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Light trails left in the sky (photographed with a long exposure time), by Starlink satellites, seen from New Mexico, USA. Mike Lewinski/Flickr, CC BY

The costly collateral damage from Elon Musk's Starlink satellite fleet

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A colossal chess game of immense consequences is being fought in outer space, right now. On March 18 and April 22 2020, two rockets from SpaceX, owned by billionaire Elon Musk, each put 60 satellites into orbit. Those launches are but the sixth and seventh in a series intended to rapidly make 1,584 satellites available.

The aim is to create a satellite network called Starlink. If Musk has his way, by 2025 no less than 11,943 of his satellites will circle the Earth, and if permission is granted, the ultimate result would be a staggering 42,000. This mind-boggling number must be compared to the 8,000 satellites sent into orbit since the Soviet Sputnik, of which 2,218 are still in operation. Why such outsized ambitions? To implement his dream of a “multiplanetary” society, and to fund it by providing all (solvent) Earthlings with high-speed Internet access.

Musk would first target the 3% or 4% of the US population living in remote areas or on island. The financial benefits of providing Internet access to such a tiny slice of the nation are not obvious. The polar regions are not known for their density of wealthy but underserved American citizens, for example. Could the expected profitability come from US defence spending? The United States maintains hundreds of oversea

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- English
- Français

bases and has already expressed its interest in using SpaceX, in putting satellites in a low Earth orbit (LEO) and also for Starlink.

Light pollution and traffic jams in orbit

Whatever the potential benefits of such a system, one of the disastrous consequences would be light pollution. As they travelled across the skies, thousands of Starlink satellites would effectively make astronomical images useless by leaving long luminous trails. At the March 9 "Satellite 2020" conference keynote speech, Elon Musk dismissed those worries and claimed that his satellites will do no harm to astronomical research – if need be, they will be painted black. This idea was tested with satellite 1130, "DarkSat". The results were unconvincing, to say the least. The next generation is supposed to be less luminous than the faintest stars that can be seen with the unaided eye, but this is still far too bright for astronomers' ultra-sensitive instruments, which can observe stellar objects four billion times fainter than that threshold.



Starry Night, Vincent van Gogh, 1889.

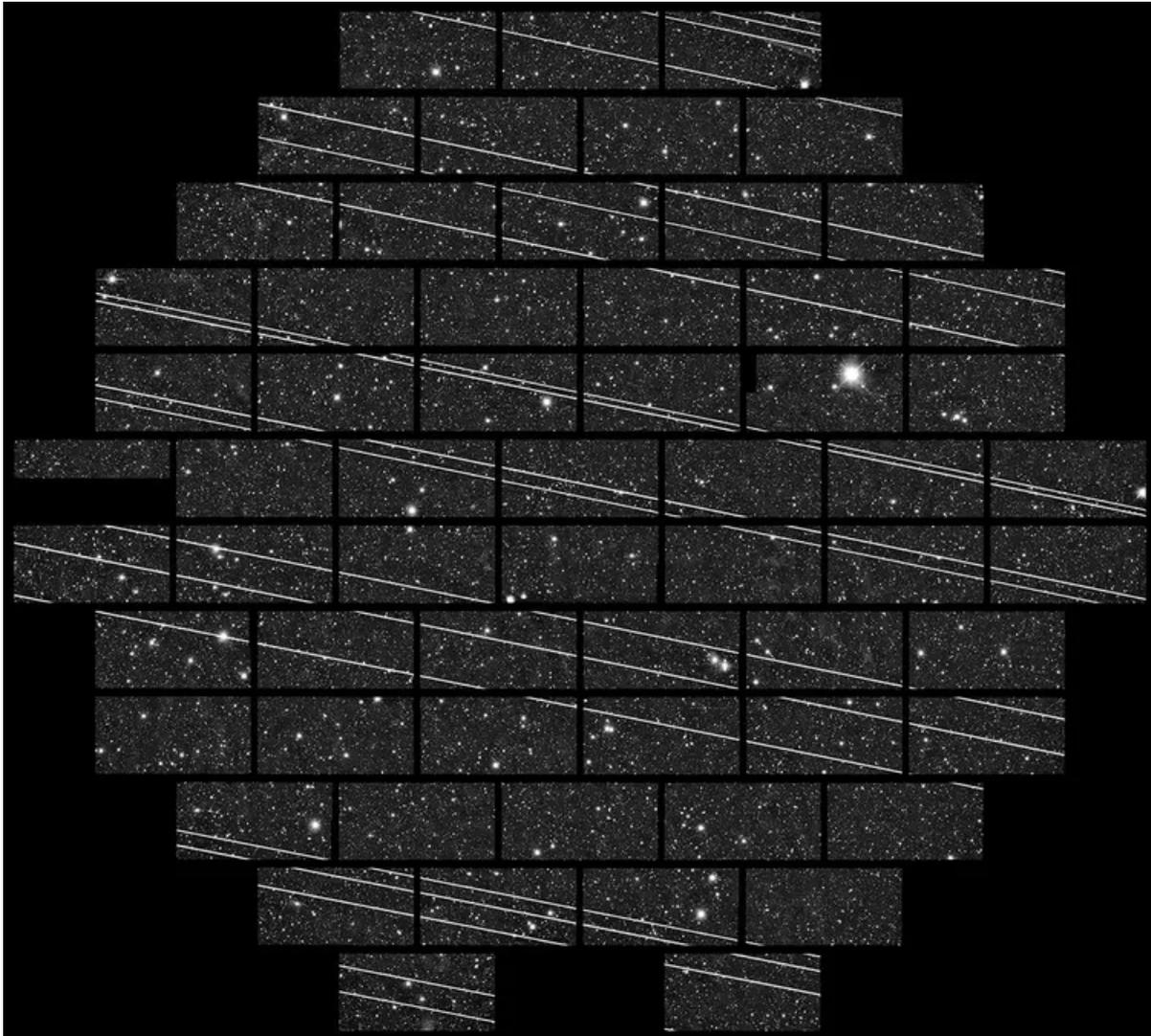
Other satellite operators are worried, too. The low Earth orbit region is already heavily used by scientific, remote-sensing and telecom satellites as well as the International Space Station (ISS). A large-scale increase in the number of satellites would increase the risk of space collisions and the ensuing multiplication of debris – in the worst-case scenario, it could render the LEO and near-space environment unusable. The first incident already took place: on September 2, 2019, the European Space Agency was forced to move away one of its Earth observation satellites to avoid a collision after Starlink refused to change the path of its satellite. Elon Musk asserts that all the satellites be equipped

with thrusters to make them fall back on Earth once they reach the end of their active life, but that doesn't reduce the risk while they're operational.

Waste in outer space, waste on Earth

Since the first launch, six Starlink satellites have already failed. If a mere 5% of Starlink's satellites broke down during their estimated lifespan of five to seven years, they would add many thousands of fragments of space debris to the 20,000 already under surveillance.

Musk initially planned to put a quarter of his constellation at the altitude of 1,110 km (690 miles). Seventy-five percent were due to be placed no higher than 600 km (370 miles). Below this altitude, residual atmospheric drag will eventually cause a failed satellite to fall out of orbit. On April 17, 2020, SpaceX modified its plans and requested permission for all its satellites to orbit lower than 600 km. This reduces the risk of broken-down satellite staying in high-earth orbit for centuries, but increases congestion in the low Earth orbit region.



Satellites Starlink imaged by the DELVE Survey of Cerro Tololo Inter-American Observatory, specialized in detection and observation of the faintest galaxies. National Optical-Infrared Astronomy Research Laboratory/CTIO/AURA/DELVE, CC BY

Beyond the operational risks, building, launching and maintaining such a gigantic network of satellites would require an enormous amount of raw materials and energy. Unlike the geostationary

satellites commonly used by telecoms, Starlink satellites will stay in a low Earth orbit and cross the visible sky of a given location for just a few minutes. To follow and connect to them, buyers will have to use purpose-built phased array antennas. To make them affordable, they would have to be mass produced, and SpaceX has asked permission for 1 million of them. For starters.

More troublingly, competitors are sharpening their knives. Kuiper is backed by Amazon, OneWeb by billionaire Greg Wyler, and Hongyan is Chinese. Just as with electrical scooters, investors are rushing into massive production, and the results could be disastrous.

Such unbridled competition has negative consequences from the environmental point of view as well as from the security and business ones. The theory is that whoever is “first past the post” will gain near-monopoly power, cornering the potentially colossal market. We could well see several redundant satellite networks duke it out in the skies. Yet, there will be only one winner. Or none.

Privatization of the commons

On March 9, 2020, Elon Musk claimed that thanks to Starlink, anybody “will be able to watch high-def movies, play video games and do all the things they want to do without noticing speed”. Thus, Musk explicitly underlines his wish to reinforce already massively energy-guzzling digital activities, such as video streaming and online video games. These consume just below the whole electricity consumption of Europe (if you want figures, the world digital energy consumption of 3,834 TWh expected in 2020 is comparable to the 4,077 TWh for European electricity in 2018). Their share of world greenhouse gas emissions is already 4% and could double to 8% by 2025.

Musk's declaration ends on an ominous note, in essence saying “My clients will be able to do whatever they want, just as I am able to do whatever I want”. The Federal Communications Commission appears to be ready to give Musk its blessing. After all, the Commission's space department is not shy about its priorities: authorize more satellites, faster, with much less regulation.

Thus the American authority tasked with regulating US telecoms – which recently decided to drop the Net neutrality principle – turns a blind eye to the privatization of space by a corporation that wants to take over the low Earth orbit region. All this in the spirit of the 2015 Commercial Space Launch Competitiveness Act, which allows US industries to “engage in the commercial exploration and exploitation of space resources”.

The 1967 Outer Space Treaty, declared outer space to be a common good of humankind. Today this may seem quaint to some, but it is more necessary than ever.

This text benefited from inputs by Emmanuelle Rio, physicist at Paris-Saclay University, Jean-Manuel Traimond, lecturer and author, and Aurélien Ficot, environmental sciences engineer and trainer. English version translated by Jean-Manuel Traimond.

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