Elon Musk's SpaceX Spy Satellites Watch You Everywhere On Earth! Can privacy survive?

by **Christopher Beam**

In 2013, police in Grants Pass, Oregon, got a tip that a man named Curtis W. Croft had been illegally growing marijuana in his backyard. So they checked Google Earth. Indeed, the four-month-old satellite image showed neat rows of plants growing on Croft’s property. The cops raided his place and seized 94 plants.

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In 2018, Brazilian police in the state of Amapá used real-time satellite imagery to detect a spot where trees had been ripped out of the ground. When they showed up, they discovered that the site was being used to illegally produce charcoal, and arrested eight people in connection with the scheme.

Chinese government officials have denied or downplayed the existence of Uighur reeducation camps in Xinjiang province, portraying them as “vocational schools.” But human rights activists have used satellite imagery to show that many of the “schools” are surrounded by watchtowers and razor wire.

Every year, commercially available satellite images are becoming sharper and taken more frequently. In 2008, there were 150

Earth observation satellites in orbit; by now there are 768. Satellite companies don't offer 24-hour real-time surveillance, but if the hype is to be believed, they're getting close. Privacy advocates warn that innovation in satellite imagery is outpacing the US government's (to say nothing of the rest of the world's) ability to regulate the technology. Unless we impose stricter limits now, they say, one day everyone from ad companies to suspicious spouses to terrorist organizations will have access to tools previously reserved for government spy agencies. Which would mean that at any given moment, anyone could be watching anyone else.

The images keep getting clearer

Commercial satellite imagery is currently in a sweet spot: powerful enough to see a car, but not enough to tell the make and model; collected frequently enough for a farmer to keep tabs on crops' health, but not so often that people could track the comings and goings of a neighbor. This anonymity is deliberate. US federal regulations limit images taken by commercial satellites to a resolution of 25 centimeters, or about the length of a man's shoe. (Military spy satellites can capture images far more granular, although just how much more is classified.)

Ever since 2014, when the National Oceanic and Atmospheric Administration (NOAA) relaxed the limit from 50 to 25 cm, that resolution has been fine enough to satisfy most customers. Investors can predict oil supply from the shadows cast inside oil storage tanks. Farmers can monitor flooding to protect their crops. Human rights organizations have tracked the flows of refugees from Myanmar and Syria.

But satellite imagery is improving in a way that investors and businesses will inevitably want to exploit. The imaging company Planet Labs currently maintains 140 satellites, enough to pass over every place on Earth once a day. Maxar, formerly DigitalGlobe, which launched the first commercial Earth observation satellite in 1997, is building a constellation that will be able to revisit spots 15 times a day. BlackSky Global promises to revisit most major cities up to 70 times a day. That might not be enough to track an individual's every move, but it would show what times of day someone's car is typically in the driveway, for instance.

Some companies are even offering live video from space. As early as 2014, a Silicon Valley startup called SkyBox (later renamed Terra Bella and purchased by Google and then Planet) began touting HD video clips up to 90 seconds long. And a company called EarthNow says it will offer "continuous real-time" monitoring "with a delay as short as about one second," though some think it is overstating its abilities. Everyone is trying to get closer to a "living map," says Charlie Loyd of Mapbox, which creates custom maps for companies like Snapchat and the Weather Channel. But it won't arrive tomorrow, or the next day: "We're an extremely long way from high-res, full-time video of the Earth."

Some of the most radical developments in Earth observation involve not traditional photography but rather radar sensing and hyperspectral images, which capture electromagnetic wavelengths outside the visible spectrum. Clouds can hide the ground in visible light, but satellites can penetrate them using synthetic aperture radar, which emits a signal that bounces off the sensed object and back to the satellite. It can determine the

height of an object down to a millimeter. NASA has used synthetic aperture radar since the 1970s, but the fact that the US approved it for commercial use only last year is testament to its power—and political sensitivity. (In 1978, military officials supposedly blocked the release of radar satellite images that revealed the location of American nuclear submarines.)

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Meanwhile, farmers can use hyperspectral sensing to tell where a crop is in its growth cycle, and geologists can use it to detect the texture of rock that might be favorable to excavation. But it could also be used, whether by military agencies or terrorists, to identify underground bunkers or nuclear materials.

The resolution of commercially available imagery, too, is likely to improve further. NOAA's 25-centimeter cap will come under pressure as competition from international satellite companies increases. And even if it doesn't, there's nothing to stop, say, a Chinese company from capturing and selling 10 cm images to American customers. "Other companies internationally are going to start providing higher-resolution imagery than we legally allow," says Therese Jones, senior director of policy for the Satellite Industry Association. "Our companies would want to push the limit down as far as they possibly could."

What will make the imagery even more powerful is the ability to process it in large quantities. Analytics companies like Orbital Insight and SpaceKnow feed visual data into algorithms designed to let anyone with an internet connection understand the pictures en masse. Investors use this analysis to, for

example, estimate the true GDP of China's Guangdong province on the basis of the light it emits at night. But burglars could also scan a city to determine which families are out of town most often and for how long.

Satellite and analytics companies say they're careful to anonymize their data, scrubbing it of identifying characteristics. But even if satellites aren't recognizing faces, those images combined with other data streams—GPS, security cameras, social-media posts—could pose a threat to privacy. "People's movements, what kinds of shops do you go to, where do your kids go to school, what kind of religious institutions do you visit, what are your social patterns," says Peter Martinez, of the Secure World Foundation. "All of these kinds of questions could in principle be interrogated, should someone be interested."

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Like all tools, satellite imagery is subject to misuse. Its apparent objectivity can lead to false conclusions, as when the George W. Bush administration used it to make the case that Saddam Hussein was stockpiling chemical weapons in Iraq. Attempts to protect privacy can also backfire: in 2018, a Russian mapping firm blurred out the sites of sensitive military operations in Turkey and Israel—inadvertently revealing their existence, and prompting web users to locate the sites on other open-source maps.

Capturing satellite imagery with good intentions can have unintended consequences too. In 2012, as conflict raged on the border between Sudan and South Sudan, the Harvard-based Satellite Sentinel Project released an image that showed a construction crew building a tank-capable road leading toward an area occupied by the Sudanese People's Liberation Army. The idea was to warn citizens about the approaching tanks so they could evacuate. But the SPLA saw the images too, and within 36 hours it attacked the road crew (which turned out to consist of Chinese civilians hired by the Sudanese government), killed some of them, and kidnapped the rest. As an activist, one's instinct is often to release more information, says Nathaniel Raymond, a human rights expert who led the Sentinel project. But he's learned that you have to take into account who else might be watching.

It's expensive to watch you all the time

One thing that might save us from celestial scrutiny is the price. Some satellite entrepreneurs argue that there isn't enough demand to pay for a constellation of satellites capable of round-the-clock monitoring at resolutions below 25 cm. "It becomes a question of economics," says Walter Scott, founder of DigitalGlobe, now Maxar. While some companies are launching relatively cheap "nanosatellites" the size of toasters—the 120 Dove satellites launched by Planet, for example, are "orders of magnitude" cheaper than traditional satellites, according to a spokesperson—there's a limit to how small they can get and still capture hyper-detailed images. "It is a fundamental fact of physics that aperture size determines the limit on the resolution you can get," says Scott. "At a given altitude, you need a certain size telescope." That is, in Maxar's case, an aperture of about a meter across, mounted on a satellite the size of a small school bus. (While there are ways around this limit—interferometry, for example, uses multiple mirrors to simulate a much larger mirror—they're complex and pricey.) Bigger satellites mean costlier launches, so companies would need a financial incentive to collect such granular data.

That said, there's already demand for imagery with sub–25 cm resolution—and a supply of it. For example, some insurance underwriters need that level of detail to spot trees overhanging a roof, or to distinguish a skylight from a solar panel, and they can get it from airplanes and drones. But if the cost of satellite images came down far enough, insurance companies would presumably switch over.

Of course, drones can already collect better images than satellites ever will. But drones are limited in where they can go. In the US, the Federal Aviation Administration forbids flying

commercial drones over groups of people, and you have to register a drone that weighs more than half a pound (227 grams) or so. There are no such restrictions in space. The Outer Space Treaty, signed in 1967 by the US, the Soviet Union, and dozens of UN member states, gives all states free access to space, and subsequent agreements on remote sensing have enshrined the principle of "open skies." During the Cold War this made sense, as it allowed superpowers to monitor other countries to verify that they were sticking to arms agreements. But the treaty didn't anticipate that it would one day be possible for anyone to get detailed images of almost any location.

And then there are the tracking devices we carry around in our pockets, a.k.a. smartphones. But while the GPS data from cell phones is a legitimate privacy threat, you can at least decide to leave your phone at home. It's harder to hide from a satellite camera. "There's some element of ground truth—no pun intended—that satellites have that maybe your cell phone or digital record or what happens on Twitter [doesn't]," says Abraham Thomas, chief data officer at the analytics company Quandl. "The data itself tends to be innately more accurate."

The future of human freedom

American privacy laws are vague when it comes to satellites. Courts have generally allowed aerial surveillance, though in 2015 the New Mexico Supreme Court ruled that an "aerial search" by police without a warrant was unconstitutional. Cases often come down to whether an act of surveillance violates someone's "reasonable expectation of privacy." A picture taken on a public sidewalk: fair game. A photo shot by a drone through someone's bedroom window: probably not. A satellite orbiting hundreds of

miles up, capturing video of a car pulling into the driveway? Unclear.

That doesn't mean the US government is powerless. It has no jurisdiction over Chinese or Russian satellites, but it can regulate how American customers use foreign imagery. If US companies are profiting from it in a way that violates the privacy of US citizens, the government could step in.

Raymond argues that protecting ourselves will mean rethinking privacy itself. Current privacy laws, he says, focus on threats to the rights of individuals. But those protections "are anachronistic in the face of AI, geospatial technologies, and mobile technologies, which not only use group data, they run on group data as gas in the tank," Raymond says. Regulating these technologies will mean conceiving of privacy as applying not just to individuals, but to groups as well. "You can be entirely ethical about personally identifiable information and still kill people," he says.

Until we can all agree on data privacy norms, Raymond says, it will be hard to create lasting rules around satellite imagery. "We're all trying to figure this out," he says. "It's not like anything's riding on it except the future of human freedom."