Market Px

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It's a star, it's a plane, it's a…

If you look up at the night sky long enough, a "shooting star" might eventually catch your eye. This point of light is different though, because unlike a shooting star, its movement is slow and deliberate. It must be an airplane then, but unlike an airliner travelling at night, this object is not blinking and is completely silent.

Chances are what you are looking at is a satellite.

Everyone recalls Sputnik, the first satellite to reach orbit. At less than two feet wide, the spherical satellite was barely visible to the naked eye. Glimpses of Sputnik were made possible only because of its highly polished surface. It transmitted a radio signal for three weeks then orbited Earth for another two months after its batteries gave out.

Since then, close to 9,000 satellites have been launched by various nations. But just like their predecessor, 4,000 of them have since burnt up in the atmosphere on re-entry, while an additional 3,000 have been left to drift in space for eternity.

What once was a two-nation pursuit is now also quickly changing. Even though the United States remains the largest player, China has surpassed Russia, and India has bettered Japan. As we shall see, satellites no longer reflect a country's ambitions to be perceived as a spacefaring nation but rather a growing need for telecommunications.

Different Satellites for Different Jobs

From the Hubble Space Telescope, made famous by the mission to fix its flawed mirror, to the Global Positioning System (GPS), to Earth observation and weather satellites, it is clear that satellites have found their place in our everyday lives and that we are still finding new uses for them.

One way to think about satellites is to consider them in terms of bus and payload. The bus is the satellite's frame and carries everything needed to support the payload, including solar panels, batteries, heating and cooling systems, positioning instruments, engines, fuel and ground communication equipment.

Depending on payload and mission requirements, the bus can be standard or highly customized. For example, Hubble's bus had to fit around its giant 2.4-meter-diameter telescope.

Telecommunications satellites, which tend to share the same objectives and mission profiles, often share similar buses. They are typically outfitted with transponders and large antennas, and, just like an antenna on Earth, are designed to operate in a specific bandwidth. The Boeing 702 and SSL 1300 buses have long been held as gold standards for telecommunication satellites.

Satellite payloads can be as varied as the missions themselves. Research satellites, like Hubble, carry scientific equipment. Earth observation satellites carry sophisticated cameras capable of relaying images back to the end users.

Some satellites carry more than one payload. Certain U.S. National Oceanic and Atmospheric Administration (NOAA) satellites, for example, not only carry instruments that monitor the weather but also ones necessary to detect aircraft, ship and personal emergency beacons.

These satellites are each customized to their missions, and it should be clear that satellites are not interchangeable with one another.

You can learn more about the different types of satellites **here**.

Old Satellites

The technology behind satellites – as well as what function that technology allows them to achieve and for how long – has evolved significantly over the years.

To ensure that **GEO satellites**, which sit above the equator in a special orbit called geostationary, reach or even exceed their life expectancies, onboard systems are made redundant. Building satellites with two or even three backup systems is a time-honored way of protecting spacecraft against equipment malfunctions. However, 15 years can feel like an eternity from a technological point of view, and given that satellites typically employ only reliable, time-tested technology, it is easy to understand why GEO satellites become outdated by the end of their lives.

GEO satellites are also expensive. Including launch, a GEO satellite can cost upward of $500 million. This means that it usually takes 10 years for a customer to recover these costs, which is why redundancy is so important and also why GEO satellites are not replaced more frequently.

LEO satellites, which populate a region called Lower Earth Orbit, come with a much cheaper price tag. As they reach their life expectancies much sooner, they are replaced more often. Part of the reason behind the difference in cost is that LEO satellites tend to be much smaller than GEO satellites, and more than one can be launched on the same rocket. This of course does not hold true for every LEO satellite; some are as expensive or more expensive than GEO satellites.

New Satellites

As computers have become smaller over time, so too have satellites. This phenomenon has given birth to mini, micro, nano, pico and femto satellites with masses of less than 100 kilograms, 10kg, 1kg and 100 grams. Of course, with such small frames, these satellites must forgo many of the systems that would normally extend their lives. But the idea behind these miniature satellites is that they are cheap enough to manufacture and launch to justify sending replacement satellites into orbit on a regular basis. With thousands of these miniature satellites having already been launched, some believe they could one day perform commercial missions that previously required much larger satellites.

Another result of technological advancement is the increase in communication satellite bandwidth. Simply put, bandwidth refers to the size of the “pipe” that data travels through. The larger the pipe, the more data a satellite can receive and transmit. GEO satellites in orbit today can process significantly more data than ten or even five years ago. As satellites age and are replaced, fewer satellites are needed to achieve the same result.

This is wreaking havoc on the satellite manufacturing industry, which has always been able to count on replacing aging satellites.

Many industry players believe that this is a temporary phenomenon, as our everyday individual data requirements are increasing exponentially year after year.

But the idea that a constellation of smaller satellites could achieve the same results as the larger ones is compounding this industry problem and has compelled traditional satellite operators to take a “wait and see” approach.

Satellite Constellations

One of simplest satellite constellations in existence today is NASA’s Tracking and Data Relay Satellites (TDRS). TDRS consists of 12 satellites in three locations along the GEO belt. TDRS is famously used for relaying signals between NASA facilities, Hubble, the International Space Station and the now-defunct space shuttle.

When line-of-sight communication are not available with the ISS (for example, when it is on the other side of the Earth), NASA can still communicate with it by bouncing signals off the satellites until they reach the station.

The Global Positioning System (GPS) is probably the most famous satellite constellation in operation today. With a little more than 30 satellites arranged in six planes at an altitude of 20,000 km, the **MEO constellation** ensures that any user on Earth is in contact with a minimum of four GPS satellites at any given time. Since its launch in the U.S. in the late 1970s, other countries such as Russia, Europe, China, India and Japan have all developed their own version of the GPS. GLONASS (Russia) and Galileo (Europe) both operate with a similar number of satellites in MEO, while BeiDou (China), NAVIC (India) and QZSS (Japan) operate hybrid constellations in both GEO and MEO.

Iridium, one of the brightest constellations in LEO because of its highly reflective antennas and close to 80 satellites in operation, was also the largest constellation until recently. It was initially conceived to enable calls from portable handsets almost anywhere on Earth and has since morphed into voice and data.

Constellation Economics

Iridium came at a time in the 1990s when satellite communication enthusiasts believed that all of Earth's connectivity challenges could be solved by huge constellations. However, with $3,000 handsets and plans starting at $4 to $7 a minute, it is not hard to imagine why Iridium never found a market outside of maritime, military, disaster relief and government organizations.

At the same time that Iridium was launching its satellites, cell towers were also being erected. Of course, cell phones will never be able to offer the same connectivity coverage as Iridium, but who really needs it anyway? With an original price tag of around $5 billion, it is not clear to us how such a bad investment was ever conceived and carried out.

Unfortunately, Iridium was not the only company to grossly overestimate the demand for satellite communications. Coming in second place, Globalstar, with its constellation of 50 satellites, was also guilty of getting caught up in the hysteria – and shared an identical fate. Less than two years after beginning full commercial operations, the company filed under Chapter 11 with over $4 billion in debt.

Teledesic also became famous for the sheer number of satellites it proposed to launch into orbit. Its first iteration entertained a constellation of 840 satellites at an altitude of 700 km at a mere cost of $9 billion, while its second considered launching close to 290 satellites at an altitude of 1,400 km. Teledesic was also different from other constellations at the time since it was the only one designed to offer broadband Internet. It was also famously backed by Bill Gates. However, the company suspended its operations following the Iridium and Globalstar bankruptcies.

Satellite Handoff

Anyone who has ever experienced a dropped call while driving has encountered the difficulty of handing off a signal. Handoffs are necessary when a cell phone leaves a cell tower's range and enters the range of another tower. The handoff process is usually a smooth one and as such a user should never be aware that he/she has transferred to another cell tower. However, as we have all experienced, the process sometimes breaks down and a call is dropped.

Now, imagine having to hand off a signal between tens, if not hundreds, of satellites travelling at 28,000 km/h. This is exactly the problem that LEO constellations are faced with. As a satellite travels over the horizon, a signal must be handed off to an adjacent satellite in view of the user on Earth. As a satellite in LEO stays in view for only five to seven minutes, this process must be repeated at a much greater frequency than with cell towers.

Back to the Future

Despite the almost comedic constellation failures of the 1990s, it appears again as though every satellite company wants to relive the errors of the past. At last count, close to 10 proposed constellations are vying to be the first to offer broadband Internet to the world.

Ahead of the pack is SpaceX's Starlink. With 955 satellites already in orbit, Starlink is offering trials in North America ahead of its 2024 goal of having 12,000 satellites in orbit. For $800 for a satellite dish, modem and power supply and $130 a month for a subscription, you too can have access to fiber-like Internet speeds anywhere – whenever Starlink decides to open its service in your region.

For a lucky few, this is already a reality.

But how is this possible, when so many have tried and failed? For one thing, satellite launches have become a lot cheaper. Thanks to its reusable lower stage rocket, SpaceX has managed to revolutionize an industry that was traditionally reserved for a select few. At $60 million, the Falcon 9 is already the cheapest launch vehicle on the market. This works out to $2,750 per kilogram of payload, a fraction of the $54,500 per kilogram it cost to launch a satellite aboard the space shuttle. This is an apples-to-oranges comparison, but it serves our purpose.

SpaceX has no intention of stopping there. As more of the rocket becomes reusable, they expect to one day bring launch costs down to $5-$7 million.

This is where it becomes important, however, to remember that we have already travelled down this road before – and it did not end well. With a cost of more than $10 billion, it remains to be seen whether there is enough of a user market to justify this kind of investment. Although we wish Starlink and the other proposed constellations well, our gut tells us to approach this euphoria with a dose of healthy pessimism.

Some Reprieve for the Satellite Manufacturers

Since the late 1960s, GEO satellites have traditionally operated in the 2-4 GHz spectrum, dubbed "S band." This band was allocated to the satellite industry because it not only suited the industry's bandwidth requirement, it was also not being overly used at the time. Unlike cell phone operators, which today have to bid in auctions to use a spectrum, satellite operators never paid for S band. Instead, it was determined that the billions of dollars spent to exploit the spectrum was payment enough.

With the advent of 3G, LTE and 5G just around the corner, cell phone operators are running out of bandwidth and have started looking outside their traditionally designated spectrum. And they have been looking at the satellites' S band with envy for some time.

Satellite operators, for their part, have gotten together and tried to bargain a private sale of a portion of the S band that they felt they could continue to operate without. Yet despite the alliance's lobbying efforts, the Federal Communications Commission (FCC) determined at the 11th hour that spectrum, being a public good, could not be auctioned off privately. In return for freeing up a portion of the spectrum, the FCC decided to compensate the satellite operators handsomely to help offset some of the costs of purchasing new satellites and modifying some of their associated ground stations.

How Is This All Going to End?

For a long time, the telecommunications satellite operators, or fixed-satellite service (FSS) operators, as they are known in the industry, used to be a bastion of stability. Every single one of their GEO satellites was contracted for its entire 15-year life and it was almost impossible and unheard of for anyone to come out of these contracts. When a satellite approached the end of its life, contracts were renegotiated and a new satellite was ordered to replace it. Revenues and expenses were very predictable.

However, as we already remarked, advancements made satellites more powerful, which meant that fewer satellites were needed to replace the previous generation. Something else was also happening – households found new ways to watch their favorite television shows. This led to cable and satellite TV “cutting.” FSS operators responded to this change in behavior by launching satellites designed to meet this increased need for broadband. It even looked for a while like commercial flight Internet could revitalize this industry.

Despite the “cord cutting” phenomenon in North America, other parts of the globe are still reliant on satellites for their everyday entertainment. Countries that did not take part in copper cable laying, followed by fiber optic, over the last half-century are now trying to catch up to their growing need for telecommunications. Satellites are still a viable option for these countries and have therefore been a focus of FSS operators.

Constellation Bandwagon

It comes to us as no surprise that in an industry that has experienced so much technological advancement in such a short period of time, traditional industry players are left to defend their turf against new entrants. It also goes without saying that an industry that sees a large number of new entrants will eventually go through the unpleasant process of consolidation and rationalization.

Although we like to believe that dominant industry players are prudent enough to anticipate and embrace change to ensure they remain relevant, history is also filled with companies that were too slow or not nimble enough to ensure their survivability. And this is where we think it gets fascinating because, outside of Telesat, not one fixed-satellite operator has jumped on the LEO constellation bandwagon. So, just like in the 1990s, the one industry that really should be driving this new initiative has decided to stay on the sidelines!

In hindsight, it is easy to see that the fixed-satellite operators were right to avoid getting caught up in the constellations of the 1990s. This time around, however, new entrants argue that the underlying conditions for constellation success have sufficiently improved to revive the concept.

Investing in Space

In the face of all this, we do not presume to know the outcome of this renewed interest in constellations. However, if there is one thing we recognize at Canso, it is that markets hate uncertainty. However, with uncertainty comes the potential for outsized returns.

We also recognize that it is all too easy to get caught up in market crazes. History is littered with investors endorsing what seemed to be good ideas at the time but turned out to be absurd once the craze had subsided.

FSS operators and satellite manufacturers are finding themselves immersed in a perfect storm created by uncertainty and constellation euphoria. Although we do not know how this is going to end, we recognize that the industry is out of favor and that has been enough to pique our interest.

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