### **Mining CP**

**Text: States should amend the Outer Space Treaty to allow private appropriation for asteroid mining**

**Private appropriation is impossible without legal reform**

**Taylor 19 explains** [Kurt Taylor, Fictions of the Final Frontier: Why the United States SPACE Act of 2015 Is Illegal, 33 Emory Int'l L. Rev. 653 (2019). Available at: <https://scholarlycommons.law.emory.edu/eilr/vol33/iss4/6>]

The world today is very different than it was fifty years ago when the Outer Space Treaty emerged. American companies like SpaceX and Moon Express have shown the desirability that private development of outer space may have, and demonstrate that such development might be highly valuable in the future.148Through the SPACE Act of 2015, the United States recognizes this and is attempting to make it easier for these companies to do the work they aim to without significant interference.149 If it is desirable to allow appropriation of outer space resources, the current international governing regime under the Outer Space Treaty simply will not work. It clearly bars all forms of appropriation; therefore, the creation of a new regime is necessary to support those goals.

By its passage of the SPACE Act of 2015, the United States is implicitly adopting a hegemonic approach to future appropriation of celestial resources. The Act explicitly allows United States citizens to recover and own resources extracted from celestial bodies,156 thus creating a property right. Passage of the act is a signal that the United States, a sovereign, is creating and enforcing that property right. Because this creation of the property right deals with outer space and celestial resources, it directly implicates the Outer Space Treaty, which in Article II broadly rejects appropriation of any kind in outer space.157 The United States’ creation of a property right that an international treaty directly governs constitutes an act of sovereignty that is impermissible under the Outer Space Treaty. Through its current language, the SPACE Act of 2015 creates an illegal property right as against Article II of the Outer Space Treaty and is thus invalid without further amendment or replacement of the Treaty itself. The dreams and work of private aerospace organizations like SpaceX and Moon Express may be for nothing. While their milestones are commendable and their dreams desirable, they simply cannot achieve what they have set out to without valid assurance—both nationally and internationally—that once they reach outer space, they can reap what they sow. Article II of the Outer Space Treaty should be interpreted broadly as to cover both private and state entities. The resulting effect of Article II is a bar on all appropriation of celestial resources, thus impeding private development in outer space and invaliding the SPACE Act of 2015. For private aerospace companies to achieve their goals, a shift in the current international regulatory regime is necessary. Either the Outer Space Treaty must undergo amendment to specifically address private appropriation, or another treaty or international agency must replace it to oversee celestial development and ensure adherence to important considerations of safety and ecological fairness.

**Amending the OST is necessary for asteroid mining investment**

**Davies**, 2-6-20**16** - Rob Davies, "Asteroid mining could be space’s new frontier: the problem is doing it legally," *Guardian*, https://www.theguardian.com/business/2016/feb/06/asteroid-mining-space-minerals-legal-issues

When Buzz Aldrin and Neil Armstrong hoisted the Stars and Stripes on the moon, the act was purely symbolic. Two years earlier, mindful of Cold War animosity, the 1967 Outer Space Treaty (OST) had decreed that outer space, including the moon and other celestial bodies, “is not subject to national appropriation by claim of sovereignty”. In other words no country, not even the US, could own the moon or any other part of space, regardless of how many flags they erected there. Half a century on, though, the OST could prove the biggest obstacle to one of the most exciting new frontiers of space exploration: asteroid mining. The reason lawyers could soon be poring over that 48-year-old document is that space mining could become a reality within a couple of decades. In what is being seen as a major breakthrough for this embryonic technology, the government of Luxembourg has thrown its financial muscle behind plans to extract resources from asteroids, some of which are rich in platinum and other valuable metals. It plans to team up with private companies to help speed the progress of the industry and draw up a regulatory framework for it. One such firm, Deep Space Industries, wants to send small satellites, called Fireflies, into space from 2017 to prospect for minerals and ice. The satellites would hitch a ride on a rocket, and larger craft would then be used to harvest, transport and store raw materials. Metals such as nickel and iron, which are plentiful on Earth, could be processed while in orbit and used to build equipment or spacecraft. And it may eventually be possible to extract valuable minerals from asteroids **cheaply enough** for it to be worth bringing them back to Earth. Rival Planetary Resources has a slightly different plan, in which telescopes would be used to analyse asteroids before craft were sent to mine them. Its backers include Google co-founder Larry Page and billionaire businessman Ross Perot, and it thinks it could be operating in space by 2025. How would asteroid mining work? A visual guide **One of the difficulties** facing these would-be space miners **is cost**, which is **fittingly astronomical**. Nasa’s Osiris-Rex expedition, which aims to bring just two kilos of asteroid material back to Earth by 2023, is set to cost $1bn. But Deep Space Industries thinks it can get the ball rolling by putting three of its Fireflies in space for just $20m. The other obvious barrier is the **technological progress** that is still required if commercial asteroid mining is to become practically possible and economically viable. However, considerable as these hurdles are, **experts believe the legal component is the most pressing**. Late last year, the US government made an attempt to update the law on space mining, producing a bill that allows companies to “possess, own, transport, use, and sell” extra-terrestrial resources without violating US law. The problem is that **putting this into practice violates the OST**. “The way a private company would enforce their right to mine is through a national court,” says space law expert Dr Chris Newman of the University of Sunderland. “In making a ruling, that court would **exercise sovereign rights, contravening the OST**. We will only know how this would play out if it is tested in court.” US lawyer Michael Listner, who founded thinktank Space Law and Policy Solutions, says the US law is **incompatible** with the OST and risks **souring international relations**: “**China and Russia will want in.** If you have conflicts of law, things start getting dicey and that could lead to **legal and political conflict**.” Newman believes that one reason why Luxembourg has included plans for drawing up a **regulatory framework** is to show the world that work is under way on untangling such legal knots. “This is something for investors to hang their hat on,” he says, “to **give them confidence** and say that there is a nascent legal framework.” But Dr Gbenga Oduntan, a space law expert at the University of Kent, warns that the international community needs to get its act together quickly. “What we don’t want is a free-for-all over asteroids,” he says. “We need to come together and do that thinking, because the law we have right now does not allow us to repatriate resources for commercial purposes.” One way to do this, he suggests, is to draw on existing legislation such as the UN Convention on the Law of the Sea, which governs how nations use the ocean. Another option might be to revive the Moon Treaty of 1979, which deemed space to be the “common heritage of mankind” but failed to win support from any space-faring nation. Such complex legal wrangles could indeed prove harder to overcome than other difficulties, such as the **huge costs involved**. But some experts believe that investing large amounts early on could **create a space economy** in which **costs are forced down by collaboration**. Ian Crawford, professor of planetary science at Birkbeck, London, says asteroid miners would most probably start off by mining water-ice, which can be broken down into hydrogen (for fuel) and oxygen (for supporting life). It is much cheaper to produce water in space than to take it there, and this process could **generate revenue and technical support** from other players in the space game. Once companies had that revenue stream under their belts, they could start thinking more seriously about the more costly business of extracting minerals and bringing them back to Earth. “**Eventually you can imagine the whole process supporting itself**,” says Crawford. “The **main hurdle is the initial investment**, and it seems these companies think they can get started and jump over that hurdle.” But he agrees that **the more pressing concern is the legal picture**, which “badly needs to be updated”. Christopher Barnatt, professional futurist and author of The Next Big Thing: From 3D Printing to Mining the Moon, says history shows us that if governments such as Luxembourg’s get behind asteroid mining, the space industry will deliver on its promise. “With the moon landings, the aspiration was way ahead of the technology. [President] Kennedy had spoken to Nasa and they’d said it couldn’t be done. He thought it could. We’ve got evidence from throughout history that when we commit ourselves to a broad goal, we can achieve it.” The ramifications could be huge, he believes, as progress in one technology **spurs breakthroughs in another**. “If you can use asteroids to make fuel, a lot of space exploration becomes cheaper. Then there’s progress in robotics and artificial intelligence... it all starts to make things possible.”

**Asteroid mining is key to platinum.**

Steven **Melendez**, 6-27-**17**, (Steven Melendez is an independent journalist living in New Orleans, “Forget Coal: Asteroid Mining Is Coming Sooner Than You Think”, Fast Company, https://www.fastcompany.com/40419405/theres-gold-and-platinum-and-cobalt-in-them-thar-asteroids)

President Donald Trump is obsessed with returning America to its coal mining past—but scientists and entreprenurs have far more ambitious plans. As the planet’s **precious metal reserves tap out,** big business and NASA are looking to the skies. The race to mine asteroids swirling around the solar system is on. Space mining may sound like science fiction, **but it’s real**, and big developments are on tap in the next decade. Asteroids are essentially massive rocks that orbit the sun, and many are thought to consist of **platinum**, gold, iron, and more. **A single** 500-meter-wide **asteroid** can contain almost **175 times**Earth’s annual **platinum** mining output, according to Massachusetts Institute of Technology research. The metal, worth about $930 per ounce, is used in jewelry and is a byword for luxury—think platinum credit cards—but it’s also used in the **catalytic converters** installed in every modern car, in industrial chemical processes, and in many electronics. SPACE MINING ECONOMICS Conventional wisdom may be that going to space to bring back what is needed on terra firma is economically nuts. Not so, analysts insist. “While the psychological barrier to mining asteroids is high, the actual financial and technological barriers are far lower,” says a recent report prepared on the subject by Goldman Sachs. Proponents say that before long, robots could be traveling to asteroids to extract platinum and other valuable minerals to haul back to Earth or even one day to use in space-based manufacturing plants. A 2012 Caltech study found that it could cost just $2.6 billion to capture an asteroid and bring it into orbit near Earth, making human exploration and robotic mining that much easier. “We expect that systems could be built for less than that given trends in the cost of manufacturing spacecraft and improvements in technology,” the Goldman report says. It also predicts the eventual result would be far lower costs: “Successful asteroid mining would likely crater the global price of platinum” by dramatically increasing the supply. “The market is a big unknown because of things like platinum,” says Jay McMahon, an assistant professor at the University of Colorado’s Center for Astrodynamics Research. “You don’t know what’s going to happen if you bring back a big haul of platinum, what that would do to the market on Earth or how much demand there is.”

**Key to hydrogen energy.**

Geoffrey **Ozin**, 10-21-**15**, (Geoffrey Ozin studied at King’s College London and Oriel College Oxford University, before completing an ICI Postdoctoral Fellowship at Southampton University. He is the Tier 1 Canada Research Chair in Materials Chemistry and Nanochemistry and Distinguished University Professor at the University of Toronto, where he currently spearheads the Solar Fuels Cluster. He is renowned for his work in defining, enabling and popularizing a chemical approach to nanomaterials for innovative nanotechnology in advanced materials and biomedical science, “Is there enough platinum to run a solar-powered hydrogen economy?”, Advanced Science News, https://www.advancedsciencenews.com/is-there-enough-platinum-to-run-a-solar-powered-hydrogen-economy/)

Hydrogen as a clean energy source for fuel cells in the transportation and power generation sectors, as well as an effective reducing agent for transforming carbon dioxide to value-added chemicals and fuels, could solve some of the adverse consequences of burning fossil fuels that release greenhouse gas into the atmosphere and chemicals that pollute the environment [1, 2]. Today, hydrogen is produced by steam reforming, gasification and electrolysis. Most of hydrogen is produced from fossil fuels (48% natural gas, 30% oil, 18% coal) while electrolysis of water accounts for only 4%. The electricity to enable water electrolysis has traditionally come from fossil and nuclear sources, which are increasingly being replaced by clean, renewable electrical energy from solar, hydro and wind. The practical realization of the full environmental and security benefits of clean and renewable hydrogen for use in fuel cells and conversion of carbon dioxide to chemicals and fuels, will necessitate the development of large-scale, low-cost hydrogen generation methods from renewable resources with a minimal carbon footprint. Amongst the different options for generating hydrogen, the photo-electrochemical approach, which utilizes sunlight to directly split water is considered to be amongst the most promising technologically and economically. Nevertheless, efficiency, figures-of-merit and longevity issues, requiring basic-directed research to improve loss mechanisms and increase electrodes, materials and device performance and stability, ultimately to develop operationally safe systems, remain the most challenging and critically important issues to enable advances in the field [3]. Photo-electrochemistry is an electrochemical technique, which employs light harvesting catalysts most often based on specialized semiconductor and metal nanostructures and combinations thereof. It is a truism that many research scientists, who recognize the axiom of the ‘**materials dilemma’**, remain skeptical of finding a practical and efficient photo-catalyst that can enable the light-assisted electrochemical H2 evolution reaction from H2O at a sufficiently large scale to facilitate a TW H2 economy. This refers to the challenge often confronted by scientists, engineers, industry and manufacturers trying to discover champion materials for a large scale catalytic process, where **the best** performers are comprised of elemental compositions **in short supply** and **too pricey** while inferior performers consist of earth abundant low cost elemental compositions. This is certainly true for the catalytically active **platinum group metals** Ru, Os, Rh, Ir, Pd and Pt in nanostructured forms as well as the catalytic sites of diverse classes of molecules, clusters, polymers and materials. In the case of the photo-electrochemical H2 evolution reaction from aqueous phase H2O, the champion catalyst remains Pt [Platinum] **despite** **much research devoted**to find a more **abundant cheaper alternative**. This is simply because Pt [platinum] as a H2 evolution catalyst still has the **world-record exchange current density** and **low Tafel slope**. Moreover, Pt is reported to be more durable in acidic environments, which is the common case in photo-electrochemical devices. This illustrates the difficult choice one has to make in translating solar fuels materials science to a technology that could be implemented on a large scale. Should one continue to focus attention on bringing down the cost of rare and expensive superior performance materials like Pt or devote time and effort to improving the poorer performance of common cheap materials? It turns out not surprisingly that the efficiency of the H2 evolution reaction sensitively depends on the loading and size of the nanostructured Pt catalyst integrated with the photon harvesting, electron transporting photocathode. In this context, it is pertinent that a recent study has quantified how much Pt is actually required to optimise the H2 evolution rate in a photo-electrochemistry experiment using an exceptionally well-defined Pt-TiO2-Ti-pn+Si composite photocathode [4]. In this experiment, the size and loading of Pt nanoparticles were controlled using a sophisticated supersonic molecular beam source that was able to deposit mass-selected Pt nanoparticles from the gas-phase, with retention of their size, onto the photocathode. From detailed materials characterization measurements and in depth photo-electrochemistry experiments, it was found that the size of the most active Pt nanoparticles for the H2 evolution reaction was 5 nm at a loading level of 100 ng/cm2 on the photocathode. For a state-of-the-art over-potential of 50 mV this translated to about 54 tons of Pt in order to create a TW scale photo-electrochemical H2 generation infrastructure. How often this 54 tons have to be replaced is a crucial question. The issue of a well-designed Pt recycling system is clearly advisable. This tonnage amounts to around 30% of the current global annual production of Pt most of which is currently used in automobile catalytic converters and jewellery. In terms of known Pt mineral resources (earth abundance 3.7×10-6 %) this does not seem like an insurmountable obstacle if it was decided by policy makers, the renewable energy industry and process engineers to establish an economically and environmentally viable TW H2 clean and green global technology founded upon the photo-electrochemical splitting of H2O using Pt as the metal of choice. It is pertinent to note that it may prove possible to reduce this amount of Pt by many orders of magnitude if the size of the Pt nanoparticles could be reduced from 5 nm to the atomically dispersed state and the catalytic activity for the H2 evolution reaction maintained if not improved [5]. Encouragingly in this context, a recent report revealed that the readily accessible, nanoporous layered material carbon nitride (C3N4), can anchor individual Pd atoms at the N sites and is able to function as a thermally stable hydrogenation catalyst for the production of many organic substances [6]. If this breakthrough can be extended to Pt atoms on C3N4-based photocathodes, this has the potential to reduce the Pt catalyst tonnage requirement by orders of magnitude. For photo-electrochemical hydrogen generating systems, besides the availability and cost of Pt, techno-economic challenges will also be encountered by constraining the area for water splitting to that of the light harvesting units and the area and cost of required land. The overall cost analysis of this kind of integrated photo-electrochemistry system will have to be compared with the cost efficiency of competing hydrogen producing technologies that employ Pt electro-catalysts based upon electrically integrated photovoltaic-electrolysis systems and grid integration of decoupled photovoltaics and electrolysis systems [7]. It is worth noting that the production of Pt since the early 2000s has varied between just over 150 tons to about 220 tons. Obviously there is scope for further production if necessary. **The price has been volatile**. It was stable from 1992 to 2000 and then steadily rose until it touched about $2,252 per ounce in 2008. It then fell off a cliff later in 2008 falling to $774 per ounce. It has since gone up and down, as high as $1,900 per ounce and today stands at about $950 per ounce [8]. The price of Pt seems to be related to the fortunes of the economy, when the economy is good and growing so does the price of Pt. A big question is, do we want to base a H2 economy on a rare element like Pt, where countries could be held to ransom on either the price or supply rather like the current situation with oil? Perhaps, when more research scientists challenge the doctrine of the ‘materials dilemma’ by using new value propositions with economic models for producing Pt, they may entice business and industry leaders to produce Pt as if it were a ‘common element’, one that was absolutely essential for creating a sustainable future. Currently, fossil fuel industry methods remain economically advantageous, despite the adverse consequences on our environment and climate. A transition to clean energy technologies **will take time,** nevertheless many companies have already realized the benefits of this ground-breaking change. An impressive example of the conversion from fossil to H2 fuel is seen with Toyota. After more than twenty years of rigorous research and development they have manufactured automobiles with H2 fuel-cell powered engines to become commercially available later this year [9]. To enable this transition, H2 fuel stations as well as H2 generators integrated into automobiles will have to be rapidly developed. It seems that we should not yet write off rare expensive Pt [platinum] as the catalytic metal of choice for making solar H2 on an industrially significant scale to power a global hydrogen economy. If Pt is selected as the catalyst of choice, there should as well be alternative choices of cheap and abundant elemental compositions, which can quickly take the place of Pt as a photo-catalyst. We shouldn’t stop looking for cheaper alternatives as there’s a whole bunch of interesting alternative materials out there. To invoke the wisdom of the American novelist, Mark Twain: “It ain’t what you don’t know that gets you into trouble. It’s what you’re sure you know that does.” If we’re so sure that Pt [platinum] is too **rare** and expensive to process on a global industrial scale, we may be adding to our troubles, rather than resolving them with this nano solution.

**Hydrogen energy production is try-or-die to solve 2°C warming – negative emissions AND solves oceans.**

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According to scientists who track humanity’s greenhouse gas budget, it’s looking more and more likely that we will emit more carbon dioxide than is compatible with limiting global warming to **2 °C**, let alone 1.5 °C, as envisioned in the Paris Agreement. That reality has focused more attention on negative emissions – technologies for pulling carbon dioxide out of the air and sequestering it more or less permanently. Many attempts to model different emissions pathways and predict future climate now assume that negative emissions will be necessary to plug the hole in our carbon budget. So far, most attention has focused on a method called bioenergy with carbon capture and storage (BECCS): grow certain trees or grasses on large plantations, harvest and burn them for energy, capture the resulting carbon dioxide, and inject it underground. The problem is that **this might not be feasible in practice**. For one thing, **the scale** of carbon removal needed **is so massive** that there may not be enough land to grow bioenergy crops without putting natural ecosystems or food production at risk. And scientists aren’t sure that storing huge quantities of carbon dioxide underground will be safe and secure over the long term. But **there may be other options**. According to an analysis published yesterday in Nature Climate Change, negative-emissions methods to produce hydrogen fuel could have **even greater power generation** and **carbon storage potential** than BECCS, and cost less. What’s more, negative-energy hydrogen would yield **byproducts** that **fight ocean acidification.**The process uses renewable energy to split water to yield hydrogen fuel. Meanwhile, a series of additional chemical reactions convert dissolved carbon dioxide to bicarbonate. Scientists have recently developed several different methods that are variations on this same basic theme. Bicarbonate is an important component of seawater and is used as raw material by shell-forming organisms. One effect of ocean acidification is that bicarbonate is in shorter supply, making it more difficult for marine organisms to make shells. Negative-emissions hydrogen would **replenish the ocean’s stock of bicarbonate while sequestering** **carbon**. It’s essentially an accelerated version of a natural process, called mineral weathering, that has kept ocean chemistry in balance across geologic time scales. In the new analysis, researchers evaluated the potential of negative-emissions hydrogen energy production and carbon dioxide removal. They calculated that the global energy system could produce between 300 and 3,000 exajoules of negative-emissions hydrogen energy per year. (One exajoule is equivalent to the amount of energy contained in 174 million barrels of oil.) The method could remove between 90 and **900 gigatonnes of carbon dioxide** from the air annually. Anthropogenic carbon dioxide emissions are currently about 41 gigatonnes per year. By comparison, other scientists have calculated that **BECCS could** produce as much as 300 exajoules of energy yearly, and **sequester up to 12 gigatonnes** of carbon per year. The new analysis also suggests that negative-emissions hydrogen is more efficient than BECCS, in that it removes about seven times more carbon dioxide per unit of energy generated. How much this would all cost depends on what form of renewable electricity is used. The researchers estimate that using hydropower to split water would cost 7 per kilowatt hour of hydrogen fuel produced, while using high-cost solar electricity would cost 64 cents. Carbon removal would cost between $3 and $161 per tonne, again depending on the form of energy used. Overall, these estimates are less than or roughly equal to the cost of carbon capture and storage in fossil fuel-based systems. They are also equivalent to or much lower than the costs associated with BECCS. On the other hand, a downside of negative-emissions hydrogen is that hydrogen fuel is not as readily used by the global energy system as the electricity produced by BECCS is. But this could change in a future **“hydrogen economy”** as this fuel gets more integrated into the transportation system and the energy grid. Negative-emissions hydrogen could also have its own environmental impacts from mining minerals and water use. And it remains to be seen how well this would work in practice, especially at a large scale. But as an argument that it’s worth exploring alternatives to BECCS, negative-emissions hydrogen looks pretty compelling. “The negative-emissions energy field is in its infancy and therefore the methods discussed here are unlikely to be the only ones ultimately worth considering,” the researchers write.

**Cross Apply their cards here, warming causing extinction and disproportionately affects marginalized groups**

### **Digital Divide DA (sv)**

#### **Digital divides are growing, especially because of the pandemic.**

Li, C. (2021, October 11). *Worsening global digital divide as the US and China continue zero-sum competitions*. Brookings. Retrieved December 14, 2021, from https://www.brookings.edu/blog/order-from-chaos/2021/10/11/worsening-global-digital-divide-as-the-us-and-china-continue-zero-sum-competitions/ Cheng Li is the director of the John L. Thornton China Center and a senior fellow in the Foreign Policy program at Brookings. He is also a director of the National Committee on U.S.-China Relations. Li focuses on the transformation of political leaders, generational change, the Chinese middle class, and technological development in China. Li is also the author or the editor of numerous books. //ech

The COVID-19 crisis has interrupted daily life and business routines across the world, caused a massive loss of millions of lives, and exacerbated economic disparities within and between countries. **COVID-19 has also revealed fundamental challenges in the international order.** As Kissinger has asserted, “the world will never be the same after the coronavirus.” One can reasonably expect that cynicism regarding regional and global integration, as well as radical populism, racism, ultranationalism and xenophobia, will likely continue to rise around the world. At this critical juncture, it has become even more essential to examine the urgent challenges that the world confronts and to engage in global cooperation instead of devolving into constant contention and confrontation. **One of the most urgent tasks for the international community is to overcome growing digital divides. Digital divides in least developed countries (LDCs) have been particularly salient, as digitally disconnected populations have been left further behind during the pandemic. The U.S. and China, two superpowers in the digital era, should work in tandem with the international community to jointly combat digital divides and COVID-19. Despite the global growth of digital technologies, a 2021 United Nations report noted that nearly half of the world’s population, 3.7 billion people, lack internet access. Deficiency of digital connectivity is especially prevalent within LDCs, where more than 80% of the population are still offline.** In comparison, the unconnected population in developed countries and developing countries stands at 13% and 53%, respectively. LDCs account for about 14% of the world’s population, and they comprise more than half of the world’s extremely poor. **Digital divides both reflect and reinforce socioeconomic disparities. The pandemic has aggravated existing inequalities, often resulting in a widening gap of digital skills. As a result of COVID-19-induced economic difficulties, the population of extreme poor in LDCs expanded by 32 million, and the number of people in poverty in LDCs grew to 36% in 2020, 3% more than in prior years. More specifically, LDCs lag further behind in the following three areas.**

#### **Starklink and other private entity developments could bridge existing digital divides, but regulations are inhibiting them.**

Estes, A. C. (2020, September 26). *The pandemic is speeding up the space internet race*. Vox Recode. Retrieved December 14, 2021, from <https://www.vox.com/recode/2020/9/26/21457530/elon-musk-spacex-starlink-satellite-broadband-amazon-project-kuiper-viasat>. Adam Clark Estes is the deputy editor of Recode. He was previously a senior editor at Gizmodo, an associate editor at Motherboard, and a staff writer at The Atlantic Wire. //ech

**In vast swaths of the United States and the world, there are millions of people who don’t have reliable internet access.** These unconnected people aren’t just in far-flung places like rural America or New Zealand or sub-Saharan Africa, either. There are plenty of people living in dense city centers with limited access to affordable broadband. **The**[Covid-19](https://www.vox.com/coronavirus-covid19)**pandemic has brought new urgency to the challenge of getting everyone connected**, and while companies like Google and Facebook have floated far-out ideas for solving the problem, the internet technology that’s most promising is also one that’s already proven: satellite broadband. In early March, just days before cities across the US shut down due to the pandemic, **Elon Musk**[shared the latest details](https://arstechnica.com/information-technology/2020/03/musk-says-starlink-isnt-for-big-cities-wont-be-huge-threat-to-telcos/)**about his plan to build a satellite broadband service called Starlink. Speaking at a satellite conference in Washington, DC, Musk described how a constellation of Starlink satellites will “blink” when they enter low-Earth orbit**. As described, they almost sound like streaks of glitter in the night sky, or magic bands of flying gadgets that can beam internet down to anyone on the planet. Combined with improvements to existing technology like DSL, cable, and fiber — not to mention 4G and 5G cellular networks — **futuristic satellite broadband stands to bridge the digital divide in the US and elsewhere.** And because the pandemic has prompted explosive demand for better, more widely available internet connectivity, fast progress seems more inevitable than ever. Musk’s new satellites went online in early September, giving beta testers download speeds [that rival those of terrestrial broadband](https://www.theverge.com/2020/9/3/21419841/spacex-starlink-internet-satellite-constellation-download-speeds-space-lasers). **SpaceX has now put 700 Starlink satellites into orbit in the past 16 months and**[has plans to deliver](https://spacenews.com/spacex-submits-paperwork-for-30000-more-starlink-satellites/)**as many as 30,000 more in the next few years. More satellites mean more bandwidth and faster speeds, and eventually, SpaceX says, its low-Earth orbit satellite constellations could deliver high-speed internet to the entire US.** [Amazon](https://www.theverge.com/2019/4/4/18295310/amazon-project-kuiper-satellite-internet-low-earth-orbit-facebook-spacex-starlink), [Facebook](https://www.wired.com/story/facebook-confirms-its-working-on-new-internet-satellite/), and several startups have made similar promises in recent years. The concept of satellite-based internet service is actually decades old. However, **the innovative low-Earth orbit satellite technology being developed by SpaceX and others could be essential, if not transformative, for everything from telemedicine to remote learning in places that aren’t already connected.** [Satellite broadband](https://www.vox.com/recode/2020/9/10/21426810/internet-access-covid-19-chattanooga-municipal-broadband-fcc) could also be very profitable for whichever company figures it out first. One could imagine Amazon using satellite broadband to boost its Amazon Web Services (AWS) business, or Facebook using it to ensure that more people get on its platform. And if Musk gets his way, his Starlink constellations will generate billions of dollars in profits to fund his mission to colonize Mars. This all sounds futuristic, but satellite broadband is already a very real thing. In fact, if you’ve ever connected to wifi on a plane or cruise ship, you’ve probably used it. The basic idea is that ground stations connected to the internet, known as gateways, can send data up to a satellite which then relays that data to antennas somewhere else on the ground — or on a ship or an airplane. **The problem with this technological feat is that it’s all very expensive**. **It can cost** hundreds of millions of dollars to launch satellites into space, and that’s not even taking into account what it takes **to get over regulatory hurdles**. Plenty of companies have tried and failed to crack the business model in the past 20 years. But rather suddenly, the space internet game has changed. “**The Covid-19 crisis has significantly accelerated attention to and investment in satellite technology**,” Babak Beheshti, dean of the College of Engineering and Computing Sciences at the New York Institute of Technology, told Recode. Beheshti added that the number of launches had gone up tenfold from last year to this year. “Why? Because schools, local governments, and others suddenly needed to have broadband internet access in areas where there was really no infrastructure in place.”

#### **The digital divide amplifies gender inequality and leads to decreased women in STEM.**

**Gromova**, K., Anderson, R., & Gupta, G. (20**21**, November 4). *Opening a global conversation about the gender digital divide*. World Bank Blogs. Retrieved December 16, 2021, from <https://blogs.worldbank.org/digital-development/opening-global-conversation-about-gender-digital-divide>. Kate Gromova worked for more than 15 years at the intersection of economics, law, technology, and entrepreneurship development. Reyn is a born lawyer, digital development specialist, and excellent project manager. Garima is a corporate lawyer turned digital development enthusiast.  //ech

[**The COVID-19 pandemic showed how critical digital technologies are in today’s world — they kept businesses, education, government services, healthcare, and economies running despite the health crisis and global economic downturn.**](https://twitter.com/intent/tweet?text=The+COVID-19+pandemic+showed+how+critical+digital+technologies+are+in+today%E2%80%99s+world+%E2%80%94+they+kept+businesses%2C+education%2C+government+services%2C+healthcare%2C+and+economies+running+despite+the+health+crisis+and+global+economic+downturn.&url=https://blogs.worldbank.org/digital-development/opening-global-conversation-about-gender-digital-divide/?cid=SHR_BlogSiteTweetable_EN_EXT&via=WBG_DigitalDev)But it also shed light on another issue — many people and communities have been left out of their country’s digital transformation. Why is this a problem? Because economic development has become more dependent on digital technologies. **Those with limited or no access to technology are falling further and further behind. In many developing countries, women and girls fall into this category**. Barriers and constraints in accessing the internet impede their full participation in the social and economic life of their communities and countries. [**Today, we are seeing long-standing development gaps between men and women moving online. It is called the gender digital divide.**](https://twitter.com/intent/tweet?text=Today%2C+we+are+seeing+long-standing+development+gaps+between+men+and+women+moving+online.+It+is+called+the+gender+digital+divide.%20&url=https://blogs.worldbank.org/digital-development/opening-global-conversation-about-gender-digital-divide/?cid=SHR_BlogSiteTweetable_EN_EXT&via=WBG_DigitalDev)**Digital transformation can’t achieve its potential when half of the world’s population is excluded or limited from the process, making it an important and relevant topic in development.** [**Closing this divide is imperative for ensuring women and girls have better and more access to healthcare, education, jobs, and civic participation.**](https://twitter.com/intent/tweet?text=Closing+this+divide+is+imperative+for+ensuring+women+and+girls+have+better+and+more+access+to+healthcare%2C+education%2C+jobs%2C+and+civic+participation.&url=https://blogs.worldbank.org/digital-development/opening-global-conversation-about-gender-digital-divide/?cid=SHR_BlogSiteTweetable_EN_EXT&via=WBG_DigitalDev)**However,**[**bridging the gender digital divide is complex — its causes are multifactorial, and the mix of factors changes across a woman’s lifetime.**](https://twitter.com/intent/tweet?text=bridging+the+gender+digital+divide+is+complex+%E2%80%94+its+causes+are+multifactorial%2C+and+the+mix+of+factors+changes+across+a+woman%E2%80%99s+lifetime.&url=https://blogs.worldbank.org/digital-development/opening-global-conversation-about-gender-digital-divide/?cid=SHR_BlogSiteTweetable_EN_EXT&via=WBG_DigitalDev) These include the legal and regulatory environment, the availability and accessibility of affordable internet, digital skills development, relevant content, online safety and security, and opportunities for education and employment in the CT sector. **Cutting across all these factors are social and cultural norms and expectations concerning girls’ and women’s roles and their relationship to technology.** For instance, cost concerns may limit the number and sophistication of smartphones used in a household. When the supply of phones or computers is limited, women’s and girls’ access is not prioritized. [Affordability concerns can also impact internet availability for girls and women; lower-cost internet access plans are usually more restrictive in terms of service and are of lower quality.](https://twitter.com/intent/tweet?text=Affordability+concerns+can+also+impact+internet+availability+for+girls+and+women%3B+lower-cost+internet+access+plans+are+usually+more+restrictive+in+terms+of+service+and+are+of+lower+quality.+&url=https://blogs.worldbank.org/digital-development/opening-global-conversation-about-gender-digital-divide/?cid=SHR_BlogSiteTweetable_EN_EXT&via=WBG_DigitalDev)The poor user experience may decrease women’s interest—or appetite — in using the internet or seeing it as a valuable resource. Security and privacy concerns also creep in, like online harassment and cyberstalking. These threats further discourage women from becoming active internet users. [**The ability to use digital technologies productively and safely requires digital literacy, skills, and confidence that may not be provided or encouraged for women and girls.**](https://twitter.com/intent/tweet?text=The+ability+to+use+digital+technologies+productively+and+safely+requires+digital+literacy%2C+skills%2C+and+confidence+that+may+not+be+provided+or+encouraged+for+women+and+girls.&url=https://blogs.worldbank.org/digital-development/opening-global-conversation-about-gender-digital-divide/?cid=SHR_BlogSiteTweetable_EN_EXT&via=WBG_DigitalDev)**Pursuing STEM education may be actively discouraged, narrowing the pipeline of potential female leaders, role models in technology fields, and gender-based innovation.**

#### **Lessening the Digital divide helps solve poverty, especially in Africa, by creating jobs.**

**The World Bank**. (20**21**, September 24). *Narrowing the Digital Divide Can Foster Inclusion and Increase Jobs*. IBRD - IDA. Retrieved December 16, 2021, from https://www.worldbank.org/en/news/feature/2021/09/24/narrowing-the-digital-divide-can-foster-inclusion-and-increase-jobs//ech

**A growing body of evidence demonstrates that digital technologies can enable economic transformation in Africa and help create more jobs for its people**. **Digital technologies do so by helping all people, and especially lower-income and lower-skilled entrepreneurs and employees, work better and learn better, catalyzing adoption and productivity of complementary technologies.** World Bank country-level studies, on Nigeria, Senegal, and Tanzania, have analyzed the impact on jobs of mobile internet availability (3G or 4G coverage), including the poor and most vulnerable. **Studies show that both internet availability and use of more sophisticated digital technologies lead to more and better jobs for lower-income, lower-skilled people, and hence reduce poverty. Labor force participation and wage employment increased significantly in areas with internet availability after three years, relative to those with no coverage.** For example, digital technologies such as the use of local language videos on tablet computers and use of a decision support tool app on a smartphone can provide personalized advice resulting in better jobs, and an increase in crop yields of lower-income farmers. Although mobile internet availability has increased, Africa’s internet coverage still lags behind other regions—with digital divides in availability still an issue in remote and poorer areas in all countries. Yet uptake is a bigger problem today than coverage. Africa’s uptake gap has widened, both relative to other regions and relative to availability: while 70 percent of Africa’s regional population have availability of mobile internet, less than 25 percent are using it—resulting in an average uptake gap of almost 50 percent. This uptake gap is highest in rural areas and informal enterprises; it is also high for older and poorer women and rural households. There are growing digital divides in use between richer, urban, literate, and better educated households with electricity and poorer households without electricity. Three World Bank country-level studies, on Nigeria, Senegal, and Tanzania, have analyzed the impact on jobs of mobile internet availability (3G or 4G coverage). **Better jobs and earnings for some people are also associated with large effects on total household consumption and poverty reduction**. **One key takeaway is that the more digital access Africans have, the more likely they are to reduce poverty over time.**

#### **Internet and technological regimes manipulate lesser developed countries so they become dependent.**

**Wade**, R. H. (20**02**, December). *Bridging the Digital Divide: New Route to Development or New Form of Dependency?* (Global Governance Vol. 8; Research Report No. 04). Brill. <https://www.jstor.org/stable/27800358>. Robert Hunter Wade is a political economy and development scholar. He is currently Professor of Global Political Economy at the Department of International Development, London School of Economics. //ech

**In this section, I look at the impact of the global ICT industry and the international ICT regimes on LDCs. ICTs seem to have a large quotient of public goodness about them and therefore high spillover benefits.** "The Internet was created in the United States, but its cost-slashing consequences for information and communications enhance people's opportunities everywhere," in the words of the Human Development Re port.16 **This might be taken to imply that LDCs are not much disadvantaged by the structure of the global ICT regimes. Not so. In several ways, developing country users are being tied more tightly into hardware and software escalation with ramifications difficult to anticipate (like the more abstruse parts of derivatives markets). Escape is increasingly limited, and the costs grow as the dependence of the users increases. This is a new form of international digital dependence for which we need a new version of the 1970s dependency theory.** The U.S./Microsoft Privilege in Software Developing countries are placed at a growing disadvantage by the soft ware-hardware arms race in the global market for savvy computer users. The software is constantly being rewritten to take advantage of unused slack in memory and speed, and then the hardware manufacturers esca late the headroom so that the new software can run as fast. The result ing complexity is attractive to the minority of younger, wealthier, and better-educated people but is a deterrence for others, who perceive that software is actually getting worse for many word processing and spreadsheet uses because the new features cause glitches and slow downs. **The effect of this technological arms race is to keep widening the digital divide between the prosperous democracies and the rest of the world. Every time Microsoft comes out with a new version of its software that can only run on the latest generation of chip, LDCs either face more costly and hassle-filled communication with customers and suppliers in the OECD countries, or spend scarce foreign exchange to re place their old machines and software.** **This is an inbuilt gravitational force against their ascent across the digital and income divide.** It is where Microsoft is most abusing its monopoly power, checked only a little by the unorganized anger of the "orphans" left with incompatible document formats.17 Almost certainly the software-hardware race and the constant need for further investment represents a huge misallocation of resources, not only in LDCs but even in the OECD countries. The rush to upgrade software, and hence hardware, comes first from large companies, ostensibly because they "need" the new capabilities. Large multinationals promote the idea of twenty-four-hour global working, for which they need to have messages and designs winging their way to Tokyo as Los Angeles closes down, and vice versa. But the rush to upgrade software is probably driven as much by organizational pressures from ICT staff and from top managers. Since salaries are linked to budgets, ICT staff press for whatever keeps ICT budgets high and fully spent by year's end. The top managers worry that the "brand" of the company will be downgraded if the company does not boast the latest ICT. Smaller organizations have to follow this trend, because otherwise they have difficulties exchanging attachments and various other text- and graphics bearing bits of software with the large companies with which they do business

### **AT: Space Debris**

#### **Collision is unlikely – all countries receive collision warnings THREE days ahead AND their evidence doesn’t assume new technology.**

**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]//ww pbj

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 **S**pace **S**urveillance **N**etwork (SSN). The project, led by the **US military**, uses **30** different systems around the **world** to **identify**, **track**, and share **info**rmation 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).

#### **No debris impact at every layer of space**

**Fange 17** (Daniel von Fange. Web Application Engineer. “Kessler Syndrome is Over Hyped,” *Braino*, 5/21/17, <http://braino.org/essays/kessler_syndrome_is_over_hyped/>) dwc 19)//ww pbj

**Kessler Syndrome is overhyped**. A chorus of **online commenters** great any news of upcoming low earth orbit satellites with worry that humanity will to lose access to space. I now think they **are wrong.** //// What is Kessler Syndrome? Here’s the popular view on Kessler Syndrome. Every once in a while, a piece of junk in space hits a satellite. This single impact destroys the satellite, and breaks off several thousand additional pieces. These new pieces now fly around space looking for other satellites to hit, and so exponentially multiply themselves over time, like a nuclear reaction, until a sphere of man-made debris surrounds the earth, and humanity no longer has access to space nor the benefits of satellites.//// It is a dark picture.//// Is Kessler Syndrome likely to happen? I had to stop everything and spend an afternoon doing back-of-the-napkin math to know how big the threat is. To estimate, we need to know where the stuff in space is, how much mass is there, and how long it would take to deorbit. //// The orbital area around earth can be broken down into four regions. //// **Low LEO** - Up to about 400km. **Things** that orbit here **burn up** in the earth’s atmosphere **quickly** - between a few months to two years. The space station operates at the high end of this range. It loses about a kilometer of altitude a month and if not pushed higher every few months, would soon burn up. For all practical purposes, Low LEO doesn’t matter for Kessler Syndrome. If Low LEO was ever full of space junk, **we’d just wait a year** and a half, **and the problem would be over**.///// High LEO - 400km to 2000km. This where most heavy satellites and most space junk orbits. The air is thin enough here that satellites only go down slowly, and they have a much farther distance to fall. It can take 50 years for stuff here to get down. This is where Kessler Syndrome could be an issue. /// **Mid Orbit** - GPS **satellites** and other navigation satellites travel here in lonely, long lives. The **volume** of space **is** so **huge, and** the number of **satellites so few**, that **we don’t need to worry** about Kessler here. //// **GEO** - If you put a satellite far enough out from earth, the speed that the satellite travels around the earth will match the speed of the surface of the earth rotating under it. From the ground, the satellite will appear to hang motionless. **Usually the geostationary orbit is used by big weather satellites and big TV broadcasting satellites**. (This apparent motionlessness is why satellite TV dishes can be mounted pointing in a fixed direction. You can find approximate south just by looking around at the dishes in your northern hemisphere neighborhood.) For Kessler purposes, GEO orbit is roughly a ring 384,400 km around. However, all the satellites here are moving the same direction at the same speed - debris doesn’t get free velocity from the speed of the satellites. Also, it’s quite expensive to get a satellite here, and so there aren’t many, only about one satellite per 1000km of the ring. Kessler is not a problem here. //// How bad could Kessler Syndrome in **High LEO be**? Let’s **imagine a worst case** scenario. //// An evil alien intelligence chops up everything in High LEO, turning it into 1cm cubes of death orbiting at 1000km, spread as evenly across the surface of this sphere as orbital mechanics would allow. Is humanity cut off from space? //// I’m guessing the world has launched about 10,000 tons of satellites total. For guessing purposes, I’ll assume 2,500 tons of satellites and junk currently in High LEO. If satellites are made of aluminum, with a density of 2.70 g/cm3, then that’s 839,985,870 1cm cubes. A sphere for an orbit of 1,000km has a surface area of 682,752,000 square KM. So there would be one cube of junk per .81 square KM. **If a rocket traveled** **through that, its odds of hitting** that **cube are tiny** - **less than 1 in 10,000**. ////// So **even in the worst case, we don’t lose access** to space. // Now though you can travel through the debris, you couldn’t keep a satellite alive for long in this orbit of death. **Kessler** Syndrome at its worst **just prevents** us from putting **satellites in certain orbits**. //// **In real life**, there’s a lot of factors that make Kessler syndrome even less of a problem than our worst case though experiment.//// **Debris** would be **spread over** a **volume** of space, not a single orbital surface, making collisions orders of magnitudes less likely.//// Most **impact** **debris** will **have a slower orbital velocity** than either of its original pieces - this makes it deorbit much sooner.//// Any **collision** will create large and small objects. **Small objects** are much **more affected by** atmospheric **drag** and deorbit faster, even in a few months from high LEO. **Larger objects** can be **tracked by earth based radar** and avoided.//// The planned big new constellations are not in High LEO, but in Low LEO for faster communications with the earth. They aren’t an issue for Kessler.//// Most importantly, all new satellite launches since the 1990’s are required to include a plan to get rid of the satellite at the end of its useful life (usually by deorbiting)//// So the realistic worst case is that insurance premiums on satellites go up a bit. Given the current trend toward much smaller, cheaper micro satellites, this wouldn’t even have a huge effect.

#### **Kessler’s Syndrome wrong and super long timeframe**

**Kurt 15** – JD-William & Mary Joseph Kurt, JD- William & Mary School of Law, BA-Marquette University, NOTE: TRIUMPH OF THE SPACE COMMONS: ADDRESSING THE IMPENDING SPACE DEBRIS CRISIS WITHOUT AN INTERNATIONAL TREATY, 40 Wm. & Mary Envtl. L. & Pol'y Rev. 305 (2015)//ww pbj

A. Practical Considerations: Feasible Solutions to the Space Debris Problem Are on Their Way One **key question in assessing** whether an international treaty is a **requisite** for solving the space debris problem is just **how difficult** it will be to fashion a remedy. The more complex and costly are feasible solutions, the more likely it is that a **comprehensive regime** is necessary to **bind the various actors together**. 93Link to the text of the note A good place to begin is to determine **just how imminent is the onset of the cascade** of exponentially more frequent debris-creating collisions, known as the Kessler Syndrome. 94Link to the text of the note To be certain, no one can be sure--this phenomenon being subject to highly complex probabilities. 95Link to the text of the note Indeed, experts' estimates of when such a cascade will become irreversible **vary** [\*316] **widely**. 96Link to the text of the note The National Research Council produced a report in 2011 that suggested that "space might be just 10 or 20 years away from severe problems." 97Link to the text of the note In fact, the cascading effect has already begun, albeit at a modest pace. 98Link to the text of the note However, Donald **Kessler**, who **first described** the eponymous effect in **1978**, has **significantly recalibrated his own outlook** over the years. 99Link to the text of the note Originally, Kessler predicted that catastrophe would **result by the year 2000**. 100Link to the text of the note That date **long passed**, Kessler **now speaks of a century-long process** that "**we have time to deal with**." 101Link to the text of the note