Igniting the Imagination for Next Next Decade Planetary Deep Space Smallsats

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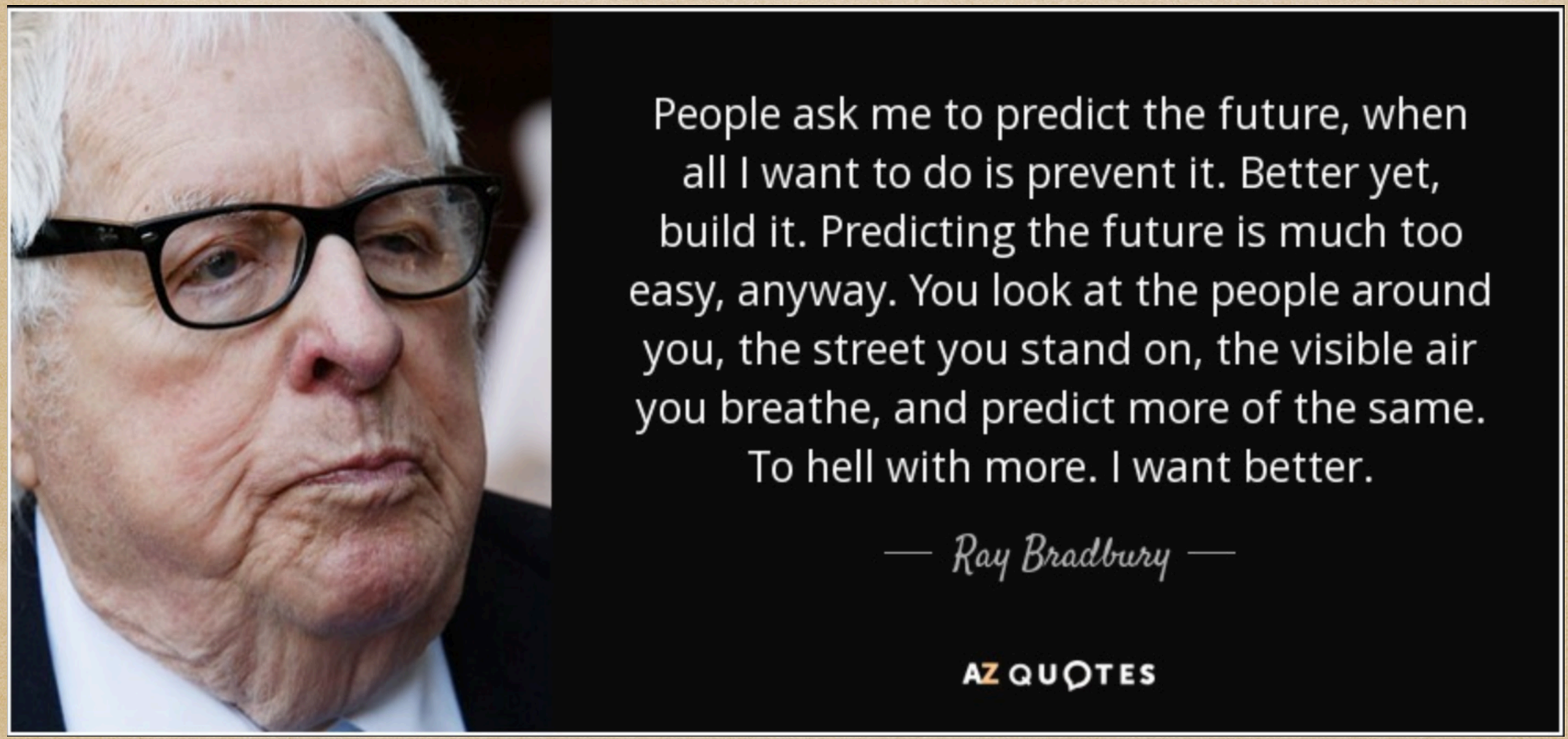
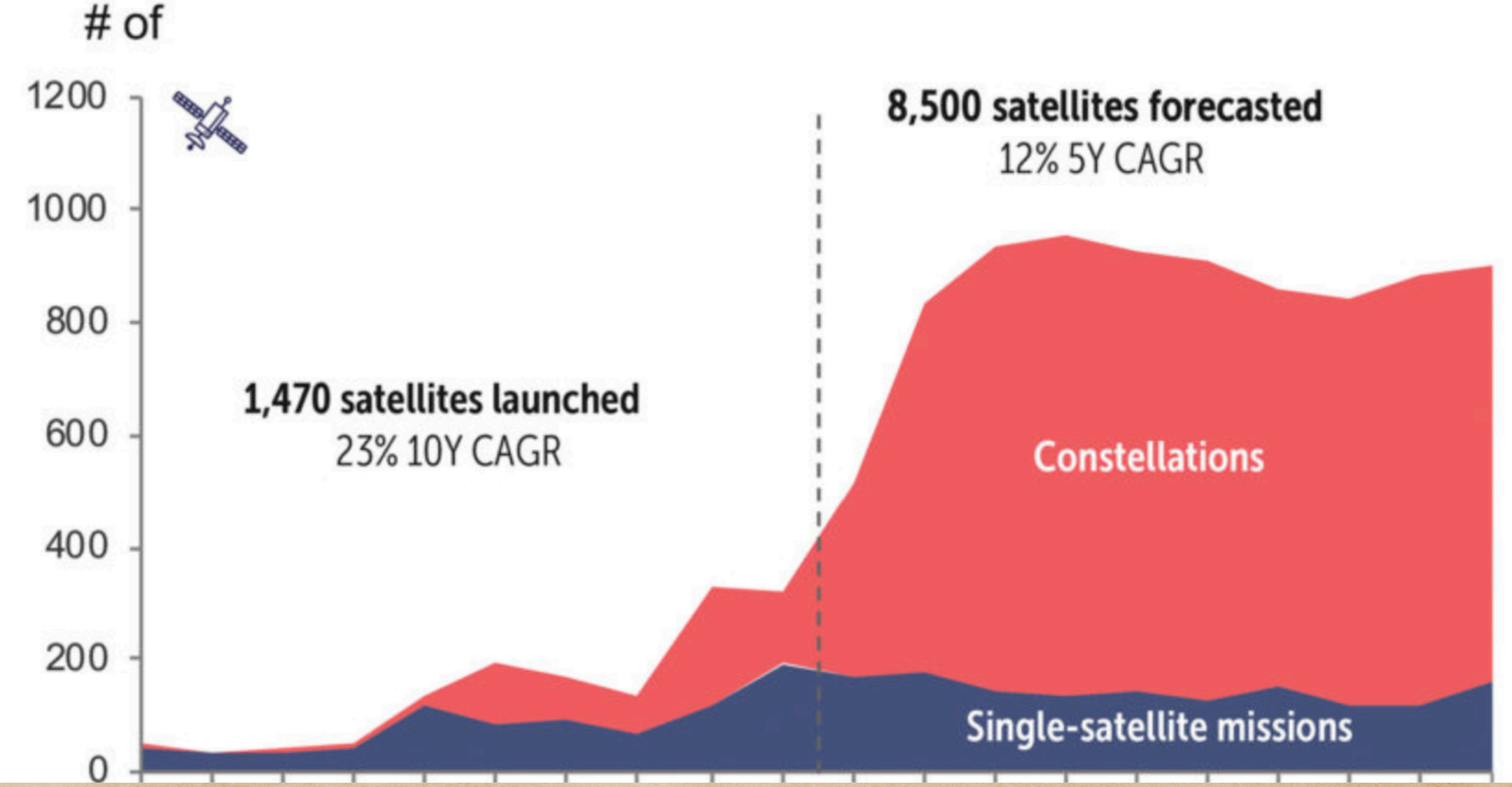
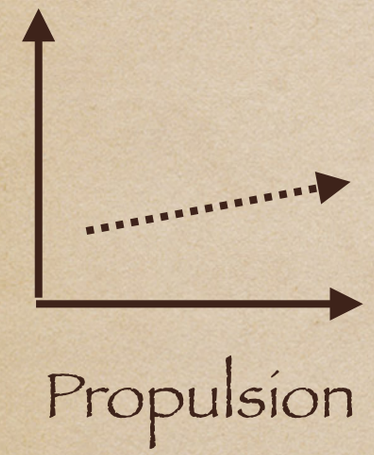

People ask me to predict the future, when all I want to do is prevent it. Better yet, build it. Predicting the future is much too easy, anyway. You look at the people around you, the street you stand on, the visible air you breathe, and predict more of the same. To hell with more. I want better.
— Ray Bradbury —
AZ QUOTES

Explosion of Earth Orbiting # and Capability

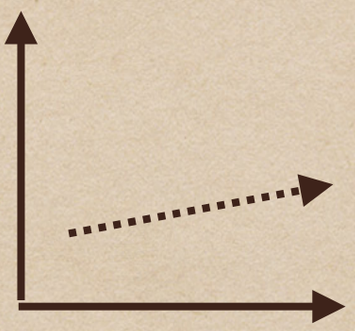
Some 8,500 satellites with a launch mass of 500 kilograms or less stand to launch between 2019 and 2028, according to Paris-based Euroconsult.



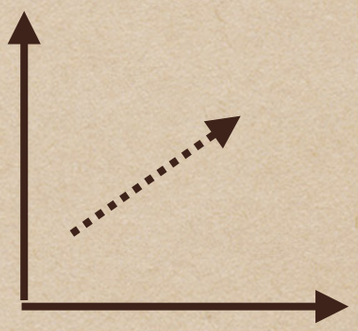
Large Increases in Earth Orbiting Capability



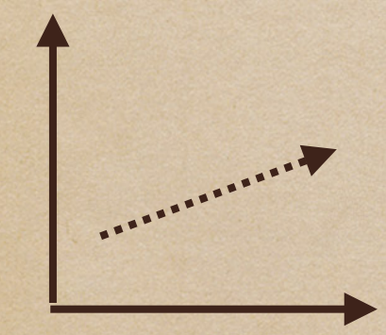
Propulsion



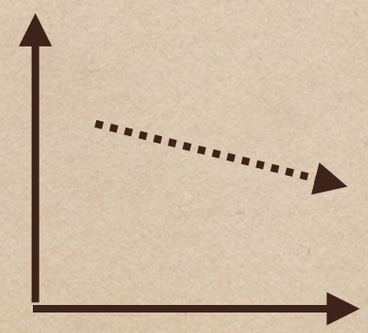
Lifetime



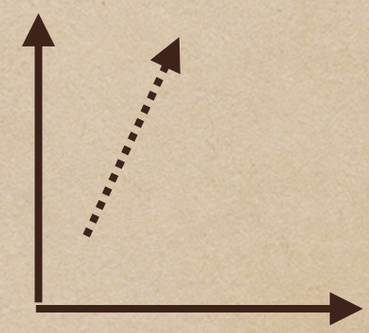
Data Rate



Intra-Satellite



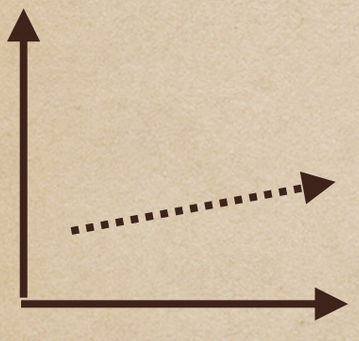
Cost



Constellation size

Which of These Apply to Deep Space?

√√



Propulsion

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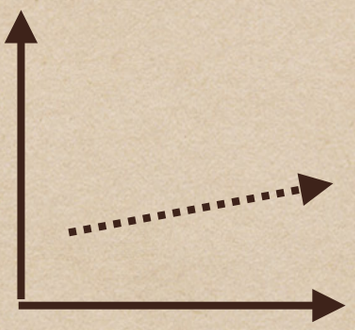

Lifetime

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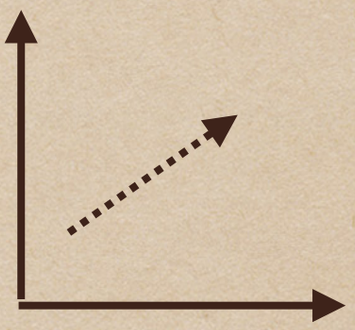
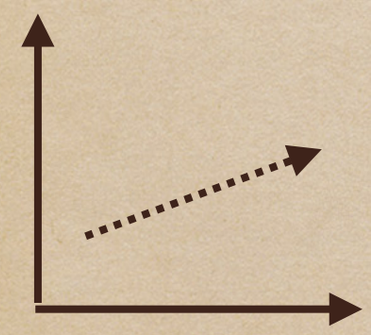


Data Rate



Intra-Satellite

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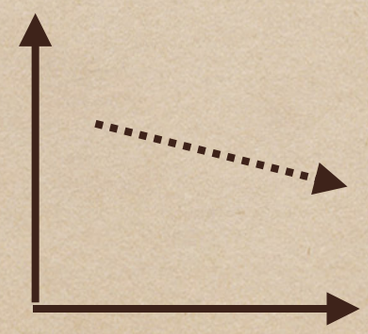

Cost

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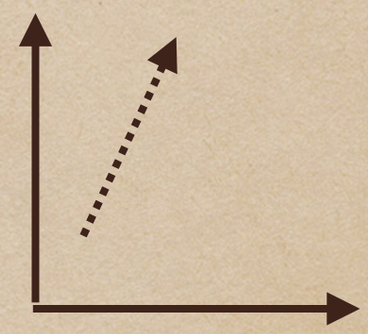
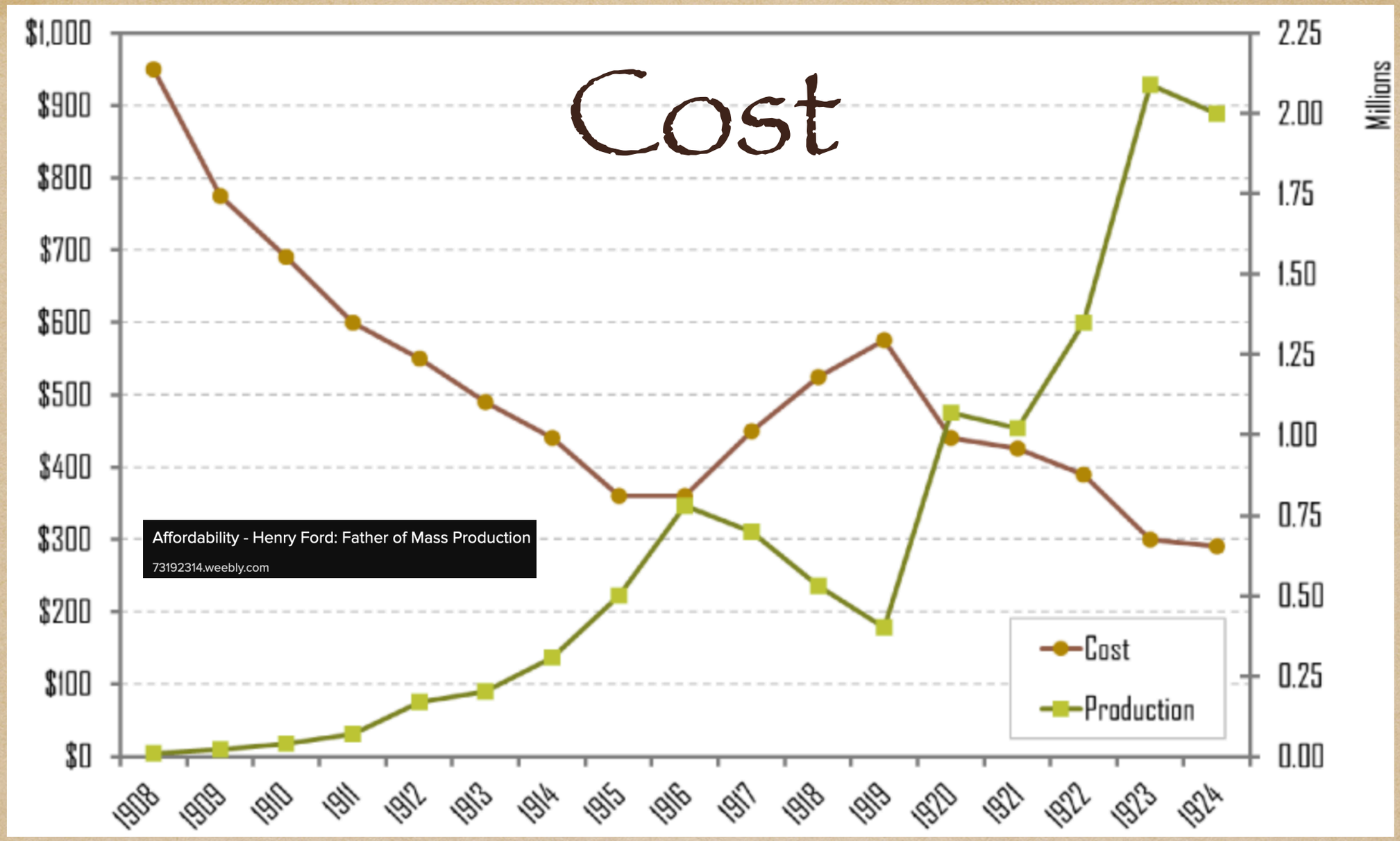


Constellation size

√

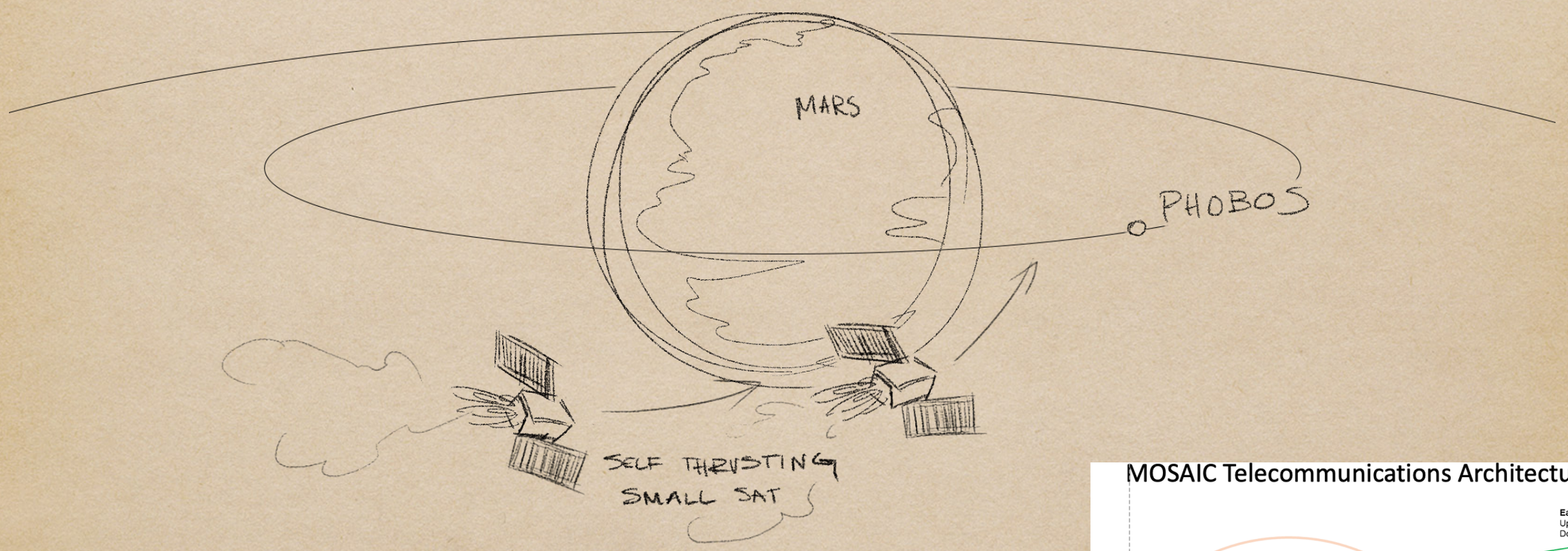
Physics Applies to Deep Space

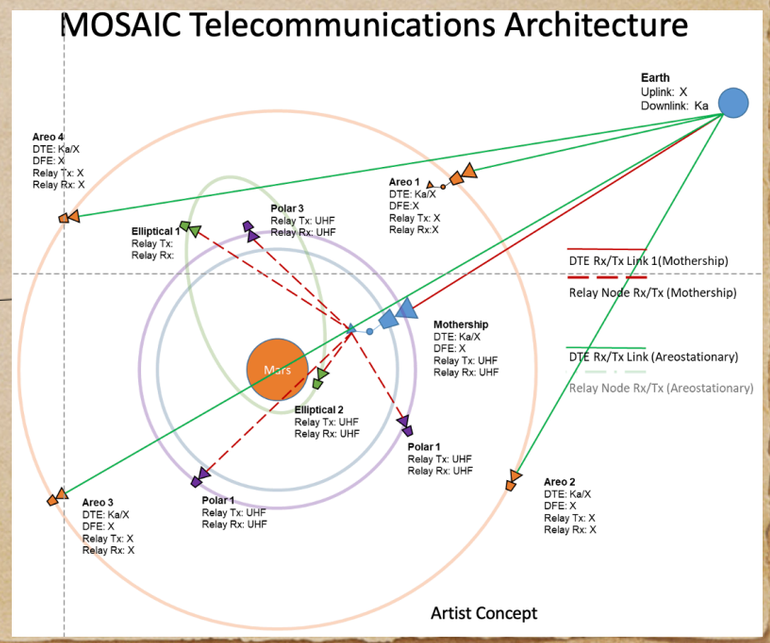
Area	Future ?	Comment
Propulsion	In miniature, much higher ΔV	Bi-prop, electric
Telecomm	Intra-satellite, deployable	Larger aperture has highest increase
Power	Deployable	What is max size possible?
Thermal	Smaller has higher power density	Cryocoolers and deployable radiators?
Instruments and Sensors	In miniature, more capable	Certain types limited by physics (for example by wavelength)



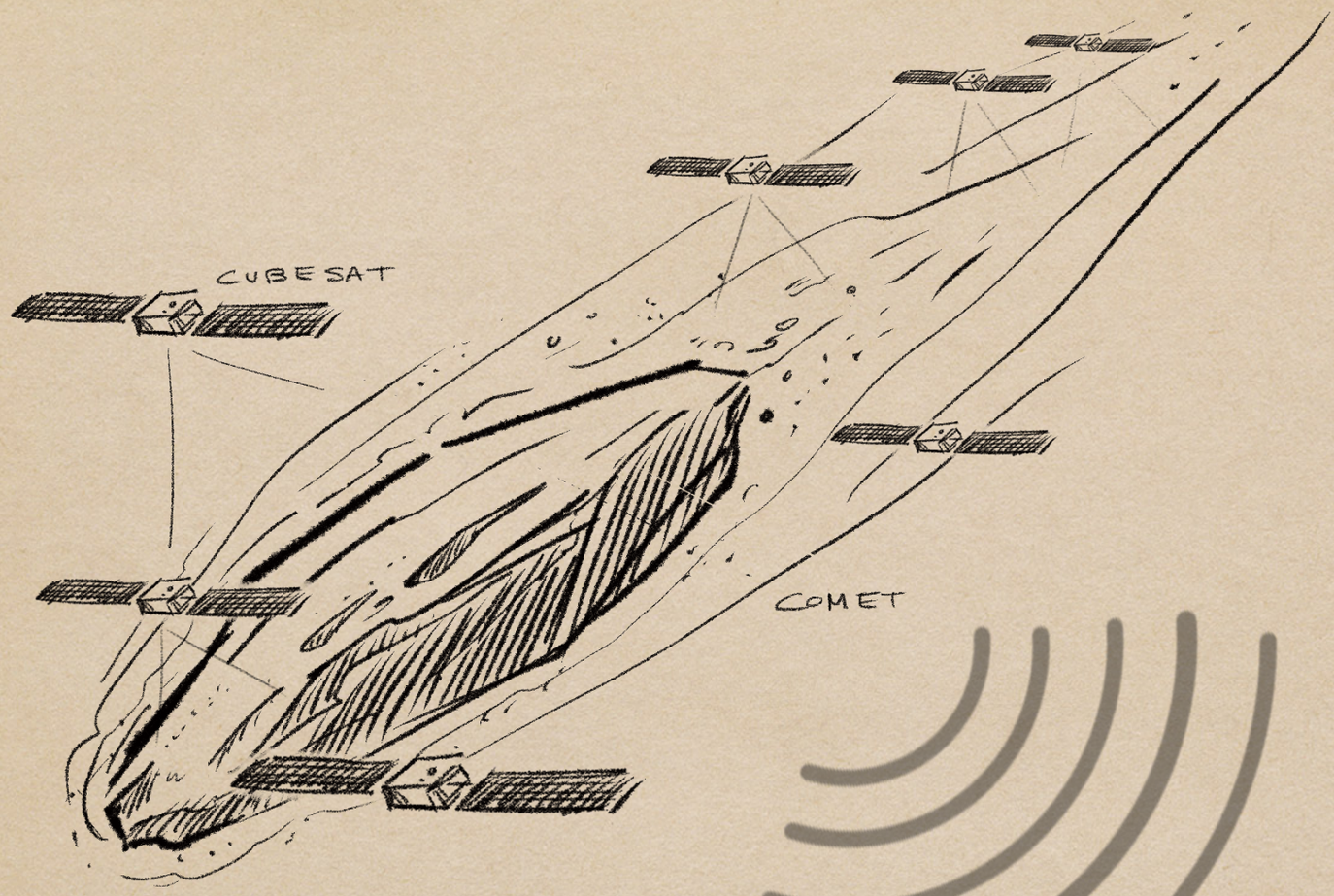
Cost must exponentially decrease in order to enable large multi-element architectures in deep space in the future

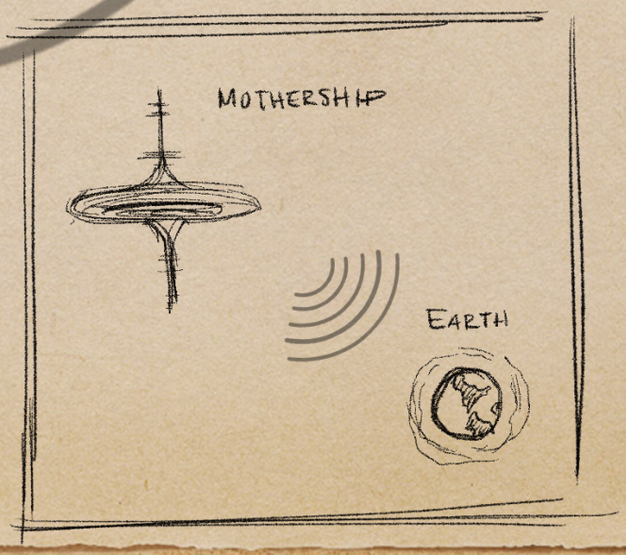
Constellation(s) for Comm/Nav, Weather, Science at Mars



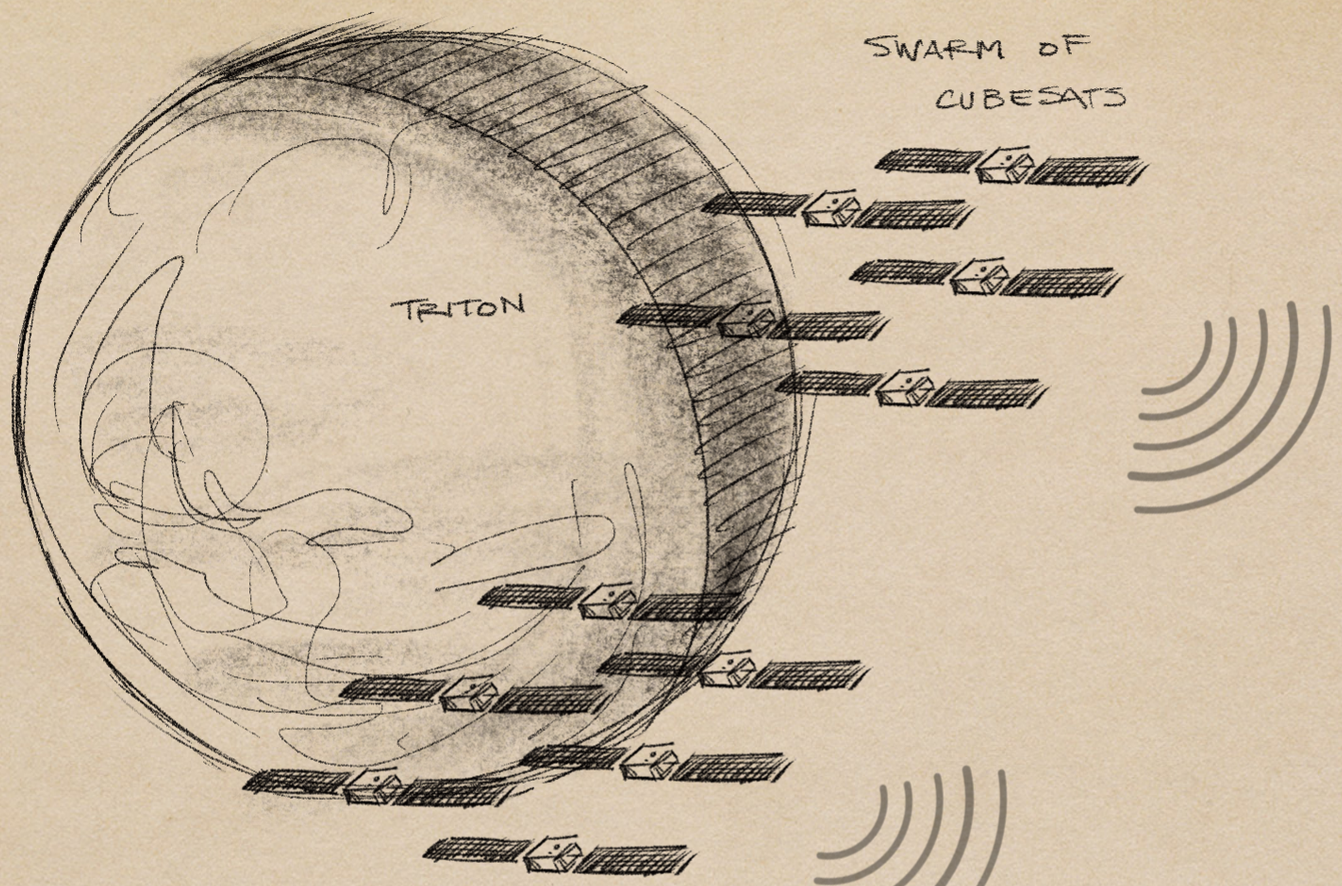


Small Body and Interstellar Object Characterization



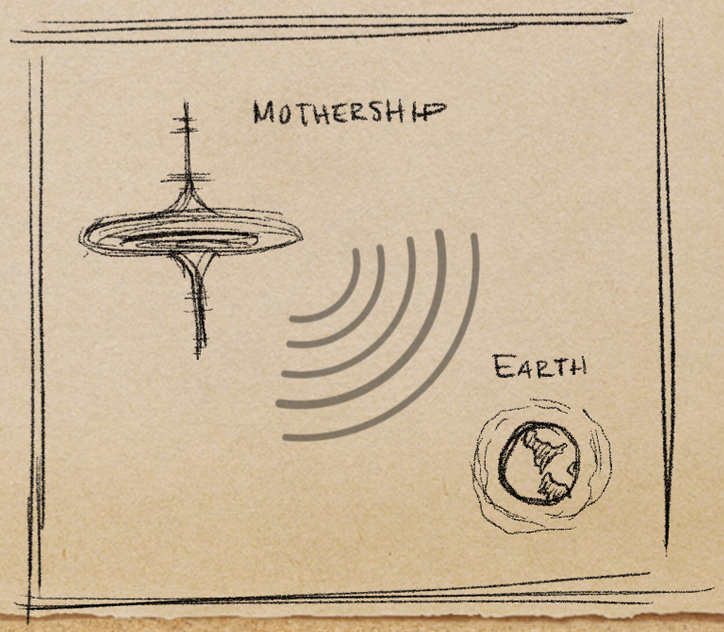


Sketches courtesy Kat J. Park, The Studio, JPL

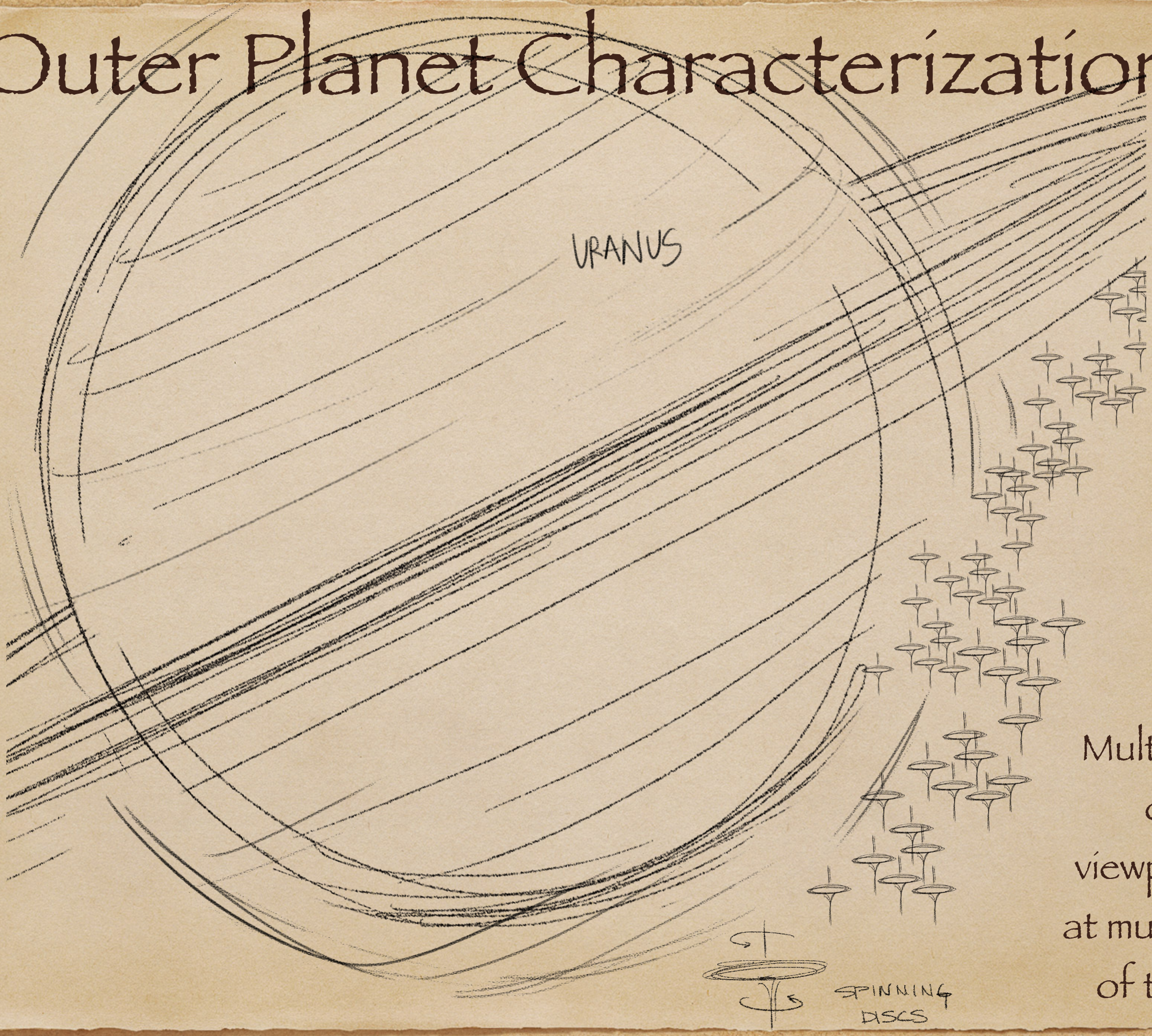


Multiple viewpoints at multiple times

Deep Space Object Characterization

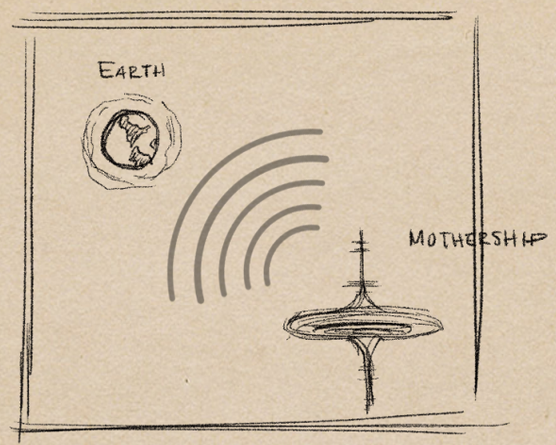


Outer Planet Characterization



Multitude of viewpoints at multitude of times

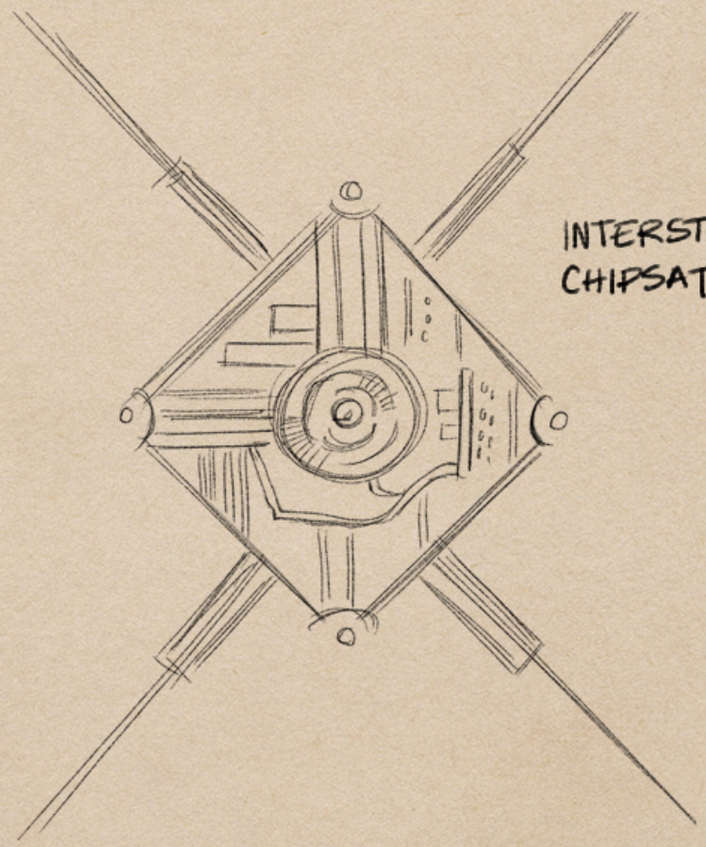
Multi-Elements to Fully Characterize High Science Value Environments



Enceladus Plume with Jets

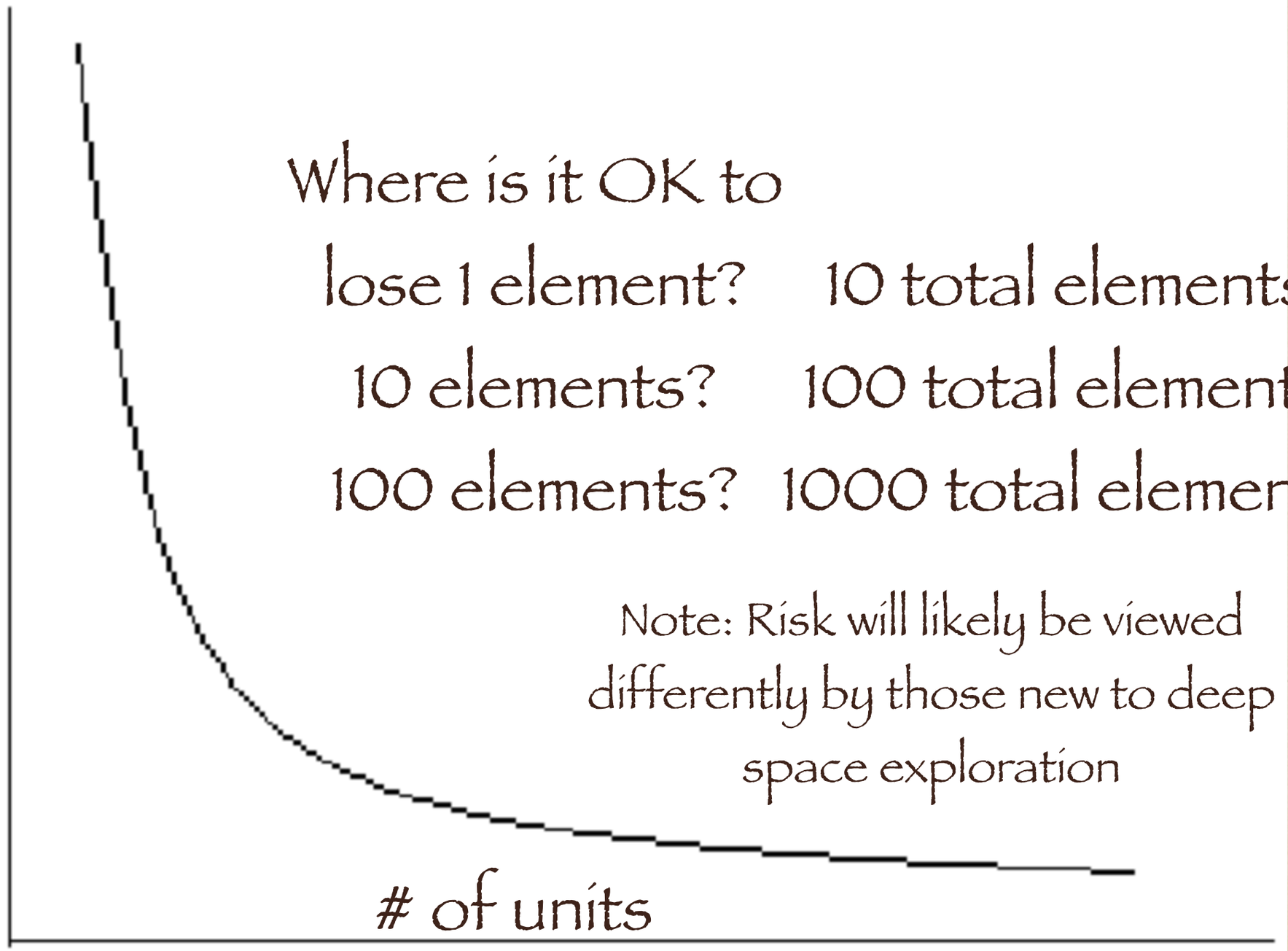
Interstellar Exploration

Next next next decade?



Interstellar Small Satellite Conference 2052?

Risk



Where is it OK to

lose 1 element? 10 total elements?

10 elements? 100 total elements?

100 elements? 1000 total elements?

Note: Risk will likely be viewed differently by those new to deep space exploration

Deep space missions are poised to benefit from Earth orbiting smallsat capabilities and cost reduction. It takes longer in deep space due to physics.

It will happen.