NC

I negate the resolution resolved: The appropriation of outer space by private entities is unjust.

Before I begin with this debate, I offer the following definitions

Appropriation

Reinstein 99 says that

Appropriation would allow private entities to claim comprehensive property rights

This is different from use which is

According to Oxford Languages

Take advantage of the value or advantage of something

Onto my fwk, My value is justice, which means the best value criterion is the one that can truly achieve justice. Thus, my criterion is consistency with libertarian ideals

Business Dictionary explains libertarian ideals as:

Philosophical principle that **[Libertarian ideals] suggest**s **that a government's involvement in** civil economical and social **matters should be limited**, **and** that the **issues should be settled amongst civilian**s. Libertarianism seeks to provide free-will participants the ability to make decisive decisions without the government determining or influencing the outcome, as long as it does not harm other individuals. Libertarianism is based off the belief that **each individual owns** every aspect of **their lives and** thus **should** have the ability to **control it.**

Prefer my criterion for the following reasons:

As a society, we generally recognize that people need individual liberties and rights. Individuals control what they do and thus we must respect their rights.. Feser:[1]

But if **individuals are** inviolable ends-in-themselves (as Kant describes them) and **self-owners**, it follows, Nozick says, **that** they **have certain rights**, in particular (and here again following Locke) rights to their lives, liberty, and the fruits of their labor. To own something, after all, just is to have a right to it, or, more accurately, to possess the bundle of rights - rights to possess something, to dispose of it, to determine what may be done with it, etc. - that constitute ownership; and thus **to own oneself is to have** such **rights to the** various **elements that make up one's self. These** rights function, Nozick says, as side-constraints on the actions of others; they set **limits on how others may**, morally speaking, **treat a person**. So, for example, since you own yourself, and thus have a right to yourself, others are constrained morally not to kill or maim you (since this would involve destroying or damaging your property), or to kidnap you or forcibly remove one of your bodily organs for transplantation in someone else (since this would involve stealing your property). **They are** also constrained **not to force you against your will** to work for another's purposes, even if those purposes are good ones. For if you own yourself, it follows that **you** have a right to

1

determine whether and **how you will use your** self-owned **body and its powers**, e.g. either to work or to refrain from working.

Individuals have rights, so people must respect your actions and cannot restrict you. This also means the government cannot restrict you unless it is to prevent harm of another person. In order to make sure these rights are protected, we have to restrict the government. Because of this, the government's only obligation is to protect rights.

Feser 2:[2]

The various programs of the modern liberal welfare state are thus immoral, not only because they are inefficient and incompetently administered, but because they make slaves of the citizens of such a state. Indeed, **the only** sort of **state that can be moral**ly justified **is** what Nozick calls a ***minimal*** *state* or "night-watchman" state, a government **which protects individuals**, via police and military forces, from force, fraud, and theft, **and administers courts** of law, but does **nothing else**. In particular, such **a state cannot** regulate what citizens eat, drink, or smoke (since this would i**nterfere with their right to use their self-owned bodies as they see fit),** **cannot control what they publish or read (since this would interfere with their right to use the property they've acquired with their self-owned labor - e.g. printing presses and paper - as they wish),**

This implies that anything the government does that is not either for protection or administering the courts is not just. So we have to minimize the government in order for it to not overstep its authority.

Also, if a government has total control over society they can become corrupted easily. They have no one to be accountable to and thus can abuse their power. Thus, we have to restrict governmental authority

2

C1 – Equality for private entities

1] Denying direct private appropriation of outer space exacerbates preexisting inequalities and access to property creating an extremely unequal playing field. Rebecca Lowe, a political philosophy and economic researcher who specializes in moral property rights, writes on February 10, 2022,

Lowe, Rebecca, "Space Invaders: Property Rights on the Moon", 10 February 2022, https://www.adamsmith.org/research/space-invaders

Perhaps it is time, therefore, to consider a different approach. Problems regarding the reaching of **international consensus are not the only flaws in a nation-focused approach**, after all. It is also the case that **such an approach can leave little opportunity for the individual, particularly in nations where particular groups of individuals are oppressed**. In other words, **it would hopefully be the case that democracies would find ways to share fairly amongst their citizens the opportunities of the national appropriation of space**, when such appropriation was made legal — through tenders, shareholder schemes, other market mechanisms, lotteries, or various types of state-determined allocation. **Under such approaches, for instance, if democratic Country A was newly allowed to appropriate a certain amount of space land, then separable parts of this amount could, for instance, be made up for grabs amongst competing citizens, on fair terms**. But **the same could not be expected from authoritarian regimes. There is an egalitarian argument, therefore, that the arbitrary oppression of opportunity that some individuals already face simply by being born in, or otherwise inhabiting, particular countries should not be further entrenched by a nation-focused approach to the governance of space opportunities.**

2] Private companies are the ones who bear the financial and reputational burden of space exploration, and not only would their ability to appropriate improve their capability to help the world but they also have a direct right to it. Rebecca Lowe continues,

Lowe, Rebecca, "Space Invaders: Property Rights on the Moon", 10 February 2022, https://www.adamsmith.org/research/space-invaders

It is clear that the private sector now drives certain space capacities. And **private space companies have had many notable recent successes, including high-profile partnerships with national and international space missions**. Nonetheless, it remains the case that **these companies are typically highly dependent on taxpayer support**: even the most successful private space companies often depend, directly or indirectly, on state grants or preferment, **and have the powerful incentive of aiming to win big government contracts**. Even so, **the situation has clearly changed. Space is no longer the preserve of the state; space development is more dependent on the private sector than ever.** It seems likely, therefore, that **private companies will continue to increase investment in space exploration, leading to greater competition between a growing number of players**. And **this will likely have the benefit of driving up standards and reducing costs, decreasing firms' dependency on inflexible direct state support, and enabling taxpayer money to be spent elsewhere**. Regardless of such predictions, however, **there is a strong argument that firms and individuals deserve to be able to gain some 'skin in the game' in the form of space ownership opportunities, as they are**

bearing an increasingly significant portion of the serious financial and reputational risk of space progress.

Case v1

Subpoint A: Mining

Asteroid mining offers incredible economic gains

Reinstein 99

Ezra J. Reinstein (JD, Associate at Kirkland & Ellis), Owning Outer Space, 20 Nw. J. Int'l L. & Bus. 59 (1999). JDN. https://scholarlycommons.law.northwestern.edu/njilb/vol20/iss1/7

Perhaps the most lucrative area of development is the mining of celestial bodies. On the moon, an assay of only 30 km2 of the lunar surface during Apollo-17 turned up deposits of Helium-3, a radiation-free fusion reactor fuel, practically nonexistent on Earth, that is more efficient than any radioactive fuel currently available.6 So-called near-Earth asteroids ("NEAs"), six are closer to Earth than our moon and more than 50 closer than Mars,7 might also be optimal targets for early development. The smaller of these asteroids have negligible gravitational fields, which would reduce fuel costs far below what is necessary for a lunar mission. **Many of these NEAs seem to be rich in raw materials that are either rare and valuable on Earth, or common on Earth, needed in space,** but expensive to launch.8 For instance, there is accumulating evidence that some NEAs contain **gold**, rhenium, germanium, and **platinum-group metals** -- platinum, palladium, iridium, **osmium**, rhodium, and ruthenium -- at concentrations of up to 100 times those that are mined on Earth.9 Glenn Reynolds 0 has observed**, "The smallest known near-Earth metal asteroid contains more metal than has been mined by humanity since the beginning of time.""** It has been estimated that 2,000 NEAs larger than 1 km in diameter exist.12

Asteroid mining protects the environment—it leads to solar-powered satellites and offsets terrestrial extraction

Taylor 19

Chris Taylor is a veteran journalist. Previously senior news writer for Time.com a year later. In 2000, he was named San Francisco bureau chief for Time magazine. He has served as senior editor for Business 2.0, West Coast editor for Fortune Small Business and West Coast web editor for Fast Company. Chris is a graduate of Merton College, Oxford and the Columbia University Graduate School of Journalism. "How asteroid mining will save the Earth — and mint trillionaires." Mashable, 2019, mashable.com/feature/asteroid-mining-space-economy. [QC]

The mission is essential, Joyce declares**, to save Earth from its major problems**. First of all, the fictional billionaire wheels in a fictional Nobel economist to demonstrate **the** actual truth that **the entire global economy is sitting on a mountain of debt**. It has to keep growing or it will implode, **so we might as well take the majority of the industrial growth off-world where it can't do any more harm to the biosphere**.

Secondly, there's the climate change fix. **Suarez sees asteroid mining as the only way we're going to build solar power satellites**. Which, as you probably know, is a form of uninterrupted solar power collection that is theoretically more effective, inch for inch, than any solar panels on Earth at high noon, but operating 24/7. (In space, basically, it's always double high noon).

The power collected is beamed back to large receptors on Earth with large, low-power microwaves, which researchers think will be harmless enough to let humans and animals pass through the beam**. A space solar power array like the one China is said to be working on**

could reliably supply 2,000 gigawatts — or over 1,000 times more power than the largest solar farm currently in existence.
"We're looking at a 20-year window to completely replace human civilization's power infrastructure," Suarez told me, citing the report of the Intergovernmental Panel on Climate Change on the coming catastrophe. **Solar satellite technology "has existed since the 1970s. What we were missing is millions of tons of construction materials in orbit. Asteroid mining can place it there."**
The Earth-centric early 21st century can't really wrap its brain around this, but the idea is not to bring all that building material and precious metals down into our gravity well. Far better to create a whole new commodities exchange in space. You mine the useful stuff of asteroids both near to Earth and far, thousands of them taking less energy to reach than the moon. That's something else we're still grasping, how relatively easy it is to ship stuff in zero-G environments.

Subpoint B: Innovation

Competition in space between private entities lowers costs and barriers of entry for other companies increasing technological innovation

Lizzy **Gurdus**, FEB 27 **2021**, CNBC, "Private companies such as SpaceX are driving costs down for everyone in the space race, says man behind UFO ETF", [https://www.cnbc.com/2021/02/27/private-companies-like-spacex-are-driving-industry-costs-down-ceo.html] ahs ja

Private space companies are paving the industry's path to profits, says the man behind the Procure Space ETF (UFO). By **taking part** in the rapidly developing "space race," billionaire-backed entities **such as Elon Musk's SpaceX and Jeff Bezos's Blue Origin are lowering costs across the board**, ProcureAM CEO Andrew Chanin told CNBC's "ETF Edge" this week. "They're able to get the cost of launch down and that's going to allow more companies to send things into outer space cheaper," Chanin said in the Wednesday interview. "They're really **opening up the entire environment for space companies and future** would-be space companies to lower those barriers of entry." They're **also lowering costs** for government-sponsored space programs by competing amongst themselves for NASA contracts, Chanin said. "They're **actually freeing up more of NASA's budget to be able to invest in other areas of space**, he said. "This competition I think is very healthy. Not necessarily every company's going to be a winner, but hopefully this competition can drive down prices and also let the best technologies win." NASA now also has contracts with more than 300 publicly traded U.S. companies, said Chanin, whose UFO ETF counts Loral Space & Communications and Gilat Satellite Networks as its top two holdings. "It's not just necessarily a pure-play space company that might get a contract," the CEO said. "It's really opening up opportunities for everyone." That's why it's important to look beyond name recognition in this particular area of investing, Matthew Bartolini, State Street's head of SPDR Americas research, said in the same "ETF Edge" interview. State Street offers the SPDR S&P Kensho Final Frontiers ETF (ROKT), the first space ETF to hit the market. The fund's top three holdings are Maxar Technologies, Virgin Galactic and Aerojet Rocketdyne. Bartolini recommended "to not just look at the high-flying names like SpaceX or Blue Origin that are in the private markets, but showcase what companies in the public markets help supply them." Aerojet Rocketdyne, which defense giant Lockheed Martin is buying in hopes of competing with private space companies, played a key role in Blue Origin's New Shepard rocket launch, Bartolini said. "You can see the derivative effects of a private company impacting the public markets just from that one example of Lockheed and Aerojet," he said. "It helps underscore the opportunity that you're seeing in space." As space companies embrace greater efficiency, more government support and more commercial applications on Earth in areas such as satellite technology, that opportunity is likely to grow and continue to filter into public markets, Bartolini said. Morgan Stanley has said the global space industry could produce revenues of over $1 trillion by 2040. Current global revenues are roughly $350 billion. UFO and ROKT both fell by more than 1% on Friday. UFO is up over 14% year to date, while ROKT is up nearly 2%.

Private Space increases innnovation

Seetha **Raghava**, August 4th **2021**, UFC TODAY, “The Impact of Innovation in the New Era of Space Exploration”, [https://www.ucf.edu/news/the-impact-of-innovation-in-the-new-era-of-space-exploration/] ahs ja

Every once in a while, a confluence of discoveries, events and initiatives results in a breakthrough so significant that it propels the entire world to a higher level, redefining what is possible in so many different fields. This breakthrough is taking centerstage now, as the new era of space exploration — catalyzed by increasing launch access — dawns upon us. The surge of innovation that comes with this will create new opportunities and inspire the next generation of doers. When this happens, boundaries between scientific and social impact are blurred. Innovation leading to scientific discovery can benefit society in the same way that social innovation can diversify and support scientific innovators, who can **contribute to global progress** To ride this wave of progress, **we must all participate and innovate in the new era of space exploration** The intersection of space exploration, innovation and impact isn’t a new phenomenon. In the past, technology developments and spin-offs from space research have consistently found their way into communities worldwide sometimes with lifesaving benefits. The International Space Station supports experiments that have led to discoveries and inventions in communication, water purification, and remote guidance for health procedures and robotic surgeries. Satellite-enabled Earth observation capabilities that monitor natural disasters, climate and crops often support early warnings for threats and mitigation strategies. Space exploration has always been relevant to everyone no matter the discipline or interest. **Commercialization of space has been key** in many ways to the current boost **in “firsts” over the last few years**. It has spurred innovation in launch vehicles and related technologies that led to firsts in vertical-takeoff-vertical landing rocket technology, reusability of rocket boosters and privately developed crewed missions to orbit. Concurrently, NASA has continued to captivate our imagination with the first flight of a helicopter in another world, a mission to return an asteroid sample to Earth and sending a probe to make the closest ever approach to the sun. While we celebrate the scientific progress, there is a vastly important question that we all need to focus on: How can we drive the surge in innovation offered by increased access to space, to benefit humankind? Access to low-Earth orbit, and eventually human exploration of space, is a portal to achieve many impactful outcomes. The numbers and completion rate of microgravity experiments conducted by scientists will be greatly increased as a range of offerings in suborbital flights provide more opportunities to advance critical research in health, agriculture, energy, and more. Lunar, planetary, and even asteroid exploration may lead to discoveries of new materials — busting the limitations now imposed on capabilities for energy, transportation, and infrastructure or creating new sensors and devices that enhance safety on Earth. Space tourism —one can hope — has the power to potentially create an awareness of our oneness that may lead to social change. But much like all scientific endeavors, we cannot ignore the importance of pre-emptively identifying and mitigating negative impacts of new ventures some of which may have already taken shape. We need to consider space debris that threatens the very access that facilitates it, safety and rescue readiness to support increased crewed missions and space tourism, national security, and effects of light pollution on astronomy. Much of these can be approached and mitigated with new concepts and ideas that have already been set in motion. One thing is for certain, space has always been the inspiration for the next generation of innovators and creative thinkers. Architects of new ideas in this era will inspire many more. Ingenuity must also come from academic and research institutions building a new space-ready generation through innovative curriculum, scholarships, and research opportunities for key fields at all levels. Most of all, engaging participation is a responsibility anyone can take by steering the conversation and gathering ideas on how we can make this era one of positive benefit for all, while making opportunities inclusive to all.

Case v2

Debris

Asteroid mining would occur on asteroids, which are literally in the asteroid belt. They have ZERO internal link about how space dust would affect satelites that are around Earth. The Asteroid Belt is quite far, Williams 16

AUGUST 10, 2016 BY MATT WILLIAMS, "How Far is the Asteroid Belt from Earth?" https://www.universetoday.com/130136/far-asteroid-belt-earth/ //LHP AV

Distance from Earth: The distance between the Asteroid Belt and Earth varies considerably depending on where we measure to. Based on its average distance from the Sun, the distance between Earth and the closest edge of the Belt can be said to be between 1.2 to 2.2 AUs, or 179.5 and 329 million km (111.5 and 204.43 million mi). But of course, at any given time, part of the Asteroid Belt will be on the opposite side of the Sun relative to us as well. From this vantage point**, the distance between Earth and the Asteroid Belt ranges from** 3.2 and 4.2 AU – 478.7 to 628.3 million km (**297.45 to 390.4 million mi**). To put that in perspective, **the distance** between Earth and the Asteroid Belt **ranges from being slightly more than the distance between the Earth and the Sun** (1 AU), to being the same as the distance between Earth and Jupiter (4.2 AU) when they are at their closest.

And, Jupiter is our savior, Louise 21:

Nickie Louise, NOVEMBER 7, 2021,"Here is how Jupiter protects Earth from asteroids and saves us from destruction," https://techstartups.com/2021/11/07/jupiter-protects-earth-asteroids/ //LHP AV

Have you ever wondered why asteroids have not hit our planet? Asteroids are small, rocky, or metallic objects orbiting the Sun. Most Asteroids are usually a little over 1 meter in diameter. The largest asteroid is Ceres, which has a diameter of 965 kilometers (600 miles). But most asteroids, including Ceres, are located in the asteroid belt between Mars and Jupiter, but some come near to or cross Earth's orbit. So how is **our planet protected from these asteroids**? **The answer lies in Jupiter's gravity**. We all know that Jupiter is the largest planet in our solar system. Jupiter is also a gaseous beast of a planet 318 times more massive, 11 times larger than Earth, and 2.5 times bigger than all the other planets combined. Surprisingly, most planetary systems don't have a gas giant like ours; only about 15 percent of planetary systems appear to. For a long time, scientists haven't exactly known what lies beyond the violent swirling clouds in the atmosphere. As it turns out, Jupiter is more than just an enormous ball of gas spinning a few hundred million miles farther out in the solar system–**Jupiter protects Earth and the other inner planets from destruction by deflecting comets and asteroids**. According to a paper published in the Proceedings of the National Academy of Sciences in May 2015, two scientists are suggesting that the inner solar system once played host to a bunch of "super-Earths" — planets that were larger than our own but smaller than Neptune. Jupiter, however, put an end to those early occupiers of the inner orbits, bulldozing in and sweeping them into the sun. The two scientists suggested that the inner solar system once played host to a bunch of "super-Earths" — planets that were larger than our own but smaller than Neptune. The planet is so vast that its gravity helps to pull and interrupt most potential asteroids from hitting Earth. There is more gravity on Jupiter than on Earth. Someone who weighs 100 pounds on Earth would weigh about 240 pounds on Jupiter. Konstantin Batygin of Caltech, one of the authors of the paper said: "Our work suggests that Jupiter's inward-outward migration could have destroyed the first generation of planets and set the stage for the formation of the mass-depleted terrestrial planets that our solar system has today." Jupiter, however, put an end to those early occupiers of the inner orbits, bulldozing in and sweeping them into the sun, according to a paper published this week in the Proceedings of the National Academy of Sciences. Jupiter's epic, the planet-shattering journey toward the sun and back out again laid the foundations for the creation of Earth and the other smaller planets nearby — Mercury, Venus, and Mars. So next time when you look at the sky, take a moment to thank Jupiter. Below is a video of how Jupiter saves Earth from destruction.

If it can deflect asteroids, it would obviously pull space dust.

Space junk is already orbitting us, and the aff can never solve the root cause – at best, they only reduce new debris. – but the only way to guarantee debris crashes don't happen is to actually remove the debris instead of just marginally stopping how much new debris gets created (bucket example can be used in 2n). According to Rhimbassen, private appropriation is key to active debris removal, also known as ADR, the only real, long-term solution to debris,

Maria Lucas-Rhimbassen*, Cristiana Santos*, George Antony Long**, Lucien Rapp* 2019, "Conceptual model for a profitable return on investment from space debris as abiotic space resource" https://chaire-sirius.eu/documents/c798f8-eucass-fp0602-1906190421.pdf

Indeed, **new technological initiatives evolving around ADR confirm the possibility of recycling space debris and transforming them into fuel**. Such initiatives come from, among others, the public sector (e.g. DARPA), spin-offs such as Russian Space Systems stemming from public agencies, which announced successful developments earlier in 2019, and **the private sector, such as the Australian start-up Neumann Space, which is among the first actors to look into the technology from a business model angle. Policy and legal limitations include, but are not limited to, the fact that space**

debris, regardless of their partial or total dysfunctionality, are under the jurisdiction and control of the State having registered it (registry or mon commonly referred to as the launching State [4]). **Registry State jurisdiction and control can only be transferred to another State, not to a private entity**. Indeed, Article VIII of the Outer Space Treaty of 1967 (OST) decrees that the nationally registering launching State retains "jurisdiction and control" of any launched spacecraft or component part. Article VIII reads, in relevant pat, as follows: "A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth [5]". **Under Article VIII, the owner (operator) of a satellite or space object retains its ownership rights at all time [6]. Likewise, title to a satellite as well as any component part of a satellite always remains with the owner as space law does not provide for any divesting of title. Therefore, no actor other than the Registry State or owner has the right to rendez-vous a decommissioned satellite or consent to the extraction or recycling of each particular piece of space debris. This circumstance bars the rush to space debris and lessens the expectations of economic incentives in that respec**t. Other policy limitations include the perceived or real dual nature (civil and military) of ADR and consequently a reluctance from the Department of Defence (DoD) to facilitate/enforce military ADR which might add tensions to the already "congested, contested and competitive" space domain. Furthermore**, policy was adopted by no other than NASA to limit its own ADR capacity for several reasons, budget being one of them: "While these small research and development grants are a step in the right direction, NASA has also decided to set strict limits on its investment in carrying research and development of ADR technologies forward. In June 2014, NASA formally adopted a policy to limit its ADR efforts to basic research and development of the technology up to, but not including, on-orbit technology demonstrations. It is believed that the main reason for this limitation was an unwillingness by NASA to take on a potentially costly major new initiative without additional funding** from Congress [7]". Our paper will try to reconcile these divergences and propose a model taking into account legal, policy and economic needs, all the more since the Technology Readiness Level (TRL) seems to take a maturing path. The stakes reside into boosting the Demand Readiness Level (DRL), still on the rocks, by ensuring a constructive, prosperous and thriving market, especially at a time when cleaning space is becoming an emergency for maintaining the security of critical space infrastructure [8]. Our model will essentially rely on the space insurance (both property and liability) as the nexus for an innovative solution from the legal, policy and economic standpoints. Our rationale is to upgrade, from a top-down approach, the on-orbit property insurance regime from optional to compulsory, and the onorbit liability regime from fault-based to absolute (or strict as in environmental law), getting thus rid of the difficult burden of proving fault in orbit, which is still required within the Convention on International Liability for Damage Caused by Space Objects of 1972 (Liability Convention). As of now, property and liability insurance are required in some States only at the launching phase. Since all objects launched into space are under the ultimate liability of the Registry or "launching" State in case of harming a third party, some States require further liability insurance caps. However, currently, on-orbit property insurance remains only optional and liability kicks in if fault is established and proven, which is difficult, which may deter OOS efforts and ADR initiatives such as recyclers.

AT Mining

Asteroid mining isn't profitable and doesn't tradeoff with terrestrial mining

Elvis 17 [(Martin, X-Ray Astronomy PhD @Leicester University, A. Stark, B. Stalder, and C. Desira) "Astronomical Prospecting of Asteroid Resources," European Planetary Science Congress, 2017] TDI

Asteroids number in the millions and the total mass of industrially useful raw materials they contain is far vaster than the accessible materials in the Earth's crust [6]. This abundance has drawn great attention lately with a number of commercial companies developing ways to prospect for the most promising asteroids.

The mining industry term for commercially profitable concentrations of materials is **ore-bearing**. A rich vein of the desired material is not enough. A **profit** is essential. Ore-bearing is a technology dependent term. Improved methods can change material into being ore-bearing. It is also economics dependent, as a drop in price can render material non-ore-bearing, and vice versa.

There are a series of **physical factors** that **reduce** the number of asteroids that could be profitable to mine with current technology [3]. In total there remain many potentially ore-bearing asteroids, but as a fraction of the total among known NEAs they are **quite rare**, roughly **1 in 660**, or 1 in 66 if low delta-v asteroids are preselected.

This fraction could rise if a thermal infrared survey of NEAs were undertaken, as the optically dark carbonaceous asteroids may well be far more common in such a survey [7]. Until at least the mid2020s though we have only NEAs selected by their reflected optical light.

If a low delta-v NEA is selected at random some 100 must be visited to find one ore-bearing asteroid. Instead, if a rough classification into one of the 3 main type: stony (S), carbonaceous (C) or uncertain, and possibly metallic (X), then this number can be reduced to about 10 [4]. Cutting the number of spacecraft probes by an order-of-magnitude may be enabling for the closing of the business case.

Unfortunately, current investigations of NEAs, while highly successful at discovery, **fall behind** on the **information gathering** needed for prospecting [1]. Of the 2000 or so NEAs being discovered each year, **almost half** have **ill-determined orbits** in the sense that they will be almost **impossible** to **re-acquire** at their **next close approach** ("apparition"). An even greater fraction, ~**90%**, have **no spectral information**, and so have **undetermined types**.