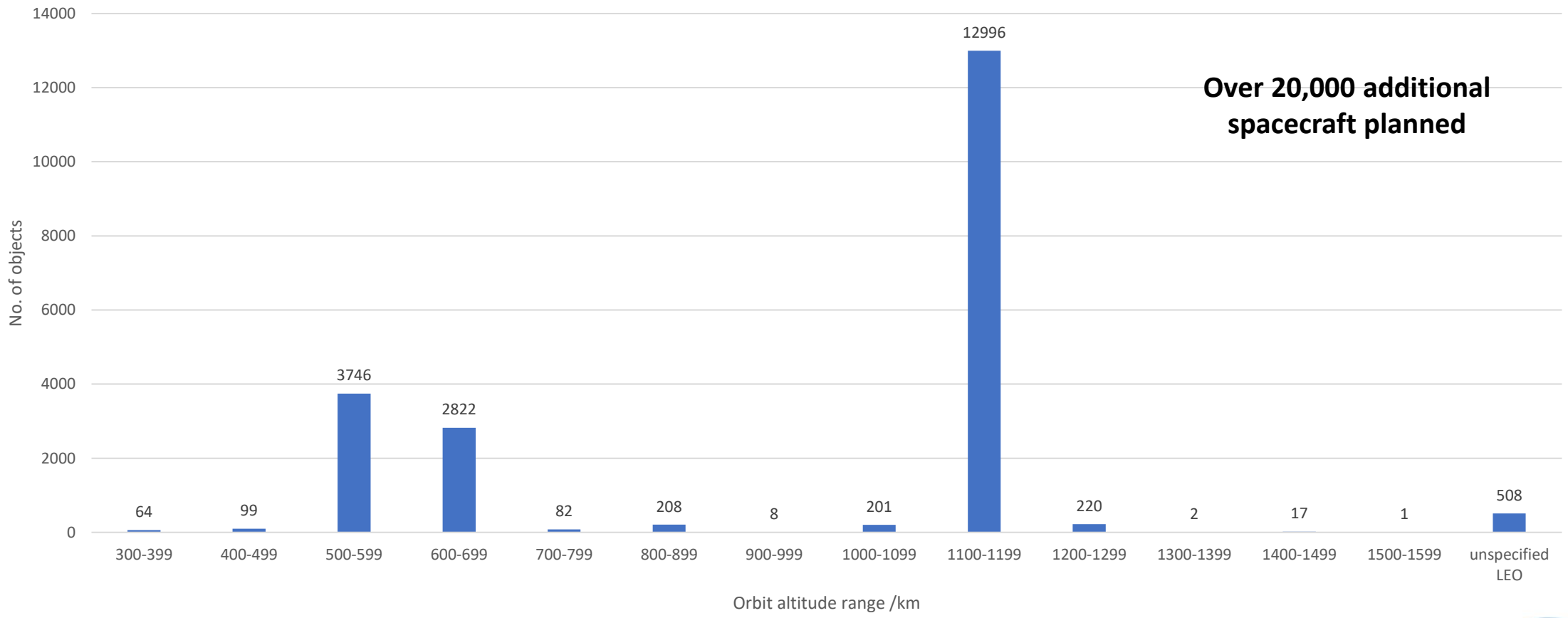
Source Seradata
***As computed by SCOR** as of 16/05/2021*

Future Outlook

Number of spacecraft currently ordered/in production for launch by end 2032, by orbit



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Source Seradata SpaceTrak

Solutions

- Mitigation
  - Prevent debris creation through design
  - Follow international and national guidelines (NASA, IADC, ISO, ESA)

- Space Situational Awareness
  - Use publicly available data
  - Commercial data becoming more accurate
  - Share your data, be seen

- Removal of Debris
  - Government and commercial initiatives and programmes
  - Various technologies

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Image Source: NASA

Actions

- Cooperation
  - Industry-Government-Academia
  - International
  - Space Safety Initiative Working Groups
- Governance
  - Responsible Regulation
  - Debris Removal
  - Space Traffic Management
- Create Norms of Behaviour

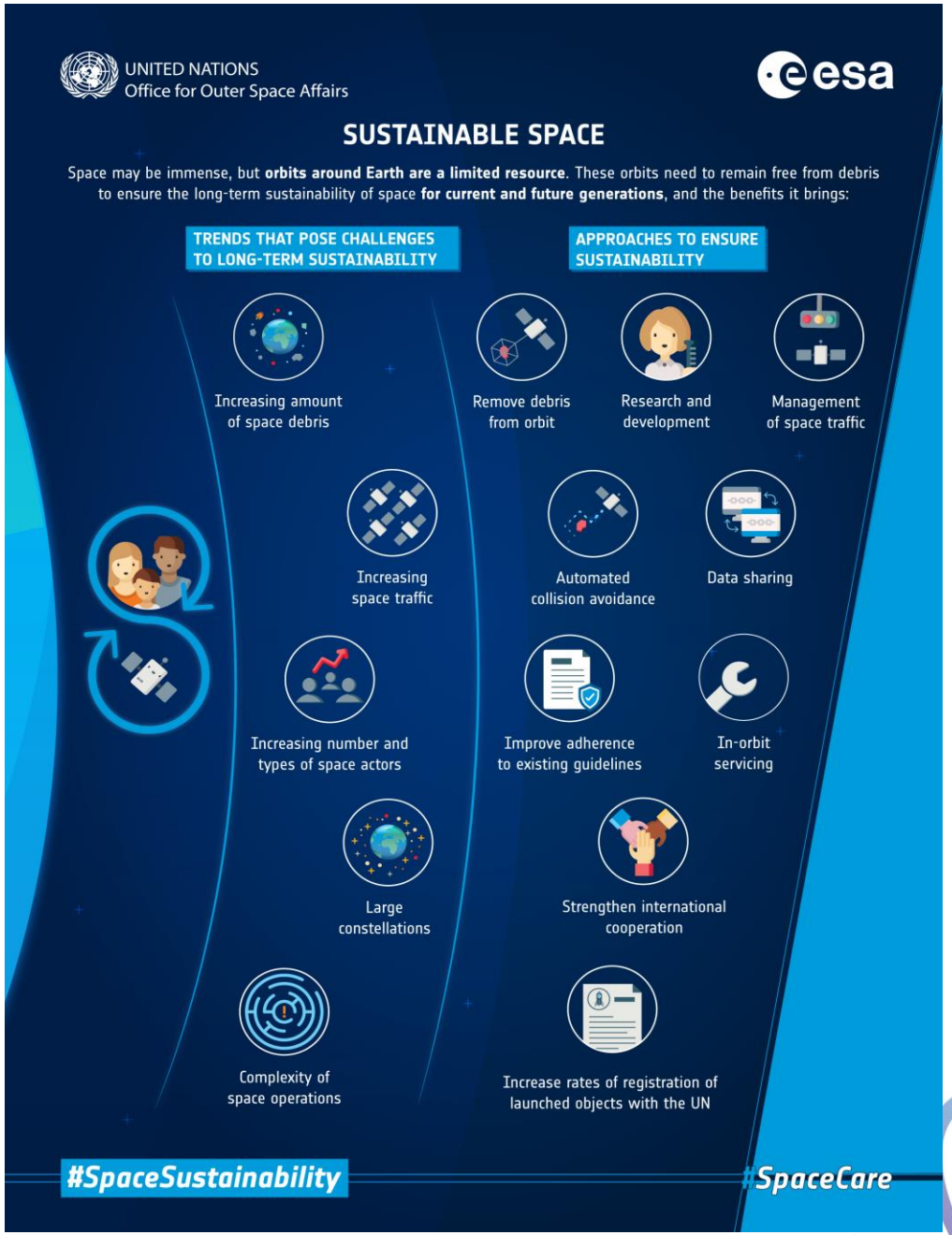

Image Source: ESA/UNOOSA

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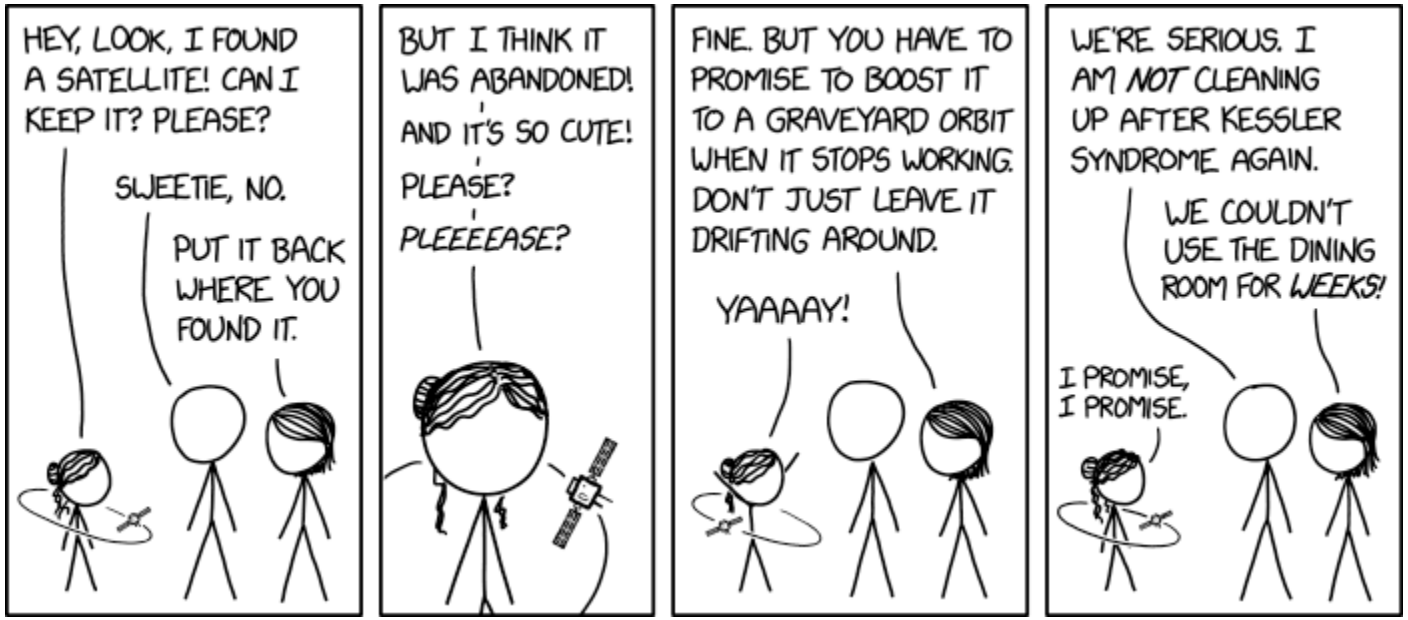
What Can the Insurance Industry Do?

- Insurance is a key enabler of the space industry
- Advocate responsible behaviour in space
- Collaborate with industry, governments and academia



Source: xkcd.com