

THE SKY IS FALLING: EARTH ORBIT SPACE DEBRIS

Don J Schmidt
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The Milwaukee Braves were playing the New York Yankees in the World Series; Jimmie Hoffa was elected President of the Teamsters Union; Little Rock Arkansas Central High School was under siege because of integration; and “Leave it to Beaver” was to debut that night on CBS. Did anything else happen on that Friday October 4, 1957? Well, yes it did, the satellite age burst upon the world with the launching of the world’s first Earth satellite, called Sputnik, by the Soviet Union. The word Sputnik is Russian for “traveling companion of the Earth”. And that is where our story begins.

The United States had been working on launching a satellite back in 1956 since it had already developed the Jupiter rocket that could travel 700 miles into space, but inter-service politics over the type of “payload” stalled the program. Wernher von Braun was the head of the

American space program, and on that day he was at the Officer's Club in Huntsville, Alabama having dinner when a British Newspaperman called him saying: "What do you think? Wernher replied, "Think of what? " "The Russian satellite that they just orbited".

Von Braun said he wasn't surprised, he had known for some time that the Russians had satellite capability. He was just disappointed and more than a little bitter that his team was not allowed, because of that inter-service politics mentioned earlier, to do it before the Russians did. Von Braun remained active in the space program up until his death from cancer at age 65 in June of 1977. He had easily earned America's highest honor, the Presidential Medal of Freedom, but President Ford declined to award it because David Gerken, a Presidential Advisor, opposed the award due to Von Braun having been a key figure in Germany's V2 rocket program in WWII. President Carter then corrected that blatant oversight when he got in office

and gave Von Braun his due with the Presidential Medal of Science.

As devastating as the news was to Americans about the Soviet's success, it turned out in the long run to be a blessing for America, as it immediately spurred the politicians in Washington to give the green light to an energetic program dubbed the "Space Age". That began with the launching of our first satellite on January 31, 1958, which ultimately led to the manned landing on the Moon, and the proliferation of satellite communication that we now have around the world.

Gabriel Heater, a well known news commentator for the Mutual Broadcasting System, delivered the following radio editorial in February 1958, just hours after Sputnik had fallen from the sky four months after launching:

"Thank you Mr. Sputnik" "You will never know how big a noise you made. You gave us a shock which hit many as hard as Pearl Harbor. You hit our pride a frightful blow.

You suddenly made us realize that we are not the best in everything. You reminded us of an old-fashioned American word, humility. You woke us up out of a long sleep. You made us realize a nation can talk too much, too long, too hard about money. A nation, like a man, can grow soft and complacent. It can fall behind when it thinks it is Number One in everything. Comrade Sputnik, you taught us more in one hour than we had learned in forty years”.

The impact of that first satellite was greatly influenced by the fact people could go out in their backyards and SEE Sputnik as it flew overhead in the night sky as a small pinprick of light. That first shabby piece of orbiting hardware now seems like a toy compared to the space station, shuttles, and missions to the moon, to Mars, and even beyond.

While the shock of that first satellite was immediate, it took many years for its effects to be fully known.

Exactly twenty years after its launching, with an American flag standing on the Moon, the Washington Post noted in an editorial that Sputnik had created a generation of engineers and scientists unmatched by any other in size and skill. They then applauded Sputnik's impact on micro-miniature electronics, which has made possible the magic boxes that we hold in our hands today. Boxes which can perform functions, that in the past would have required a computer the size of a house. However, not an inconsequential number of opinion writers, and of course some politicians, at that time complained about the amount of money spent by the United States on our answer to the Russian Sputnik, but it is a great myth that it brought the world little in return. Let me bore you with just a partial list of the products that resulted from this. Teflon, Velcro, fuel cells, Kevlar, inertial guidance systems, tooth paste you can swallow, inorganic paints, air tank breathing systems, watch batteries, food sticks, reservation systems, police radios, robots, insulation material, heart rate monitors, high temperature lubricants,

ceramic powders, solar panels, poison detectors, unscratchable sun glasses, Retin A, water filters, Jarvik artificial hearts, cordless tools, freeze dried food, and in the sport's world, heated ski goggles, and composite graphite fiber used in tennis rackets, and golf clubs. Those 300 to 400 yard Tiger Woods drives trace all the way back to Sputnik. So as the old song says "the beat goes on", as new developments are seen every year. But of all the space program's developments, none can match the satellite proliferation that has come about because of good ole Sputnik, which has then led to the problem of the hour, space debris.

Just how much "stuff" is out there in space orbiting our Earth? As of November 2023, the European Space Agency estimated 50,000 tons (100 million pounds) had been placed into orbit. Some 15,880 satellites had been launched, with 10,590 still operational, with more having been launched in the last two years than in the previous

6 decades. But those satellites are just the beginning of the problem.

As satellites begin to fall to earth they begin to break-up into pieces, It has been estimated that there are 21,000 pieces greater than 4 inches in diameter; 500,000 pieces between 0.4 and 4 inches in diameter; and millions less than 0.4 inches in diameter. NASA has a program, based in Houston, tasked with tracking and removing space debris. It has even developed a competition with a \$120,000 prize that invites the public to submit ideas on how to handle this problem. Unfortunately your chance of winning anything is greatly diminished because the deadline for submission passed on Nov. 15, 2023. The European Space Agency has taken the lead in debris removal by finalizing a Zero Debris Charter calling on nations to commit to actions that would limit the amount of space debris floating in space by 2030. It basically says: "What you bring in you must take with you when you leave." Much like what is a requirement now in our National Parks.

What are the sizes of the satellites floating around out there in space and how many are there?

Well, by far the largest is the Space Station which weighs 450 tons or 900,000 pounds. It is as big as a football field, travels at 17,200 miles per hour, completes 15.7 orbits per day, and is in an orbit 216 miles above the earth. Excluding the Space Station, the largest satellite is Russian at 18,100 pounds, or 9 tons. It is still circling the earth at a height of approximately 20,000 miles above the earth, but is inoperable. Of the satellites still in the sky one year ago, according to the United Nations, 58% are still active. Of course this number is increasing yearly as there were 155 launches in 2022. Those launches were accomplished from 31 different sites around the world, which leads us to realize a great number of other countries are in this satellite business besides us. While we have 4,529, according to the Union of Concerned Scientists, China has 590, Russia 174 and

the other countries of the world have 1,425. Many of these countries you would not expect to be participants, countries such as Belarus, Ethiopia, Slovenia, Venezuela, Nigeria, Algeria, Malaysia, and Lithuania too name just a few. Of the U.S. satellites 4000 are commercially owned, 286 are government and 247 are military. While there are over 50 different owners of the American satellites, the company, SpaceX, owned by Elon Musk, owns the most by far with 1,655. The first Starlink rocket was launched by SpaceX in May of 2019, it had a pay load of 60 satellites, all put in space by a single rocket.

SpaceX is planning for as many as 7,000 Starlink satellites to eventually be launched, adding to their already 5,000. They will be roughly 573 pounds each and the size of a kitchen table. Starlink is currently averaging a rocket launch every 4 days and the Chinese are launching every 6 days. Remember a rocket launch may carry many, many satellites in its pay load. China has two projects under way that will have two constellations with a total of

25,000 satellites. That sounds like a lot of eventual junk, but consider that 60 tons of meteoroid material enters the Earth's atmosphere every day. When Starlink's first generation of satellites are ready for decommissioning, we can expect 2.2 tons entering the atmosphere daily.

What are all of these satellites used for? We are mostly familiar with their use in weather observation, but they are also used for communication, defense, and mapping. The capability of the pay load on mapping and communication satellites has increased dramatically. For example in 2004, 20 years ago, the storage capability was 2 gigabites (Gbps) but in 2022 it had increased to 1000 Gbps! Communications make-up 63% of all satellites with Earth observation coming in second with 23%.

Satellites are segregated by size and location of their orbits. More than 3,000 satellites are in low earth orbit, which is where you will find those commonly used for

communications and and remote sensing. This is where SpaceX Starlink satellites can be found, as well as the Space Station and Hubble Telescope. The next highest orbit has the second most usage and is for telecommunications and Earth observation. They are located in an orbit that circles the equator which gives them the appearance of standing still in a fixed position. Next is the highest orbit used for navigation systems such as GPS. Then there is the elliptical orbits which is for satellite radio, and other applications.

How do these things we shoot up into space stay there?. Well, they follow a Newtonian principal. First, remember from you high school physics, there is no such thing as the absence of gravity. Gravity decreases the further you get from earth, but never ceases to exist. Let's illustrate with the principle of Newton's Cannon. When you fire a cannon horizontally on earth, the cannon ball goes some distance as it falls to the ground. Fire the cannon ball

faster out of the cannon and it will travel further around the earth before crashing.

What if you could fire the cannon ball at an unbelievable speed of 5 miles per second? The cannon ball would follow the curvature of the earth, being pulled down by gravity but NEVER reaching the ground. But today it is possible to travel at speeds of 5 miles per second with rockets. At 62 miles altitude and accelerating to 5 miles per second, it will never crash to earth, and it will circumnavigate the globe in 90 minutes. Once in orbit the rocket motor can be switched off and it will coast for days to years before the exceptionally thin atmosphere would drag it back to earth.

What happens when the satellites succumb to the atmospheric friction and gravity and fall back to Earth? Well they become pieces of trash.

In the last five decades, an average of one piece of debris fell to the Earth each day. However most of the trash raining down burns up in the atmosphere before it

ever reaches the surface. Those that survive often fall into water; remember, the ocean makes up approximately 70 percent of the Earth's surface. According to NASA's Orbital Debris Program Office, no serious injury or significant property damage from falling debris has ever been confirmed.

What about possible collisions between satellites? The NASA Astronautics Research Group in 2021, computer modeled that each week there are 1600 encounters with just Starlink satellites within 0.6 miles of another object. Another way of looking at possible collisions is to note that the Space Station through December 2022 had to adjust its orbit 32 times to avoid a collision.

So is anyone worried about all this space junk and the damage it could do? Well, yes and no. Space Agencies and some companies are investigating ways to clear away the junk. Some of the ideas include lasers to change the

orbits, magnets and claws to grab the junk pieces. Note, these are only ideas at this point. The best solution is for companies to build into their satellites mechanisms to have them re-enter the Earth's atmosphere and burn up. Space X is currently doing this. The FCC on September 29, 2022 passed a rule requiring satellites to be removed from orbit within 5 years. That same propulsion system for reentry into the Earth's atmosphere is also used for evasive maneuvers, which is the best system for avoidance so far.

There have been many near misses over the years but only one collision back in 2009 between an active communications satellite and a long-dead Russian satellite creating 2000 pieces of space junk. Most of that space junk is still orbiting the earth. The 20 most dangerous satellites still in orbit are all Russian, weighing about 20,000 pounds each, and are located in the most populated area, which is low earth orbit. Low Earth orbit is a range of approximately 125 to 1,250 miles.

Just this past year two Russian satellites came within 20 feet of each other. If they had collided, thousand of pieces of debris would have been created staying in orbit for up to a century.

In the past month the first fine for littering in space was assessed by the FCC. The Wall Street Journal reported; “Dish Network became the first company to pay a fine for littering outer space. Like many companies with space operations, satellite TV provider Dish retired a satellite last year by leaving it to float in orbit. The FCCsaid that Dish left the satellite too close to the area reserved for working satellites. The agency ordered the company to pay a \$150,000 fine.”

Now, in addition to all of the space junk and satellites floating around us, there is also the unknown number of UFO's. A recent Pentagon investigation that claimed to

have solved most recent UFO sightings conceded that 171 sightings remain unexplained. It's not that the government knows these UFO's are alien; what officials find embarrassing to admit is that they are "clueless" about many startling documented sightings and can't rule out they are of alien origin. This according to an article by Garrett Graff in the *Atlantic*.

The reality is that there is something, or more likely many things up there, besides satellites, and none of us know what. And with that bit of tantalizing conjecture, Chicken Little's observation that the "sky is falling" may well be correct.

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