## 1

#### Interp: The affirmative must specify jurisdiction in a delimited text in the 1AC.

#### Jurisdiction is flexible and has too many interps – normal means shows no consensus and makes the round irresolvable since the judge doesn’t know how to compare between types of offense and o/w since it’s a side constraint on decision making – independently turns judicial application.

Maggie **Koerth-Baker, 15** [Maggie Koerth-Baker, (Maggie Koerth, formerly known as Maggie Koerth-Baker, is an American science journalist. She is a senior science editor at FiveThirtyEight and was previously a science editor at Boing Boing and a monthly columnist for The New York Times Magazine.)]. "Who Makes the Rules for Outer Space?." No Publication, 10-30-2005, Accessed 12-13-2021. https://www.pbs.org/wgbh/nova/article/space-law/ // duongie

#### But while the rules of empire are pretty neatly spelled out in the treaty—no nukes, no planting a flag and claiming anything in space as your country’s territory—the rules of commerce aren’t quite as clear-cut. Now, almost 50 years later, with a private space race underway in the United States, lawyers and politicians are starting to really hash out what it means for a government to be responsible for a corporation and what the fair use of space should look like. With President Barack Obama’s signing of the U.S. Commercial Space Law and Competitiveness Act, it’s a discussion that’s likely to grow more heated. Basics of Space Law A fundamental tenet of space law—the concept of governments being responsible for the work of non-governmental actors—has few, if any, precedents. There are places on Earth that are governed by laws similar to those that govern space—the sea, for instance. But no country is inherently responsible for whatever its citizens do when they’re out in international waters, says Joanne Gabrynowicz, professor of space law at the University of Mississippi and editor-in-chief of the Journal of Space Law . If that were the case, every pirate would technically be a privateer—their buckles swashed with official state approval. But you don’t need anything as exotic as the specter of space privateering to see why government responsibility can be a problem. As it currently stands, two private companies operating in space couldn’t even sue each other without the prior approval of their governments, says Michael Listner, an attorney and the principal of Space Law and Policy Solutions, a legal think tank. Currently, this is an issue that primarily affects the U.S. There are lots of countries with commercial, but not necessarily private, operations in space—Russia, China, Canada, Japan. Commercial entities launch rockets and manage satellites all the time. But in most of those cases, “commercial” basically means “revenue generating,” not “private enterprise,” Gabrynowicz says. Some of the corporations operating in space are government-owned, while others are technically private but operate with levels of government control and government money that would be unfamiliar to Americans, says Fabio Tronchetti, associate professor of law at China’s Harbin Institute of Technology. Government Minders The U.S. has the largest and most important private sector operating in space, from launching people and supplies for NASA to more speculative companies dedicated to space tourism and asteroid mining. Many of those companies would prefer there be less government involvement in their business. For instance, Bigelow Aerospace is a company that designs and builds inflatable pods that humans can live in in orbit—one of their pods will be attached to the International Space Station next year—or on a surface like the moon. For many years, Bigelow had to treat its products, legally, as though it were dealing in arms, wrangling with export controls meant to prevent guns, bombs, and valuable military secrets from being sold to the wrong people, stolen, or accidentally exposed. Even the most innocuous, non-weaponizable parts of their system fell under these controls. At one point, the company was forced to have two government officials watching two guards who were protecting a coffee-table-shaped kickstand for their pod. When the company had technical interchange meetings with partners in Moscow, it had to pay to bring along government minders. “If you dropped an alien in the room and said ‘point to the free country,’ they would have pointed to the Russians because we had two government monitors monitoring our every word,” says Mike Gold, Bigelow’s director of operations and business growth. “We spent hundreds of thousands of dollars on that. I would joke that KGB would spy on you, but at least they had the courtesy to do it for free.” That problem was solved by changes to U.S. export control rules in 2013, but cutting back on regulations still remains a popular mantra in the industry. Among several features of the U.S. Commercial Space Law and Competitiveness Act is the extension of a moratorium on regulation for human spaceflight safety requirements. The bill also leaves open a regulatory hole, wherein the Federal Aviation Administration licenses and monitors launches and re-entries, but there is no federal authority in charge of activities that happen in orbit. Gabrynowicz thinks this is problematic because the U.S. government also has a risk-sharing regime with these companies where it indemnifies them beyond their insurance coverage. The bill extends that, as well. So, she says, the government is responsible for the companies by authority of international law, the government will pay for any particularly large financial damages incurred by the companies, and the government is reducing or not establishing regulations on those companies. To Gabrynowicz, that looks like a moral hazard. Privatizing the Space Race The Outer Space Treaty of 1967 did a good job of keeping the space race between the U.S. and the Soviet Union from devolving into something out of a James Bond movie. But it didn’t do a very good job of planning for future races to claim resources found in space. Article II of the treaty is just 30 words long. It says, “Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.” Today, space lawyers are spending an awful lot of time debating what, exactly, that means. Lawyers are split pretty evenly on whether you can mine an asteroid and profit from it. The debate has been spurred by the handful of companies that have announced an interest in mining asteroids or the moon for minerals and other resources. None of these plans are likely to become reality in the next 20 years. In fact, it’s still debatable whether mining an asteroid is technically feasible or would make financial sense at all. But the companies interested in this business plan—including Planetary Resources and Deep Space Industries—want some kind of assurance that, if they do succeed, they will get to profit off what they dig up. That’s a reasonable request…but it’s assurance that the Outer Space Treaty can’t unequivocally offer. “There’s a spurious argument that, well, the State can’t appropriate, but I can!” Johnson says. “But that’s easily refuted. Property exists as a relationship between citizen and sovereign. You only get property rights based on the State.” We buy and sell property with the help of legal contracts. Those contracts are only real in so much as a state exists to enforce them. At best, say Johnson, Listner, Gabrynowicz, and Tronchetti, you can say that the Outer Space Treaty neither affirms nor denies the right of a private company to mine an asteroid, keep what it mines, and sell those resources for profit. Lawyers, Listner says, are split pretty evenly on whether that means you can do it or you can’t. Which is where the U.S. Commercial Space Law Competitiveness Act comes in, again. One of the most important things the bill does is say, explicitly, that U.S. companies can own and sell resources they mine. But the new law could become a problem, space lawyers say. Essentially, it’s the U.S. trying to unilaterally settle an open question. “It’s really an ideological and intellectual battle,” Listner says. Even more troubling, from the perspective of Gabrynowicz and Tronchetti is the fact that the Space Resource and Utilization Act doesn’t set up any system for licensing those mining activities. Given that the Outer Space Treaty obliges countries to maintain control over companies operating in space, that could be seen as the U.S. refusing to follow international law, Gabrynowicz says. Uncharted Territory Space lawyers can point out many other potential problems with the U.S. Commercial Space Law and Competitiveness Act, but the repercussions depend on what other countries decide to do. Historically, ever since the Outer Space Treaty was signed, countries have worked out their differences off the books, in bilateral negotiations. That happened in 1978, when a Soviet Kosmos satellite, powered by an onboard nuclear reactor, crashed in western Canada. That country initially billed the Soviet Union more than $6 million to cover the costs of cleanup and containment. Ultimately, the two countries came to an agreement where the Soviets paid half that amount and never formally had to acknowledge liability. “More recently, you had a piece of Chinese debris that crashed into a Russian satellite,” Tronchetti says. “Essentially, they just let that go.” So what happens if the United States decides companies can own minerals mined on an asteroid and another country, China say, decides they can’t? “That’s the problem, isn’t it?” Tronchetti says. “Nobody knows. But we should think about international consequences.” Gabrynowicz, for instance, worries that making unilateral decisions about space law could affect efforts to negotiate the rules that manage disputed places here on Earth, like the Arctic, where Russia, the U.S., and other countries are currently jockeying for access to oil and other resources. The geopolitical climate isn’t amenable to a new space treaty. In theory, a new treaty would solve all of these problems. But nobody thinks it would work. The Outer Space Treaty succeeded, Johnson says, because there were really only two parties at the table back then—the U.S. and the Soviet Union. “They just said, ‘Let’s come up with compromise text and then take it to the rest of the world and tell them we’ve agreed. We’re the most important people doing anything in space and everyone else will just go along,’ ” he says. Needless to say, that’s not how things work today. Even just a few years after the passage of the Outer Space Treaty, in 1979, an expanded document known as the Moon Treaty failed to draw any interest from the U.S. or the Soviets. That treaty would have clarified some of the issues the Outer Space Treaty left vague, including banning commercial sale and use of extraterrestrial resources. Only 16 countries are part of the treaty—none of them a major spacefaring nation. The geopolitical climate isn’t amenable to a new space treaty, Johnson says. There are too many stakeholders now and their goals don’t align enough. “The era of treaty making has really been over since the 1980s,” Johnson says. Now, the future of space is in the hands of the diplomats and lawyers who will hash out bespoke compromises in backrooms and boardrooms all over the world.

#### Violation – you don’t.

#### Prefer –

#### 1] Stable Advocacy – they can redefine in the 1AR to wriggle out of DA’s which kills high-quality engagement and becomes two ships passing in the night – triggers presumption since the aff wasn’t subject to well researched scrutiny. We lose access to Tech Race DA’s, Asteroid DA’s, basic case turns, and core process counter plans that have different definitions and 1NC pre-round prep.

#### 2] Ground – not defining hurts my strategy since they can shift out as I ask DA questions, so I err on the side of caution and read generics which get destroyed by AC frontlines.

#### 3] Real World – Policy makers will always how they are implementing a law. It also means zero solvency, absent spec, private entities can circumvent since there is no delineated way to enforce the aff and means their solvency can’t actualize.

#### ESspec isn’t regressive or arbitrary – its core topic lit for what happens when the aff is implemented and cannot be discounted from policies that require enforcement to function.

#### Fairness and education are voters – debate’s a game that needs rules to evaluate it and is the reason why schools fund debate

#### Drop the debater—the abuse has already occurred and my time allocation which leads to severance in the 1ar which ow/s on magnitude b) to deter future abuse, big punishment incentivizes people to stop bad practices

#### Competing interps – a] reasonability is arbitrary and encourages judge intervention since there’s no clear norm b] it creates a race to the top where we create the best possible norms for debate.

#### No RVIs – a) illogical – you shouldn’t win for being fair – it’s a litmus test for engaging in substance b) norming – I can’t concede the counterinterp if I realize I’m wrong which forces me to argue for bad norms, c) chilling effect – forces you to split your 2AR so you can’t collapse and misconstrue the 2NR, d) topic ed – prevents 1AR blip storm scripts and allows us to get back to substance after resolving theory d) Double Bind – either 1) my Theory shell is unwarranted in which case you shouldn’t have any problem answering it or 2) you’re actually abusive in which case the whole shell stands and outweighs.

## 2

#### Interp – space mining isn’t appropriation – its not permanent and OST consensus.

hHofmann and Bergamasco 19 [Mahulena Hofmann (SES Chair in Space, SatCom and Media Law at the University of Luxembourg) and Federico Bergamasco (PhD Researcher in aviation, telecommunication and space law University of Luxembourg). “Space resources activities from the perspective of sustainability: legal aspects”. Global Sustainability. 9 December 2019. Accessed 12/18/21. <https://www.cambridge.org/core/services/aop-cambridge-core/content/view/DF153F4A77970AC9E12444EC2B001F8A/S2059479819000279a.pdf/div-class-title-space-resources-activities-from-the-perspective-of-sustainability-legal-aspects-div.pdf> //Xu]

However, the purpose of space mining activities is considered to be neither any ‘appropriation’ of parts of outer space nor of space resources in situ. Instead, the sole aim of any such activities is their extraction, use and commercialization, without any territorial demands or titles as to the celestial bodies (or parts thereof) concerned (Mizushima et al., 2017). The argument, which sees in the use or exploitation of a space mineral by one subject a limitation of the same right of another subject, is difficult to contest by other means than analogy with space exploration. As has been recognized by the drafters of the OST in its Articles IX and XII, a purely scientific project in one area of outer space could de facto prevent research at the same site by a subject from another State. To avoid such situations, the Treaty pre-envisages a system of international consultations aimed at avoiding any harmful interference with operations.

#### OST is the standard for space law.

Wikipedia No Date [Wikipedia. “Outer Space Treaty.” No Date. Accessed 12/18/21. <https://en.wikipedia.org/wiki/Outer_Space_Treaty> //Xu]

The Outer Space Treaty, formally the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, is a multilateral treaty that forms the basis of international space law. Negotiated and drafted under the auspices of the United Nations, it was opened for signature in the United States, the United Kingdom, and the Soviet Union on 27 January 1967, entering into force on 10 October 1967. As of February 2021, 111 countries are parties to the treaty—including all major spacefaring nations—and another 23 are signatories.[1][5][note 1]

#### Semantics o/w –

#### a] Precision – they can arbitrarily jettison words which decks ground and preparation because there is no stasis point

#### b] Jurisdiction – the judge doesn’t have the authority to vote aff if it wasn’t legitimate

#### Vote for predictable limits – their aff explodes the object of the resolution to include random space activities from tourism to research to satellite surveillance – that allows them to cherry-pick the best aff with no neg ground – also kills predictable advocacies which decks prepared engagement.

## 3

#### Mining is now – multiple companies are competing in mineral exploitation to obtain rare earth metals.

Gilbert 4-26 [Alex Gilbert is a complex systems researcher and a PhD student in space resources at the Colorado School of Mines. Milken Institute, “Mining in Space Is Coming”; <https://www.milkenreview.org/articles/mining-in-space-is-coming>] kelvin

Space exploration is back. after decades of disappointment, a combination of better technology, falling costs and a rush of competitive energy from the private sector has put space travel front and center. indeed, many analysts (even some with their feet on the ground) believe that commercial developments in the space industry may be on the cusp of starting the largest resource rush in history: mining on the Moon, Mars and asteroids.

While this may sound fantastical, some baby steps toward the goal have already been taken. Last year, NASA awarded contracts to four companies to extract small amounts of lunar regolith by 2024, effectively beginning the era of commercial space mining. Whether this proves to be the dawn of a gigantic adjunct to mining on earth — and more immediately, a key to unlocking cost-effective space travel — will turn on the answers to a host of questions ranging from what resources can be efficiently.

As every fan of science fiction knows, the resources of the solar system appear virtually unlimited compared to those on Earth. There are whole other planets, dozens of moons, thousands of massive asteroids and millions of small ones that doubtless contain humungous quantities of materials that are scarce and very valuable (back on Earth). Visionaries including Jeff Bezos imagine heavy industry moving to space and Earth becoming a residential area. However, as entrepreneurs look to harness the riches beyond the atmosphere, access to space resources remains tangled in the realities of economics and governance.

Start with the fact that space belongs to no country, complicating traditional methods of resource allocation, property rights and trade. With limited demand for materials in space itself and the need for huge amounts of energy to return materials to Earth, creating a viable industry will turn on major advances in technology, finance and business models.

That said, there’s no grass growing under potential pioneers’ feet. Potential economic, scientific and even security benefits underlie an emerging geopolitical competition to pursue space mining. The United States is rapidly emerging as a front-runner, in part due to its ambitious Artemis Program to lead a multinational consortium back to the Moon. But it is also a leader in creating a legal infrastructure for mineral exploitation. The United States has adopted the world’s first space resources law, recognizing the property rights of private companies and individuals to materials gathered in space.

However, the United States is hardly alone. Luxembourg and the United Arab Emirates (you read those right) are racing to codify space-resources laws of their own, hoping to attract investment to their entrepot nations with business-friendly legal frameworks. China reportedly views space-resource development as a national priority, part of a strategy to challenge U.S. economic and security primacy in space. Meanwhile, Russia, Japan, India and the European Space Agency all harbor space-mining ambitions of their own. Governing these emerging interests is an outdated treaty framework from the Cold War. Sooner rather than later, we’ll need new agreements to facilitate private investment and ensure international cooperation.

What’s Out There

Back up for a moment. For the record, space is already being heavily exploited, because space resources include non-material assets such as orbital locations and abundant sunlight that enable satellites to provide services to Earth. Indeed, satellite-based telecommunications and global positioning systems have become indispensable infrastructure underpinning the modern economy. Mining space for materials, of course, is another matter.

In the past several decades, planetary science has confirmed what has long been suspected: celestial bodies are potential sources for dozens of natural materials that, in the right time and place, are incredibly valuable. Of these, water may be the most attractive in the near-term, because — with assistance from solar energy or nuclear fission — H2O can be split into hydrogen and oxygen to make rocket propellant, facilitating in-space refueling. So-called “rare earth” metals are also potential targets of asteroid miners intending to service Earth markets. Consisting of 17 elements, including lanthanum, neodymium, and yttrium, these critical materials (most of which are today mined in China at great environmental cost) are required for electronics. And they loom as bottlenecks in making the transition from fossil fuels to renewables backed up by battery storage.

The Moon is a prime space mining target. Boosted by NASA’s mining solicitation, it is likely the first location for commercial mining. The Moon has several advantages. It is relatively close, requiring a journey of only several days by rocket and creating communication lags of only a couple seconds — a delay small enough to allow remote operation of robots from Earth. Its low gravity implies that relatively little energy expenditure will be needed to deliver mined resources to Earth orbit.

The Moon may look parched — and by comparison to Earth, it is. But recent probes have confirmed substantial amounts of water ice lurking in permanently shadowed craters at the lunar poles. Further, it seems that solar winds have implanted significant deposits of helium-3 (a light stable isotope of helium) across the equatorial regions of the Moon. Helium-3 is a potential fuel source for second and third-generation fusion reactors that one hopes will be in service later in the century. The isotope is packed with energy (admittedly hard to unleash in a controlled manner) that might augment sunlight as a source of clean, safe energy on Earth or to power fast spaceships in this century. Between its water and helium-3 deposits, the Moon could be the resource stepping-stone for further solar system exploration.

Asteroids are another near-term mining target. There are all sorts of space rocks hurtling through the solar system, with varying amounts of water, rare earth metals and other materials on board. The asteroid belt between the orbits of Mars and Jupiter contains most of them, many of which are greater than a kilometer in diameter. Although the potential water and mineral wealth of the asteroid belt is vast, the long distance from Earth and requisite travel times and energy consumption rule them out as targets in the near term.

Even the surface of celestial bodies pose a challenge to mining machinery since they consist of unconsolidated rocky materials called regolith instead of more familiar soil.

Wannabe asteroid miners will thus be looking at smaller near-Earth asteroids. While they are much further away than the Moon, many of them could be reached using less energy — and some are even small enough to make it technically possible to tow them to Earth orbit for mining.

Space mining may be essential to crewed exploration missions to Mars. Given the distance and relatively high gravity of Mars (twice that of the Moon), extraction and export of minerals to Earth seems highly unlikely. Rather, most resource extraction on Mars will focus on providing materials to supply exploration missions, refuel spacecraft and enable settlement.

Technology Is the Difference

The prospects for space mining are being driven by technological advances across the space industry. The rise of reusable rocket components and the now-widespread use of off-the-shelf parts are lowering both launch and operations costs. Once limited to government contract missions and the delivery of telecom satellites to orbit, private firms are now emerging as leaders in developing “NewSpace” activities — a catch-all term for endeavors including orbital tourism, orbital manufacturing and mini-satellites providing specialized services. The space sector, with a market capitalization of $400 billion, could grow to as much as $1 trillion by 2040 as private investment soars.

But despite the high-profile commercial advances, governments still call the shots on the leading edge of space resource technologies. The United States extracted the first extraterrestrial materials in space from the Moon during the Apollo missions, followed by the Soviet Union’s recoveries from crewless Luna missions. President Biden recently borrowed one of the Apollo lunar rocks for display in the Oval Office, highlighting the awe that deep space can still summon.

For the time being, scientific samples remain the goal of mining. Last October, NASA’s OSIRIS-REx mission — due to return to Earth in 2023 — collected a small amount of material from the asteroid Bennu. In December, Japan returned a sample of the asteroid Ryugu with the Hayabusa2 spacecraft. And several weeks later, China’s Chang’e 5 mission returned the first lunar samples since the 1970s.

Sample collection is accelerating, with recent missions targeting Mars. Japan is planning to visit the two moons of Mars and extract a sample from one. NASA’s robotic Perseverance rover will collect and cache drilled samples on Mars that could later be returned to Earth. Perseverance also carries gear for the unique MOXIE experiment on Mars — an attempt to produce oxygen on the planet with technologies that could eventually extract oxygen for astronauts to breath and refuel spacecraft.It’s about as wide as the Eiffel Tower is tall and it could be where we obtain the elements needed to power bases on the moon, Mars or in orbit one day.

#### Private companies are key to space mining – investors, profitability, and market demand.

Krishnan 20 [C A Krishnan, 8-6-2020, "Space mining: Just around the corner?," Week, <https://www.theweek.in/news/sci-tech/2020/08/06/Space-mining-Just-around-the-corner.html> [accessed 12-6-21] lydia

A Mars mission carrying 100 metric tons cargo in 2022 followed by a manned mission by 2024 are the immediate milestones of Elon Musk’s SpaceX plan which aims to create a self sustaining Mars city by 2050. Just a few decades back this would have sounded as fantasy, but today it looks as if this time frame may actually be bettered. Space missions are set to undergo revolutionary changes and Elon Musk’s vision and timelines are indicators of this. Space is increasingly being seen as a treasure trove of precious minerals and also a place for future human habitation beyond the earth. Global private space industry investors believe that space mining has the potential to shape and define the 21st Century. NASA estimates that the 'Asteroid belt’ holds minerals worth quintillion of dollars. American astrophysicist Neil Degrasse Tyson believes, “The first trillioners will be those who mine asteroids”. The “Main Asteroid Belt” is located between the orbits of Mars and Jupiter, about 450 to 650 million Kilometers from earth, with million asteroids in it. Over the decades, apart from Moon and Mars, governments and private agencies have been carrying out extensive research and studying asteroids for their composition, possibility of mining them and their mining value —Asteriod ‘Bennu’ has been assessed at $670 million and asteroid ‘2011 UW158’ at $ 5.7 trillion. Transportation of the mined resources for utilisation, however, poses major hurdles. A ‘BBC Future’ report by Sarah Cruddas puts the cost of shipping a ton of water into space at about $ 50 million. As per Chris Lewicki, president of Planetary Resources, an asteroid mining company, it takes more energy to escape the first 300 kilometers from the Earth than the next 300 million kilometers. Similarly, bringing back anything more than a few kilograms of samples from space to the Earth would be even more complex in terms of logistics. To start with, therefore, global space industry investors are focusing on keeping mined space resources in space itself for ‘in situ resource utilisation’. Availability of water on the Moon, Mars and asteroids offer very attractive prospects; apart from being crucial for supporting life and growing food, it also opens the possibility of using its constituents, hydrogen and oxygen, for making rocket fuel. Today, the possibility of manufacturing tools and even building habitats on Moon or Mars with the help of 3D printers using iron, nickel, cobalt, gold, platinum, and iridium etc which are available on the Moon, Mars and asteroids seem within reach. Researchers are working on using regolith, the weathered rock particles found on lunar surface for making moon bricks using 3D printers. These bricks will form the basic construction material for the first moon station and even the first moon hotel. Space industry players believe that an investment of $ 4 billion in water mining in space can generate annual revenue worth about $2.4 billion. Similarly, there is a new community of customers who are already looking for buying propellant in space. American space launch provider, United Launch Alliance (ULA), a Lockheed Martin and Boeing joint venture that provides launch rockets, has made it known that, ULA is willing to pay about $ 3000 a Kg for propellant in low earth orbit. Fast paced developments are taking place in the field of space mining technology with private players in the lead. Optical mining using concentrated sunlight, robotics, automated mining applications, advanced drilling machines etc are just a few examples. Participation of private players has reduced the investment burden and greatly enhanced the width and pace of innovation. It is believed that launch of the first asteroid mining vehicle as well as setting up of the first fuelling stations on the Moon and in low earth orbit could become a reality within a decade. Japanese mission ‘Hayabusa’ was the first to bring samples from an asteroid to earth in 2010. ‘Hayabusa - 2’ made its rendezvous with the near earth asteroid ‘162173 RYUGU’ in June 2018, left the asteroid after collecting samples in November 2019 and will be back on earth on December 6, 2020. Similarly the NASA mission OSIRIS-REx, costing about $ 1 billion, launched in 2016 is due to return to earth with samples of asteroid ‘101955 Bennu’ on September 24, 2023. The latest US space mission, ‘Perseverance’ launched on July 30, 2020 will land on Mars on February 18, 2021. It will be using a helicopter on Mars, set to be the first use of a helicopter outside the earth. Apart from collecting samples from Mars and search for signs of habitable conditions on Mars, it will also test the possibility of manufacturing molecular oxygen from the carbon dioxide-rich Mars atmosphere. Beyond the technological capability, there are, however, complex legal issues. While making fuel and water in space and its ‘in situ resource utilisation’ may pass the scrutiny, commercial exploitation of space through minerals mining, tourism, real estate etc may prove hugely contentious in terms of international legal framework for space. The current legal frameworks were adopted when space activities were entirely within the domain of national governments and were confined to research alone. But with the nature of space activities moving from purely research activities to military applications to commercial activities and with the entry of private players and a new community of consumers in space, the vintage outer space treaty has been rendered grossly inadequate; vagueness of the treaty does not cater for the ‘new types of uses’ or the ‘new users’ of space. Louis de Gouyon Matignon, in a thesis on the subject observed that “some states have already taken the absence of express prohibition as a sign that the utilisation of space resources is permissible, and both the USA and Luxembourg recently adopted national legislations expressly allowing it”. This has, however, triggered a response from the international community denouncing such unilateral initiatives and recommending a collective approach on the lines of the laws for high seas and deep sea bed. Whether a widely acceptable new space treaty comes through or not, Space mining is a reality and the early entrants are likely to retain monopoly and huge economic advantages for a very long time.

#### Commercial mining solves extinction from scarcity, climate, terror, war, and disease.

Pelton 17—(Director Emeritus of the Space and Advanced Communications Research Institute at George Washington University, PHD in IR from Georgetown). Pelton, Joseph N. 2017. The New Gold Rush: The Riches of Space Beckon! Springer. Accessed 8/30/19.

Are We Humans Doomed to Extinction? What will we do when Earth’s resources are used up by humanity? The world is now hugely over populated, with billions and billions crammed into our overcrowded cities. By 2050, we may be 9 billion strong, and by 2100 well over 11 billion people on Planet Earth. Some at the United Nations say we might even be an amazing 12 billion crawling around this small globe. And over 80 % of us will be living in congested cities. These cities will be ever more vulnerable to terrorist attack, natural disaster, and other plights that come with overcrowding and a dearth of jobs that will be fueled by rapid automation and the rise of artifi cial intelligence across the global economy. We are already rapidly running out of water and minerals. Climate change is threatening our very existence. Political leaders and even the Pope have cautioned us against inaction. Perhaps the naysayers are right. All humanity is at tremendous risk. Is there no hope for the future? This book is about hope. We think that there is literally heavenly hope for humanity. But we are not talking here about divine intervention. We are envisioning a new space economy that recognizes that there is more water in the skies that all our oceans. Th ere is a new wealth of natural resources and clean energy in the reaches of outer space—more than most of us could ever dream possible. There are those that say why waste money on outer space when we have severe problems here at home? Going into space is not a waste of money. It is our future. It is our hope for new jobs and resources. The great challenge of our times is to reverse public thinking to see space not as a resource drain but as the doorway to opportunity. The new space frontier can literally open up a “gold rush in the skies.” In brief, we think there is new hope for humanity. We see a new a pathway to the future via new ventures in space. For too long, space programs have been seen as a money pit. In the process, we have overlooked the great abundance available to us in the skies above. It is important to recognize there is already the beginning of a new gold rush in space—a pathway to astral abundance. “New Space” is a term increasingly used to describe radical new commercial space initiatives—many of which have come from Silicon Valley and often with backing from the group of entrepreneurs known popularly as the “space billionaires.” New space is revolutionizing the space industry with lower cost space transportation and space systems that represent significant cost savings and new technological breakthroughs. “New Commercial Space” and the “New Space Economy” represent more than a new way of looking at outer space. These new pathways to the stars could prove vital to human survival. If one does not believe in spending money to probe the mysteries of the universe then perhaps we can try what might be called “calibrated greed” on for size. One only needs to go to a cubesat workshop, or to Silicon Valley or one of many conferences like the “Disrupt Space” event in Bremen, Germany, held in April 2016 to recognize that entrepreneurial New Space initiatives are changing everything [ 1 ]. In fact, the very nature and dimensions of what outer space activities are today have changed forever. It is no longer your grandfather’s concept of outer space that was once dominated by the big national space agencies. The entrepreneurs are taking over. The hopeful statements in this book and the hard economic and technical data that backs them up are more than a minority opinion. It is a topic of growing interest at the World Economic Forum, where business and political heavyweights meet in Davos, Switzerland, to discuss how to stimulate new patterns of global economic growth. It is even the growing view of a group that call themselves “space ethicists.” Here is how Christopher J. Newman, at the University of Sunderland in the United Kingdom has put it: Space ethicists have offered the view that space exploration is not only desirable; it is a duty that we, as a species, must undertake in order to secure the survival of humanity over the longer term. Expanding both the resource base and, eventually, the habitats available for humanity means that any expenditure on space exploration, far from being viewed as frivolous, can legitimately be rationalized as an ethical investment choice. (Newman) On the other hand there are space ethicists and space exobiologists who argue that humans have created ecological ruin on the planet—and now space debris is starting to pollute space. Th ese countervailing thoughts by the “no growth” camp of space ethicists say we have no right to colonize other planets or to mine the Moon and asteroids—or at least no right to do so until we can prove we can sustain life here on Earth for the longer term. However, for most who are planning for the new space economy the opinion of space philosophers doesn’t really fl oat their boat. Legislators, bankers, and aspiring space entrepreneurs are far more interested in the views of the super-rich capitalists called the space billionaires. A number of these billionaires and space executives have already put some very serious money into enterprises intent on creating a new pathway to the stars. No less than five billionaires with established space ventures—Elon Musk, Paul Allen, Jeff Bezos, Sir Richard Branson, and Robert Bigelow—have invested millions if not billions of dollars into commercializing space. They are developing new technologies and establishing space enterprises that can bring the wealth of outer space down to Earth. This is not a pipe dream, but will increasingly be the economic reality of the 2020s. These wealthy space entrepreneurs see major new economic opportunities. To them space represents the last great frontier for enterprising pioneers. Th us they see an ever-expanding space frontier that offers opportunities in low-cost space transportation, satellite solar power satellites to produce clean energy 24h a day, space mining, space manufacturing and production, and eventually space habitats and colonies as a trajectory to a better human future. Some even more visionary thinkers envision the possibility of terraforming Mars, or creating new structures in space to protect our planet from cosmic hazards and even raising Earth’s orbit to escape the rising heat levels of the Sun in millennia to come. Some, of course, will say this is sci-fi hogwash. It can’t be done. We say that this is what people would have said in 1900 about airplanes, rocket ships, cell phones and nuclear devices. The skeptics laughed at Columbus and his plan to sail across the oceans to discover new worlds. When Thomas Jefferson bought the Louisiana Purchase from France or Seward bought Alaska, there were plenty of naysayers that said such investment in the unknown was an extravagant waste of money. A healthy skepticism is useful and can play a role in economic and business success. Before one dismisses the idea of an impending major new space economy and a new gold rush, it might useful to see what has already transpired in space development in just the past five decades. The world’s first geosynchronous communications satellite had a throughput capability of about 500 kb / s. In contrast, today’s state of the art Viasat 2 —a half century later— has an impressive throughput of some 140 Gb/s. Th is means that the relative throughput is nearly 300,000 greater, while its lifetime is some ten times longer (Figs. 1.1 and 1.2 ). Each new generation of communications satellite has had more power, better antenna systems, improved pointing and stabilization, and an extended lifetime. And the capabilities represented by remote sensing satellites , meteorological satellites , and navigation and timing satellites have also expanded their capabilities and performance in an impressive manner. When satellite applications first started, the market was measured in millions of dollars. Today commercial satellite services exceed a quarter of a billion dollars. Vital services such as the Internet, aircraft traffi c control and management, international banking, search and rescue and much, much more depend on application satellites. Th ose that would doubt the importance of satellites to the global economy might wish to view on You Tube the video “If Th ere Were a Day Without Satellites?” [ 2 ]. Let’s check in on what some of those very rich and smart guys think about the new space economy and its potential. (We are sorry to say that so far there are no female space billionaires, but surely this, too, will come someday soon.) Of course this twenty-fi rst century breakthrough that we call the New Space economy will not come just from new space commerce. It will also come from the amazing new technologies here on Earth. Vital new terrestrial technologies will accompany this cosmic journey into tomorrow. Information technology, robotics, artificial intelligence and commercial space travel systems have now set us on a course to allow us humans to harvest the amazing riches in the skies—new natural resources, new energy, and even totally new ways of looking at the purpose of human existence. If we pursue this course steadfastly, it can be the beginning of a New Space renaissance. But if we don’t seek to realize our ultimate destiny in space, Homo sapiens can end up in the dustbin of history—just like literally millions of already failed species. In each and every one of the five mass extinction events that have occurred over the last 1.5 billion years on Earth, some 50–80 % of all species have gone the way of the T. Rex, the woolly mammoth, and the Dodo bird along with extinct ferns, grasses and cacti. On the other hand, the best days of the human race could be just beginning. If we are smart about how we go about discovering and using these riches in the skies and applying the best of our new technologies, it could be the start of a new beginning for humanity. Konstantin Tsiokovsky, the Russian astronautics pioneer, who fi rst conceived of practical designs for spaceships, famously said: “A planet is the cradle of mankind, but one cannot live in a cradle forever.” Well before Tsiokovsky another genius, Leonardo da Vinci, said, quite poetically: “Once you have tasted flight, you will forever walk the earth with your eyes turned skyward, for there you have been, and there you will always long to return.” The founder of the X-Prize and of Planetary Resources, Inc., Dr. Peter Diamandis, has much more brashly said much the same thing in quite diff erent words when he said: “The meek shall inherit the Earth. The rest of us will go to Mars.” The New Space Billionaires Peter Diamandis is not alone in his thinking. From the list of “visionaries” quoted earlier, Elon Musk, the founder of SpaceX; Sir Richard Branson, the founder of Virgin Galactic; and Paul Allen, the co-founder of Microsoft and the man who financed SpaceShipOne, the world’s first successful spaceplane have all said the future will include a vibrant new space economy. Th ey, and others, have said that we can, we should and we soon shall go into space and realize the bounty that it can offer to us. Th e New Space enterprise is today indeed being led by those so-called space billionaires , who have an exciting vision of the future. They and others in the commercial space economy believe that the exploitation of outer space may open up a new golden age of astral abundance. They see outer space as a new frontier that can be a great source of new materials, energy and various forms of new wealth that might even save us from excesses of the past. Th is gold rush in the skies represents a new beginning. We are not talking about expensive new space ventures funded by NASA or other space agencies in Europe, Japan, China or India. No, these eff orts which we and others call New Space are today being forged by imaginative and resourceful commercial entrepreneurs. Th ese twenty-fi rst century visionaries have the fortitude and zeal to look to the abundance above. New breakthroughs in technology and New Space enterprises may be able to create an “astral life raft” for humanity. Just as Columbus and the Vikings had the imaginative drive that led them to discover the riches of a new world, we now have a cadre of space billionaires that are now leading us into this New Space era of tomorrow. These bold leaders, such as Paul Allen and Sir Richard Branson, plus other space entrepreneurs including Jeff Bezos of Amazon and Blue Origin, and Robert Bigelow, Chairman of Budget Suites and Bigelow Aerospace, not only dream of their future in the space industry but also have billions of dollars in assets. These are the bright stars of an entirely new industry that are leading us into the age of New Space commerce. These space billionaires, each in their own way, are proponents of a new age of astral abundance. Each of them is launching new commercial space industries. They are literally transforming our vision of tomorrow. These new types of entrepreneurial aerospace companies—the New Space enterprises—give new hope and new promise of transforming our world as we know it today. The New Space Frontier What happens in space in the next few decades, plus corresponding new information technologies and advanced robotics, will change our world forever. These changes will redefi ne wealth, change our views of work and employment and upend almost everything we think we know about economics, wealth, jobs, and politics. Th ese changes are about truly disruptive technologies of the most fundamental kinds. If you thought the Internet, smart phones, and spandex were disruptive technologies, just hang on. You have not seen anything yet. In short, if you want to understand a transition more fundamental than the changes brought to the twentieth century world by computers, communications and the Internet, then read this book. There are truly riches in the skies. Near-Earth asteroids largely composed of platinum and rare earth metals have an incredible value. Helium-3 isotopes accessible in outer space could provide clean and abundant energy. There is far more water in outer space than is in our oceans. In the pages that follow we will explain the potential for a cosmic shift in our global economy, our ecology, and our commercial and legal systems. These can take place by the end of this century. And if these changes do not take place we will be in trouble. Our conventional petro-chemical energy systems will fail us economically and eventually blanket us with a hydrocarbon haze of smog that will threaten our health and our very survival. Our rare precious metals that we need for modern electronic appliances will skyrocket in price, and the struggle between “haves” and “have nots” will grow increasingly ugly. A lack of affordable and readily available water, natural resources, food, health care and medical supplies, plus systematic threats to urban security and systemic warfare are the alternatives to astral abundance. The choices between astral abundance and a downward spiral in global standards of living are stark. Within the next few decades these problems will be increasingly real. By then the world may almost be begging for new, out of- the-box thinking. International peace and security will be an indispensable prerequisite for exploitation of astral abundance, as will good government for all. No one nation can be rich and secure when everyone else is poor and insecure. In short, global space security and strategic space defense, mediated by global space agreements, are part of this new pathway to the future.

#### Otherwise terrestrial mining destroys the environment.

Williams 19 [Matthew S. writer at Universe Today; Aug 1 2019, "Asteroid Mining: What Will It Involve and Is This the Future of Wealth?", Interessting Engineering, <https://interestingengineering.com/asteroid-mining-what-will-it-involve-and-is-this-the-future-of-wealth>] brett

Of course, this raises the obvious question: wouldn't it be really expensive to do all this mining? Why not simply continue to rely on Earth for sources of precious metals and resources and simply learn to use them better?

To put it simply, we are running out of resources. To be clear, learning to use our resources better and more sustainably is always a great idea. And while it is certainly true than Earth-based mining is far cheaper than going to space would be, that may not be the case indefinitely.

Aside from the fact that off-world minerals and ices would be of considerable value to Earth's economy, there is also the way that growing consumption is leading our reserves to become slowly exhausted.

In fact, according to some estimates, it is possible that our planet will run out of key elements that are needed for modern industry and food production within the next 50 to 60 years. This alone is a pretty good incentive to tap the virtually inexhaustible supply of elements located off-world.

Plus, there are a lot of benefits to expanding humanity's resource base beyond Earth. Here on Earth, mining takes a considerable toll on the natural environment. In fact, depending on the methods used, it can result in erosion, sinkholes, habitat destruction, and the destruction of native animal and plant life.

There's also the dangers of toxic runoff and the contamination of soil, groundwater, and surface water, which is a danger to humans, as well as to wildlife and the natural environment.

As for smelting, machining, and manufacturing, the environmental damage that results is well-documented. Combined with power generation, these industrial processes are one of the leading contributors to air, water, and pollution.

By shifting these burdens off-world, humanity could dramatically-reduce the impact it has on the natural environment.

## Case

### Adv 1 O/V

#### Alt causes to debris – small sats, meteoroids, EMPs.

Kelley, Electrical and Computer Engineering @ Cornell, et al. 12

[Michael C.; Stephanie Pancoast, Electrical and Computer Engineering @ Cornell; Sigrid Close, Aeronautics and Astronautics @ Stanford; Zhenzhen Wang, Physics and Astronomy @ UIowa: “Analysis of electromagnetic and electrostatic effects of particle impacts on spacecraft.” Elsevier Ltd. doi:10.1016/j.asr.2011.12.023]//AD

\*Hypervelocity means over 11km/s

Spacecraft are continually subject to impacts by meteoroids and space junk. The space shuttle and the International Space Station have been repeatedly hit and a space tether was severed by such an event. Such impacts can clearly have mechanical effects on spacecraft, but in recent years, evidence has arisen that electrical effects may be more important. Two types of effects are possible (Close et al., 2010). High-velocity impacts result in vaporization/ionization of the incoming particle and spacecraft material as well. This material is thought to be ejected as energetic ions that subsequently draw out electrons (Krueger, 1996; Ratcliff et al., 1997a,b). The result is that the vehicle potential initially drops sharply, rises again as the electron emission overcompensates positively, and then returns to its prior state by ambient plasma collection. These events may be intense enough to create an Electrostatic Discharge (ESD), which could damage spacecraft electronics. The expanding ions can separate from the electrons by a Debye length, after which an electric field builds up to draw out the electrons. The two plasma constituents then oscillate about each other at the plasma frequency while, at the same time, the plasma expands at the ambipolar diffusion rate. This continues until electron ion collisions are sufficient to slow the expansion process to the collisional diffusion rate. As the expansion proceeds, the plasma frequency decreases, as does the frequency of the radiation generated. This electrostatic oscillation will act as an antenna and radiate electromagnetic waves, which propagate in and around the spacecraft in a phenomenon we call an Electromagnetic Pulse (EMP). In this paper, we compare the theory proposed by Close et al. (2010) with observations of particle impacts on the Cassini spacecraft, which was instrumented with ESD and EMP detectors as well as dust/ice detectors. 0273-1177/$36.00 2011 COSPAR. Published by Elsevier Ltd. All rights reserved. doi:10.1016/j.asr.2011.12.023 ⇑ Corresponding author. Tel.: +1 607 255 7425; fax: +1 607 255 6236. E-mail addresses: mck13@cornell.edu (M.C. Kelley), pancoast@ stanford.edu (S. Pancoast), sigridc@stanford.edu (S. Close), zhenzhen-wang @uiowa.edu (Z. Wang). 1 Now at Stanford University. www.elsevier.com/locate/asr Available online at www.sciencedirect.com Advances in Space Research 49 (2012) 1029–1033 1.1. Review and analysis of ESD and EMP observations on Cassini The Radio and Plasma Wave Science (RPWS) instrumentation on Cassini detected a high rate of impact by dusty ice particles when it penetrated the rings of Saturn (Wang et al., 2006) and the Jupiter flyby (Meyer-Vernet et al., 2009). The instrument detected pulse-like potential changes between a short monopole antenna and spacecraft ground. The ground potential pulse had the waveform, V ðtÞ ¼ 0:4 1 et=s Q C ; ð1Þ where s = 40 ms, Q is the maximum charge on the spacecraft, and C is its capacitance (Wang et al., 2006). The factor 0.4 is due to a capacity divider at the amplified input. The Fourier Transform of the associated waveform is a two-component power law spectral response: f 2 at low frequencies (less that 4 kHz) and f 4 at high frequencies (4– 100 kHz). This is shown here in Fig. 1. Superposed on this power law behavior was a 10 db increase in power between 40 and 80 kHz. Fig. 3 of Wang et al. (2006) shows the wavelength of a double probe detection during impact events. The initial polarity can be of either sign. This rules out vehicle potential changes since the sign of the common mode voltage would always have the same polarity. We thus conclude that the signal is due to impact on one of the probes by ejected plasma. Depending on the proximity of one or the other probes to the impact, the sign will change. Unfortunately, since we do not know where the impact occurred, we cannot interpret whether ions or electrons were ejected first. Using Eq. (1) and a capacitance of 200 pF, the charge emissions were estimated to be 10 pC. Following work by Krueger (1996) for 15 km/s impacts of a dielectric on a metal, Wang et al. (2006) determined an rms ice particle size of 77 pg and an rms diameter of 5.2 lm for these dusty ice particles. Dividing the emitted charge by the charge on an electron, 10 pC corresponds to 5 107 ions released initially, which is followed by an equal number of ions. The expansion of the ions will occur for about one Debye length before the electrons are attracted by the ambipolar electric field. Thus, the number density at that time can be found from, n ¼ 3N=4pðkDÞ 3 ð2Þ and kD ¼ ðV eÞth=xp; ð3Þ where kD is the Debye length, xp is the plasma frequency, N is the total number of electrons emitted and (Ve)th is the electron thermal speed we take to be 106 m/s. For a fixed Te, Eq. (2) depends only on n and we can solve for t to find n = 2.25 1018 m3 . The initial plasma frequency is thus 10 GHz. Initially, until about 10 collision times, the expansion will continue at the ambipolar rate, which is thought to be about 104 m/s. We believe that the excess power in the spectrum between 40–80 kHz is oscillation of the ions and electrons at the plasma frequency, which decreases in time as the plasma expands. Only a narrow window of the plasma frequency oscillations spectrum is available due to the power spectral density in the FFT of the pulse and the upper limit of the instrument frequency response. Sixty kiloHertz will be attained after about 1 ls at the ambipolar expansion rate. The spectrum in Fig. 1 is intriguing but is a composite and cannot be used to explore the time dependence of the electromagnetic response to an impact. However, another set of impact events were recorded on Cassini (Meyer-Vernet et al., 2009) that were due to nanometer-size dust particles being accelerated by the solar wind to 450 km/s. In this case, we have the full waveform to work with, up to 110 kHz. We have analyzed the broadband data from the dipole antenna on Cassini during such events. Because of the high common-mode rejection ratio for the system, the initial pulse caused by the vehicle potential change is greatly suppressed but the EMP is well documented. Fig. 2 shows the waveform (top panel) for one of the impacts along with a Fourier analysis (central panel) and a wavelet analysis (lower panel). At the left-hand side of the top panel, the suppressed ESD pulse is seen as a 25 lv pulse, followed by a series of oscillations that decreases with time from about 80 kHz to less than 20 kHz during 180 ms. Fourier analysis is not well suited for analyzing such a time series, but the middle panel does show the FFT of various segments of the interval. The wavelet analysis is much more revealing. The initial pulse is characterized by intense wavelets over the entire 32 frequency bins as befits a sharp change in the signal. This is followed by wavelet intensities that occur first at the highest frequency and then progress to the lower frequencies over time. For reference, the unity scale wavelet has a characteristic time of 0.67 ms. Fig. 1. Composite spectrum from many impacts. [After Wang et al. (2006). Reproduced with permission of Elsevier.] 1030 M.C. Kelley et al. / Advances in Space Research 49 (2012) 1029–1033 0 0.0225 0.045 0.0675 0.09 0.1125 0.135 0.1575 0.18 −1.5 −1 −0.5 0 0.5 1 x 10−5 Time (ms) E (V/m) 0 20 40 60 80 100 120 0 0.2 0.4 0.6 0.8 1 x 10−5 FFT (V2/m2Hz) Freq (kHz) Time (ms) scales a 0.0225 0.045 0.0675 0.09 0.1125 0.135 0.1575 0.18 1 7 13 19 25 31 Fig. 2. Waveform, Fourier analysis, and wavelet analysis for the impact of nanometer-size particles at solar wind velocity on Cassini. A symlet order-2 wavelet was used. The scale a = 1 corresponds to the frequency >148 kHz and scale = 32 corresponds to 4.7 kHz. 100 101 102 103 10−7 10−6 10−5 Freq (kHz) FFT (V2/m2Hz) FFT of signal Fitted curve 0 20 40 60 80 100 120 0 1 2 3 4 x 10−6 Freq (kHz) FFT (V2/m2Hz) 0 20 40 60 80 100 120 0 0.5 1 1.5 2 x 10−6 Freq (kHz) FFT (V2/m2Hz) Slope = −3.4569 Fig. 3. Three spectral presentations. The top panel is a log–log plot of the first third of the data set. The middle panel covers the whole period in a loglinear format. The lower panel does not include the pulse. M.C. Kelley et al. / Advances in Space Research 49 (2012) 1029–1033 1031 In Fig. 3 we replot the various spectra using log–log and log-linear axes. The top panel is for the first third of the period, which includes the pulse. We see an f 2 power law followed by an f 4 power law, as is also found in Fig. 1. The middle panel is the FFT of the whole interval, whereas the lower panel begins at 10 ms and does not include the pulse. Evidence for high-frequency oscillations is seen when the pulse is absent or when the frequency is high enough for the power to exceed that of the pulse spectrum. In Fig. 4 we present three more examples of waveforms and wavelet analysis for dust impacts. In each case, the pulse and oscillations are seen. To study this quantitatively, we follow Meyer-Vernet et al. (2009) and Close et al. (2010) for nanoparticles at these high velocities. The former authors calculate that the charge release was 5 1013 C. Dividing by the charge on an electron yields 3 106 particles. Note that the plasma expands for 0.225 ms before we first can measure the plasma frequency since, before this, the vehicle potential change dominates the signal. Ratcliff et al. (1997a,b) predict an expansion velocity of 10 km/s, which yields a diameter of 2.25 m at that time and a plasma density of 84,000 m3 for a sphere and twice that for a half sphere. The plasma frequency at that time is thus 2600–3600 Hz, in reasonable agreement with the data. Since the volume increases as t 3 , the plasma frequency at 10 times the delay should be 260–360 Hz, which is also in good agreement with the data. 2. Scaling to other impacts Close et al. (2010) and Stewart and Valiant (2006) studied the impact effects over a wide range of metallic (meteoroid) impact particles. To scale this to earth-orbiting satellites impacted by meteors, we need to increase the differential velocity to as high as 45 km/s, which increases the Q release to 1000 C/g (Lee et al., 2012). Since the vehicle potential changes scales with this differential Q, we find that it rises from the 20 mV measured on Cassini to 500 V (for metallic impactors of the same size as those in the Cassini case). The released charge scales linearly with mass and as V3.8 (Lee et al., 2012), so very large potentials are possible. There is thus a definite possibility that an Electrostatic Discharge (ESD) is possible for impacts on the spacecraft ground plane. Note that the Cassini impacts are thought to have been on the large conducting high-gain antenna. Hoerz et al. (1975) and Stewart and Valiant (2006) developed a crater impact theory and compared it favorably with data for Martian craters. If we extrapolate these data to the rms particle size detected on Cassini, a diameter 0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1 −1 0 1 x 10−5 Time (ms) E (V/m) Time (ms) scales a 1 7 13 19 25 31 0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1 −10 −5 0 5 x 10−5 E (V/m) Time (ms) Time (ms) scales a 1 7 13 19 25 31 0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1 −2.5 −2 −1.5 x 10−5 Time (ms) E (V/m) Time (ms) scales a 1 7 13 19 25 31 Fig. 4. Three more examples of waveforms and wavelet analysis for dust impacts. The scales are identical to those in Fig. 2. 1032 M.C. Kelley et al. / Advances in Space Research 49 (2012) 1029–1033 of 5.2 lm, the ejected volume is 108 m3 , corresponding to a linear dimension of 0.22 cm. For impact of aluminum on aluminum, this corresponds to 6.3 1020 atoms. For an impact of ice on aluminum, we lower this by a factor of 10. Finally, since the impact velocity on Mars is about 1.7 times higher than ice on Cassini and the particle release varies as the velocity to the fourth power, we lower this by another factor of 30–2.1 1019. Dividing by the initial volume found above yields a neutral number density of 3 1022 m3 . The number density of plasma particles was found above to be n = 2.25 1018. The low ratio of charged particles to neutral atoms available strongly suggests that most of the charge is tied up on dust particles. Murr and Rivas (1994) studied the recoagulation of atoms from ablating meteors. They found that for meteors larger than 10 g, recoagulation proceeds exponentially. Of course, the number density of the tail for such a large meteoroid would be much smaller than an impact event of the same size, so recoagulation is very fast. We turn now to the case of 6 nm particles traveling at solar wind speeds (450 km/s). The comparison with Martian craters does not work as well for such small particles and we work the problem backwards. At .27 ms, the expanding sphere is 2.7 m in diameter and the oscillation frequency is 5 kHz. This corresponds to a plasma density of 3.1 105 m3 and a total number of ejected ions of 2.4 107 . A 6 nm particle would make a crater about 10 times its diameter at 40 km/s. For a hemisphere, the volume would be 4.3 1022 m3 . The volume scales as V2 so, at 400 km/s, it would be 4.3 1020 m3 . Aluminum would hold 5 104 particles. Since the incoming particle is the same size, this estimate yields 4 106 particles, a factor only five times lower than the data suggest. The vehicle potential is not likely to be affected by these particles We have compared observations of high-velocity impacts on the Cassini spacecraft with the theory of Close et al. (2010). We find excellent agreement with both the vehicle potential changes and the plasma oscillations for large, low-velocity particle impacts and for small, hypervelocity particles. When applied to particle impacts on earth-orbiting satellites, our first conclusion is that very high vehicle potential changes are possible for hyper-velocity metallic impacts on spacecraft ground, which could lead to ESD failures. We also find that an Electromagnetic Pulse will be generated and radiated by such impacts.

### AT: Scenario 1

#### Collisions unlikely.

**Mosher ’19** [Dave; September 3rd; Journalist with more than a decade of experience reporting and writing stories about space, science, and technology; Business Insider, “Satellite collisions may trigger a space-junk disaster that could end human access to orbit. Here’s How,” <https://www.usafa.edu/app/uploads/Space_and_Defense_2_3.pdf>; GR]

The Kessler syndrome plays center-stage in the movie "Gravity," in which an accidental space collision endangers a crew aboard a large space station. But Gossner said that type of a runaway space-junk catastrophe is unlikely. "Right now I don't think we're close to that," he said. "I'm not saying we couldn't get there, and I'm not saying we don't need to be smart and manage the problem. But I don't see it ever becoming, anytime soon, an unmanageable problem." There is no current system to remove old satellites or sweep up bits of debris in order to prevent a Kessler event. Instead, space debris is monitored from Earth, and new rules require satellites in low-Earth orbit be deorbited after 25 years so they don't wind up adding more space junk. "Our current plan is to manage the problem and not let it get that far," Gossner said. "I don't think that we're even close to needing to actively remove stuff. There's lots of research being done on that, and maybe some day that will happen, but I think that — at this point, and in my humble opinion — an unnecessary expense." A major part of the effort to prevent a Kessler event is the Space Surveillance Network (SSN). The project, led by the US military, uses 30 different systems around the world to identify, track, and share information about objects in space. Many objects are tracked day and night via a networkof radar observatories around the globe. Optical telescopes on the ground also keep an eye out, but they aren't always run by the government. "The commercial sector is actually putting up lots and lots of telescopes," Gossner said. The government pays for their debris-tracking services. Gossner said one major debris-tracking company is called Exoanalytic. It uses about 150 small telescopes set up around the globe to detect, track, and report space debris to the SSN. Telescopes in space track debris, too. Far less is known about them because they're likely top-secret military satellites. Objects detected by the government and companies get added to a catalog of space debris and checked against the orbits of other known bits of space junk. New orbits are calculated with supercomputers to see if there's a chance of any collisions. Diana McKissock, a flight lead with the US Air Force's 18th Space Control Squadron, helps track space debris for the SSN. She said the surveillance network issues warnings to NASA, satellite companies, and other groups with spacecraft, based on two levels of emergency: basic and advanced. The SSN issues a basic emergency report to the public three days ahead of a 1-in-10,000 chance of a collision. It then provides multiple updates per day until the risk of a collision passes. To qualify for such reporting, a rogue object must come within a certain distance of another object. In low-Earth orbit, that distance must be less than 1 kilometer (0.62 mile); farther out in deep space, where the precision of orbits is less reliable, the distance is less than 5 kilometers (3.1 miles). Advanced emergency reports help satellite providers see possible collisions much more than three days ahead. "In 2017, we provided data for 308,984 events, of which only 655 were emergency-reportable," McKissock told Business Insider in an email. Of those, 579 events were in low-Earth orbit (where it's relatively crowded with satellites).

#### Their dromal evidence is hypothetical – the only example of space terror was the Sri Lankan Tigers and that was a video broadcast that was immediately shut down.

Satellite Today ’07 Satellite Today, “Intelsat Shuts Down Transponder Hijacked By Terrorists,” published April 30, 2007. Accessed 1/6/22 by OHS OE. https://www.satellitetoday.com/telecom/2007/04/30/intelsat-shuts-down-transponder-hijacked-by-terrorists-2/.

Intelsat Ltd. has shut down a satellite transponder that was being used by Sri Lanka’s Tamil Tigers rebel group to make **unauthorized broadcasts in Europe and Asia**, the Sri Lankan Ministry of Defense announced. Phillip Spector, Intelsat’s general counsel, reported April 24 that the transponder used by the Liberation Tigers of Tamil Eelam (LTTE) had been turned off over the previous weekend. The Tamil Tigers, labeled by the U.S. government as a terrorist group, had been broadcasting for more than a year before Intelsat acquired the spacecraft in its July 2006 acquisition of PanAmSat, the Sri Lankan Embassy in Washington said. Intelsat this month described the Tamil Tigers’ use of its satellite as "unauthorized," adding the company "does not tolerate terrorists or others operating illegally on its satellites."

### AT: Scenario 2

#### No miscalc from satellite disruptions or space dust -- empirically denied. Also takes out the Russia scenario---their ev casually asserts escalation while we have examples from after their card was written that disprove it.

Mazur 12 (Jonathan Mazur, Manager Engineering at Northrop Grumman, writing in Space & Defense, from the Eisenhower Center for Space and Defense Studies. Past U.S. Actions: Redlines in Space. Space & Defense, Volume 6, Number 1, Fall 2012. https://inss.ndu.edu/Portals/97/Space\_and\_Defense\_6\_1.pdf?ver=2018-09-06-135424-147)

U.S. Reactions To Foreign Disruption Of U.S. Capabilities

In the 1970s, it was suspected that a U.S. maritime communications satellite was turned off by the Soviets when it was outside of the range of U.S. tracking stations.25 There does not appear to be any documented U.S. reaction, and I suspect there was none. In the mid-1990s, satellite hackers in Brazil began hijacking U.S. military communication satellite signals to broadcast their own information, though it took until 2009 for Brazil to crack down on the illegal activity with the support of the DoD.26 In 1998, a U.S.-German satellite known as ROSAT was rendered useless after it turned suddenly toward the sun. NASA investigators later determined the accident was possibly linked to a cyber-intrusion by Russia.

The fallout? Though there was an ongoing criminal investigation as of 2008; NASA security officials have seemed determined to publicly minimize the seriousness of the threat.27 In 2003, a signal originating from Cuba—later determined to be coming from Iranian embassy property— was jamming a U.S. communications satellite that was transmitting Voice of America programming over Iran, which was publicly referred to as an “act of war” by a U.S. official. 28 Press reporting indicates the U.S. administration was [frozen]“paralyzed” about how to cope with the jamming that continued for at least a month, even after U.S. diplomatic protests to Cuba.29 In 2005, U.S. diplomats protested to the Libyan government after two international satellites were illegally jammed disrupting American diplomatic, military, and FBI communications.30 In 2006, press reporting indicates that China hit a U.S. spy satellite with a ground-based laser. This action was acknowledged by the then director of the NRO, though the DoD remained tight lipped about the incident.31

“We’re at a point where the technology’s out there, and the capability for people to do things to our satellites is there. I’m focused on it beyond any single event.” – Air Force Space Command Commander, General Chilton, 2006 32

In 2009, a U.S. commercial Iridium communications satellite—extensively used by the DoD—was accidently destroyed by a collision with a dead Russian satellite.33 The U.S. company, Iridium, was able to minimize any loss of service by implementing a network solution within a few days.34 As of early 2011, no legal action had been taken by the company either because it is not clear who was at fault or because it might be politically problematic for the United States, which is trying to enter into bi-lateral transparency and confidence-building measures (TCBM) with Russia regarding space activities.35 Since August of 2010, North Korea has been intermittently using GPS jamming equipment, which reportedly has been interfering with U.S. and South Korean military operations and civilian use south of the North Korean border.36 Reportedly, only South Korea and the United Nations International Telecommunications Union—at the request of South Korea—have issued letters to Pyongyang demanding the cessation of disruptive communications signals in South Korea.37

It appears that the only time the U.S. military has responded with force to a disruption in U.S. space capabilities was in 2003, a few days after the start of the Iraq war.38 According to U.S. officials, Iraq was using multiple GPS jammers—which supposedly did not affect military GPS functionality. However, the U.S. military bombed the jammers anyway after a diplomatic complaint to Russia.39 The use of military force against the GPS jamming threat was possibly because the United States was already intervening in Iraq, and the bombing probably would not have occurred if the United States was not at war.

#### Congestion induces restraint, not aggression.

Bowen 18 [Bleddyn, Lecturer in International Relations at the University of Leicester; ELN; 20 Februrary 2018; “The Art of Space Deterrence,” <https://www.europeanleadershipnetwork.org/commentary/the-art-of-space-deterrence/>] brett

Fourth, the ubiquity of space infrastructure and the fragility of the space environment may create a degree of existential deterrence. As space is so useful to modern economies and military forces, a large-scale disruption of space infrastructure may be so intuitively escalatory to decision-makers that there may be a natural caution against a wholesale assault on a state’s entire space capabilities because the consequences of doing so approach the mentalities of total war, or nuclear responses if a society begins tearing itself apart because of the collapse of optimised energy grids and just-in-time supply chains. In addition, the problem of space debris and the political-legal hurdles to conducting debris clean-up operations mean that even a handful of explosive events in space can render a region of Earth orbit unusable for everyone. This could caution a country like China from excessive kinetic intercept missions because its own military and economy is increasingly reliant on outer space, but perhaps not a country like North Korea which does not rely on space. The usefulness, sensitivity, and fragility of space may have some existential deterrent effect. China’s catastrophic anti-satellite weapons test in 2007 is a valuable lesson for all on the potentially devastating effect of kinetic warfare in orbit.

#### Their ev overhypes escalation---be suspect.

Bowen 18 [Bleddyn, Lecturer in International Relations at the University of Leicester; ELN; 20 Februrary 2018; “The Art of Space Deterrence,” <https://www.europeanleadershipnetwork.org/commentary/the-art-of-space-deterrence/>] brett

Space is often an afterthought or a miscellaneous ancillary in the grand strategic views of top-level decision-makers. A president may not care that one satellite may be lost or go dark; it may cause panic and Twitter-based hysteria for the space community, of course. But the terrestrial context and consequences, as well as the political stakes and symbolism of any exchange of hostilities in space matters more. The political and media dimension can magnify or minimise the perceived consequences of losing specific satellites out of all proportion to their actual strategic effect.

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#### No space war—interdependence checks AND commercial entanglement reduces the risk.

Bragg et al 18 [Principle research scientist at NSI, Inc. Lecturer in polisci @ Texas A&M, July 2018. Allison Astorino-Courtois. Robert Elder. Belinda Bragg. “Contested Space Operations, Space Defense, Deterrence, and Warfighting: Summary Findings and Integration Report,” NSI, <https://nsiteam.com/social/wp-content/uploads/2018/11/Space-SMA-Integration-Report-Space-FINAL.pdf>] brett

Everyone needs space While the US may be relatively more dependent on space for national security than are other states, it is far from alone in relying on space. Nuclear armed states are dependent on space for important command and control functions, and major powers are increasingly using space for battlefield situational awareness and communications. China and Russia were identified as having significant (and fairly equal) levels of strategic risk in space (ViTTa Q16), although their regional security priorities and (to date) less spacedependent economies place them at an advantage to the US. They may, therefore, see the strategic risk of conflict is space as lower than does the US. Still, space capabilities remain a source of economic expansion and national pride for both, and their calculations of the cost of conflict involving space may include consideration of these factors. Even now, there is a general consensus that the US and other actors have more to gain from space than they have from the loss of space-based capabilities (ViTTa Q3). This suggests that, although the US is more vulnerable in the space domain than are other states, the likelihood that aggressive action against an adversary’s space assets would be reciprocated may provide a degree of security. It also creates another incentive for actors to use diplomacy and international law to reduce risk and increase transparency in the space domain.

#### Legal norms, empirics, costs.

Pavur and Martinovic 19 [James Pavur, DPhil Researcher Cybersecurity Centre for Doctoral Training Oxford University, Ivan Martinovic, Professor of Computer Science Department of Computer Science Oxford University, “The Cyber-ASAT: On the Impact of Cyber Weapons in Outer Space,” 2019 11th International Conference on Cyber Conflict: Silent Battle, <https://ccdcoe.org/uploads/2019/06/Art_12_The-Cyber-ASAT.pdf>] brett

3. STABILITY IN SPACE Given the uncomfortable combination of high dependency and low survivability, one might expect to observe frequent attacks against critical military assets in orbit. However, despite decades of recurring prophesies of impending space war, no such conflict has broken out [14]–[18]. It is true that a handful of space security crises have occurred; most notably, the 2007 Chinese anti-satellite weapon (ASAT) test and the 2008 US ASAT demonstration in response [19]. Moreover, a recent Centre for Strategic and International Studies report suggests increasing interest in attacking US space assets, particularly among the Chinese, Russian, North Korean and Iranian militaries [20]. Overall, however, the space domain has remained puzzlingly peaceful. In this section, we outline three major contributors to this enduring stability: limited accessibility, attributable norms, and environmental interdependence. A. Limited Accessibility Space is difficult. Over 60 years have passed since the first Sputnik launch and only nine countries (ten including the EU) have orbital launch capabilities. Moreover, a launch programme alone does not guarantee the resources and precision required to operate a meaningful ASAT capability. Given this, one possible reason why space wars have not broken out is simply because only the US has ever had the ability to fight one [21, p. 402], [22, pp. 419–420]. Although launch technology may become cheaper and easier, it is unclear to what extent these advances will be distributed among presently non-spacefaring nations. Limited access to orbit necessarily reduces the scenarios which could plausibly escalate to ASAT usage. Only major conflicts between the handful of states with ‘space club’ membership could be considered possible flashpoints. Even then, the fragility of an attacker’s own space assets creates de-escalatory pressures due to the deterrent effect of retaliation. Since the earliest days of the space race, dominant powers have recognized this dynamic and demonstrated an inclination towards de-escalatory space strategies [23]. B. Attributable Norms There also exists a long-standing normative framework favouring the peaceful use of space. The effectiveness of this regime, centred around the Outer Space Treaty (OST), is highly contentious and many have pointed out its serious legal and political shortcomings [24]–[26]. Nevertheless, this status quo framework has somehow supported over six decades of relative peace in orbit. Over these six decades, norms have become deeply ingrained into the way states describe and perceive space weaponization. This de facto codification was dramatically demonstrated in 2005 when the US found itself on the short end of a 160-1 UN vote after opposing a non-binding resolution on space weaponization. Although states have occasionally pushed the boundaries of these norms, this has typically occurred through incremental legal re-interpretation rather than outright opposition [27]. Even the most notable incidents, such as the 2007-2008 US and Chinese ASAT demonstrations, were couched in rhetoric from both the norm violators and defenders, depicting space as a peaceful global commons [27, p. 56]. Altogether, this suggests that states perceive real costs to breaking this normative tradition and may even moderate their behaviours accordingly. One further factor supporting this norms regime is the high degree of attributability surrounding ASAT weapons. For kinetic ASAT technology, plausible deniability and stealth are essentially impossible. The literally explosive act of launching a rocket cannot evade detection and, if used offensively, retaliation. This imposes high diplomatic costs on ASAT usage and testing, particularly during peacetime. C. Environmental Interdependence A third stabilizing force relates to the orbital debris consequences of ASATs. China’s 2007 ASAT demonstration was the largest debris-generating event in history, as the targeted satellite dissipated into thousands of dangerous debris particles [28, p. 4]. Since debris particles are indiscriminate and unpredictable, they often threaten the attacker’s own space assets [22, p. 420]. This is compounded by Kessler syndrome, a phenomenon whereby orbital debris ‘breeds’ as large pieces of debris collide and disintegrate. As space debris remains in orbit for hundreds of years, the cascade effect of an ASAT attack can constrain the attacker’s long-term use of space [29, pp. 295– 296]. Any state with kinetic ASAT capabilities will likely also operate satellites of its own, and they are necessarily exposed to this collateral damage threat. Space debris thus acts as a strong strategic deterrent to ASAT usage.