Democratising Access to Space: Co-creating a Star Trek Universe

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Introduction

Before Sputnik was launched, science fiction writers have long been writing about the future of humanity as it migrates outwards beyond the surface of the Earth and into the outer reaches of the solar system. Permanent stations, settlements on the Moon and Mars, and thriving sustainable industries on the asteroid belt and beyond. These long-range visions of the settlement of space have long inspired people to work on space projects. While science fiction explored many possible futures, there were many examples of visions of humanity unified in the exploration of space. The non-dystopian narratives of a unified and peaceful Earth sending exploration missions across the galaxy in peace, were exemplified in the *Star Trek* universe, that is the epitome of the global space industry's idealized future. This hopeful future of a unified Earth continued in science fiction even while space activities were dominated by the space race between the USA and USSR.

The space industry today is no longer a race between two superpowers competing for dominance and national pride. It has become an integral part in enabling today's daily *infrastructure* - from the time one wakes up to check the weather, navigate to work, and communicate halfway across the globe. Today, satellites fly overhead 24/7 capturing precious data that helps improve agricultural yield, monitor disaster zones, or secure marine and border security. While space applications have grown substantially, most of these space systems have developed by governments and companies within a handful of countries.

As we increase the burden on Earth for resources to sustain a growing global population, living on a finite planet with finite resources poses challenges. Space exploration presents an opportunity to venture out for abundant resources elsewhere in the solar system. Science fiction has inspired people to imagine bringing large-scale manufacturing off planet. The opportunity presented by the abundant resources of the solar system inspires us to imagine how to peacefully explore space together. Developing space technologies and the outward push towards a *Star Trek* universe is then a moral imperative to safeguard our planet and future generations to come. It is vital to explore space and develop space resources for the benefit of humanity, but we must also find a way to expand opportunities for all of humanity to participate in space activities.

Exponential Technology Offers an Opportunity

Decades after Apollo, the industry seemed to have stalled with very little progress. The US Space Shuttle, intended to provide low cost access to space at $4M per flight, had actually cost

$1.6B per flight - more than each Apollo Saturn V launch. The development of truly reusable vehicles that can sustainably support a huge industry across the globe was nowhere in sight. But disruptive technologies, based primarily on advances in computing, were being developed. These exponential technologies start out slowly before their transformative power is recognized. For the past decade, a slow exponential growth of the private sector in the form of New Space technologies, products and services has started to transform the landscape of what was once traditionally government led and dominated industry. The rise of New Space - commercial start-ups and projects that are driven by the private sector - have tipped the balance and have started the accelerated development of new technologies that are cheaper, faster, and off the shelf.

This has been made possible because of exponential technologies like AI, robotics, computing, and additive manufacturing. These exponential technologies follow Moore's Law's pattern of exponential growth, doubling in capability roughly every two years. Case in point, a single cell phone today is equivalent in computing power to a million times the capability of all Apollo program computers combined. Satellites that used to cost hundreds of millions of dollars, with a development timeline of several years, can now be developed in weeks. In 2018 Fleet Space Technologies, a start-up company in Australia, was able to develop and launch a satellite within 18 weeks, through agile regulations and licencing from the New Zealand space agency and launch provider Rocket Lab, a pioneer in the small satellite launch market.

Today, nanosatellites or cubesat components can be purchased and assembled, pre-qualified from an online store. These small satellites have become a routine commodity product. The cost of satellites has also drastically been reduced. Components and sensors from terrestrial products, such as phone cameras, accelerometers and smartphone CPUs, have become standard off-the-shelf components for cubesats. The miniaturization of components has allowed satellites to be smaller and cheaper to launch, thus allowing companies like Planet to launch constellations of hundreds of satellites to monitor the health of planet Earth 24/7 (figure 1). One mission included 88 Planet satellites launched at one time. This has created a satellite launch market boom and the potential for a huge downstream opportunity for the data analysis and applications market.

Accessibility has also been greatly improved with open source software and publicly available data. A general data specialist today can learn to use QGIS, an open source geographic information system, download NASA or ESA free satellite imagery from Landsat or Sentinel, and start a business on satellite applications with little capital investment beyond a computer with high speed internet connectivity and data storage.

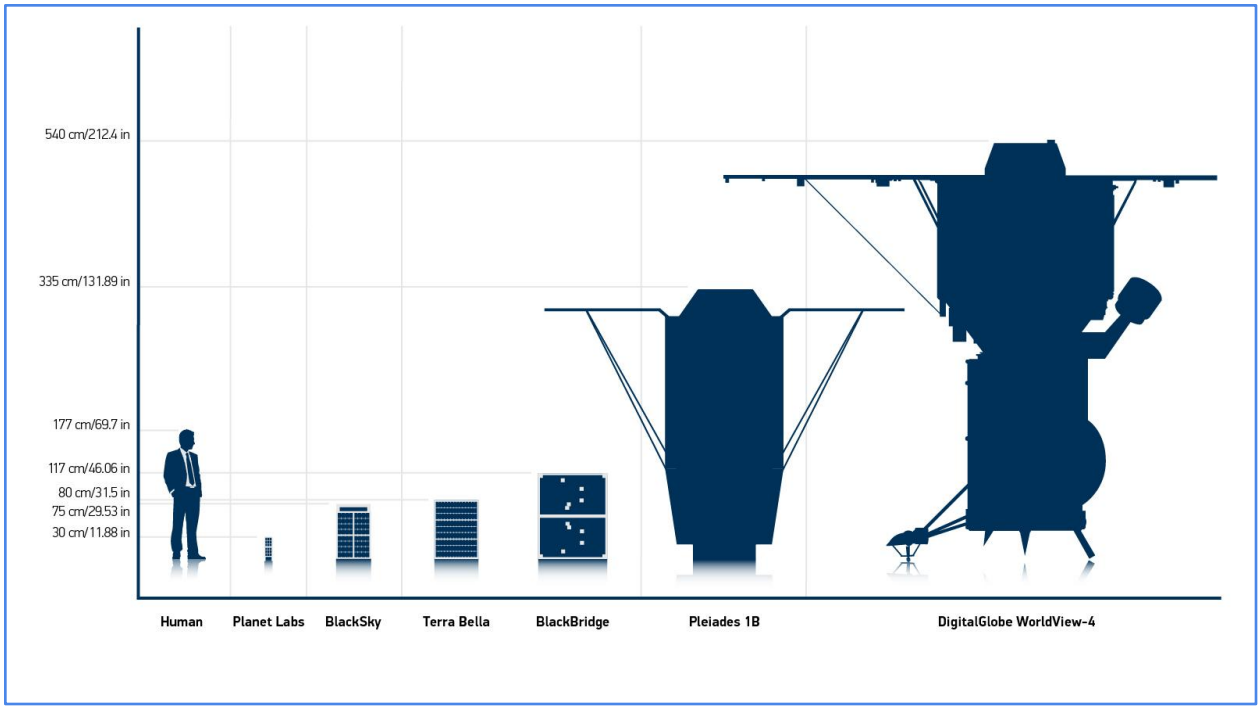

Figure 1. Comparison of low-cost Planet Labs cubesats (left) with other remote sensing spacecraft (Digital Globe).

With the democratization of technology, the space industry has slowly moved from traditional government owned and commissioned hardware to purely commercial owned spacecraft and services. The commercial services have the potential to move faster, be agile in response to changing conditions, cheaper to develop, and have great opportunity for economic growth. The recent launch of two NASA astronauts to the International Space Station in a SpaceX Dragon-2 on a Falcon 9 launch vehicle is one example of a commercially developed and owned launch system. This has now opened up the possibilities for frequent and reliable transport to future private space stations, hotels, or beyond in the longer-term future. Ten years ago, SpaceX was a new player in the industry with no space legacy and very little probability of success. Fast forward ten years, and it is now the leading space launch provider at a fraction of the cost, with the ability to reuse its rockets - an impossibility only a few years ago.

Investments in space were previously viewed as too risky. But the size of the space investment market is now $109 Billion (figure 2). The number of investments in space start-up companies increased from 535 to 822 start-ups worldwide in the same time period (Space Capital, 2020). A number of recent reports (from Merrill Lynch and Morgan Stanley) have predicted the global space industry to reach almost $2 trillion by 2040 with the bulk of the market coming from Earth observation platforms and applications (Sheetz, 12 Oct 2017) (Sheetz, 31 Oct 2017).

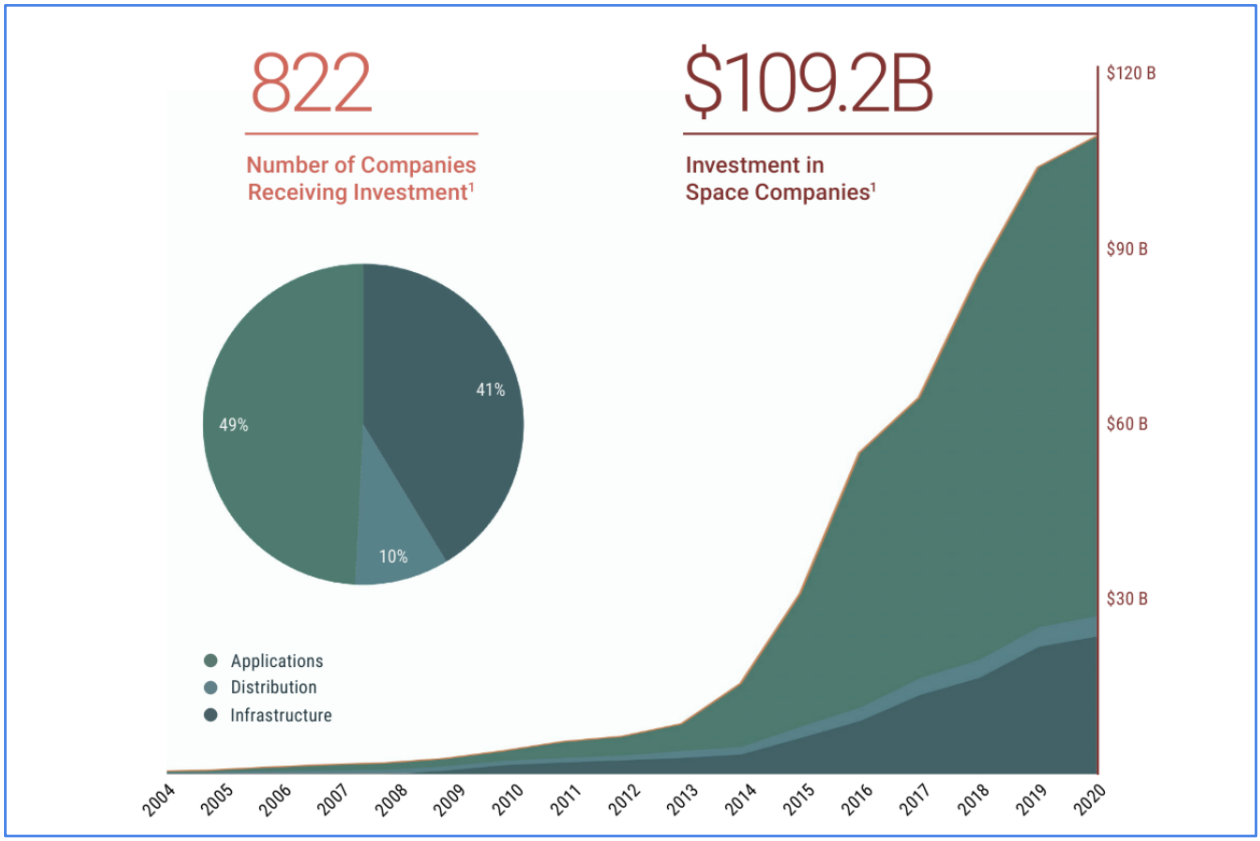

Figure 2. Cumulative equity investment from 2004 to present. (Space Capital, 2020)

A Problem with Global Opportunities

The global space industry is indeed changing and is bringing about the opportunity and potential to work towards an idealized future. But in practical terms today, this progress is still unevenly distributed with over 70 percent of the global space industry activities and economic growth happening in the nine wealthiest nations of the world (figure 3).

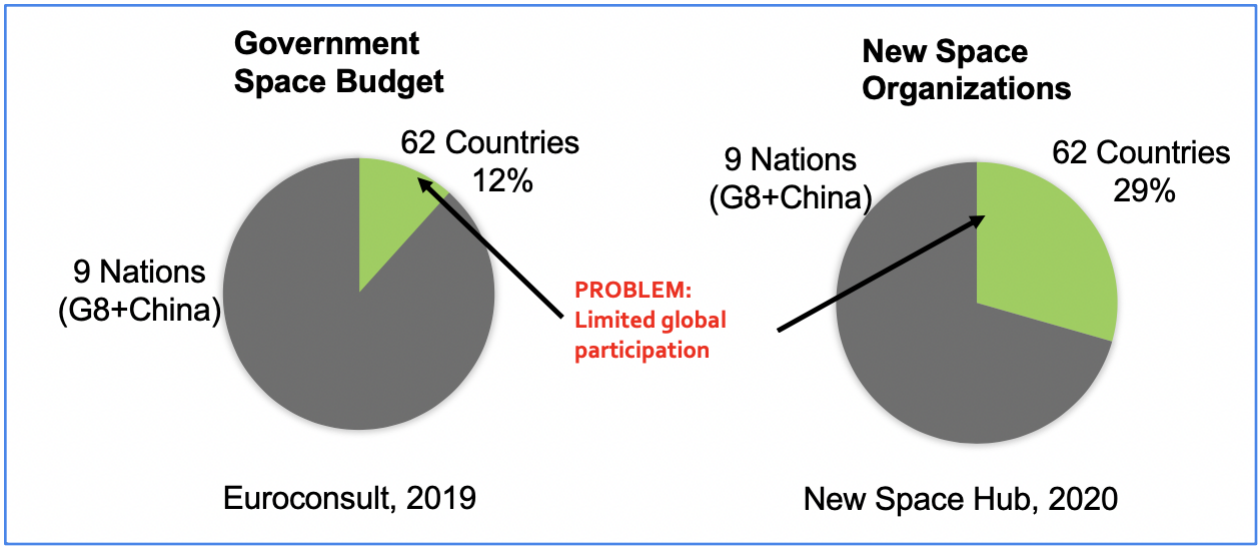

Figure 3. Chart of uneven distribution of activities in the space sector (Seminari, 2019), (New Space Hub, 2020).

This trend will continue to grow the divide between wealthy and developing nations, giving only the few space faring countries the ability to leverage growth markets in this industry. Instead of a *Star Trek* universe, the world would most likely develop into a “haves and have-nots” society - illustrated by the movie *Elysium* - where the ultra-rich are able to live off planet and reap the rewards of technological progress, while the rest of the world suffer in an apocalyptic dystopia.

Part of the challenge is the general public’s bias towards the space industry as a non-essential service. Today, the industry is still associated with rockets and rocket ships. Viewed as expensive programs that have no practical value other than to satisfy a nation’s patriotic needs or, perhaps, the need for scientific discovery. While these are worthy pursuits, the ubiquitous role that the space industry plays in navigation, communications, remote sensing and monitoring is often overlooked. But even if a vital role of space activities is acknowledged, the next challenge is for the society to devote the resources and support from multiple stakeholders within the ecosystem to build capacity and effectively grow.

The Potential Solution

To change this paradigm, intervention needs to happen from within countries using both a top down and bottom’s up approach to instigate a mind-shift for capacity and ecosystem building and catalyse a local space industry.

Over the past three years, SpaceBase has been prototyping to create a playbook for ecosystem building. In 2017 we incorporated as a not-for-profit company focused on catalysing space ecosystems in developing and emerging countries, starting in New Zealand. We are catalysing the industry through three major elements - education, entrepreneurship, and community building.

In order to create a paradigm shift, re-education on the definition of the space industry is a first step towards letting the general public know about the opportunities for addressing international space markets with a locally grown industry.

Education and Entrepreneurship

Leveraging incentive prizes has long been an effective method for accelerating innovation as well as birthing new ideas, projects, and potential businesses. Throughout history, the space industry has been incentivized with prizes. The *Ansari XPRIZE* - a $10 Million purse for the first private company to reach 100 km, and repeat within a week, was won by *SpaceShipOne* in 2004. This spurred the beginning of the suborbital launch spaceflight industry. Similarly, the *Lunar Google XPRIZE*, though it failed to award a team to land the first commercial lunar lander on the Moon - has catalysed start-up companies like *Astrobotics*, *SpaceIL*, and *Orbit Beyond*. All became viable companies that have attempted to land or have NASA contracts to land on the Moon. Smaller incentive prizes such as NASA's Space Apps and Act in Space have also spurred innovation across the globe, creating interest and educational opportunities for space research and development.

Along the same lines, SpaceBase has run two national space and aerospace challenges in New Zealand as a mechanism to educate and promote entrepreneurship on a national level (figure 4). The challenges also gave an opportunity to address an inherent problem in New Zealand that could potentially be solved by leveraging space technology. The challenges created a platform to educate and brief different stakeholders from across the country while recruiting for applicants to participate in the competition.

As part of the process, SpaceBase ran the very first virtual aerospace incubator, leveraging already established incubator and accelerator programs across New Zealand. These incubators also naturally supported the applicant teams from their region through mentorship and co-working space support.

Not only did a cash purse incentivize teams to apply for the chance of gaining some resource funds for further research and development, the winners have also been given the option of a six month on-ramp in an incubator to further develop their challenge solutions. This increased the likelihood for success and an on-ramp for potential start-ups to continue their projects.

Figure 4. Impact summary from SpaceBase *NZ Aerospace Challenge 2019*.

Community Building and Collaboration

By way of the challenge, these mechanisms incentivized different regional development agencies across the country to collaborate and support the educational briefings as well as supporting local challenge teams. In a way, it became a friendly competition between the regions, and a way for each to discover their own strengths and capabilities for participating in a new space industry. As a result, SpaceBase managed to engage all 14 Economic Development Agencies (EDA) across New Zealand while they leveraged their own judges, mentors and local incubators to support their local teams.

This partnership with local EDAs has contributed to a more extensive study by the Christchurch government leading to a regional strategic plan and identification of needs for the aerospace sector in the Canterbury region.

In order to understand the landscape of the local area and identify both capabilities and potential opportunities, SpaceBase created a platform for the New Zealand Space Industry directory. A directory gives a snapshot of the emerging niche capabilities by region and location which then became the starting point for a space industry capabilities analysis report for the country. On a more grassroots level, SpaceBase also initiated creating local space Meetup groups as well as helping catalyse the national space student association at the university level, which now has two chapters in Wellington and Christchurch.

Challenges to Implementing Solutions

While incentive prizes and catalysing a space community are effective at building an ecosystem, the biggest challenge is always finding the right funding resources to seed projects and start-ups. The space industry is normally a capital-intensive endeavour that takes years to see return on investment. Therefore, government initial funding and incentives are critical to the growth of the industry. For example, New Zealand government support for competitions and grants for new space initiatives were essential in the increase in space activities over the past two years.

The presence of established academic institutions that have aerospace and space science offerings also play a large role in ramping up capacity building within a certain area. As an example, University of Canterbury's strength in engineering and rocketry allowed research and development to be spun off to propulsion applications, which would later be applied to Rocket Lab's success. A majority of its New Zealand engineers come from University of Canterbury. It would be more difficult to accomplish these results without the academic institutions in place. An emerging alternative is the increasing availability of online education offerings across the globe, giving anyone with a laptop and internet access the same privileges as a student in some of the more prestigious universities around the world.

A national level space ecosystem driven solely by commercial growth will take longer to thrive without the backing of its government. This is evident in several of the countries that have started new space initiatives like Luxembourg, Singapore, and most recently Australia. In New Zealand, the New Zealand Space Agency was created out of a commercial necessity. With Rocket Lab's needs for policy and regulations to conduct launch operations, the New Zealand government created the necessary legislation in an agile and commercially focused environment. This progressive and future focused mindset has contributed to Rocket Lab's success in creating a small satellite launch industry from New Zealand.

Lastly, space is a risky industry and needs a culture of risk takers and first adopters to flourish. In New Zealand while the entrepreneurial community exists, it is still in its infancy and would benefit much from Silicon Valley style of investing and resourcing start-ups. The culture of risk and ingenuity born of a country in isolation works in its favour. A "can do" attitude and a "number 8 wire" mentality has birthed companies like *Rocket Lab* and *Dawn Aerospace*, and has enticed companies like *LeoLabs* and *Google* to invest in infrastructure and testing projects within the country.

Current Global Efforts

As the technology gets democratized and of-the-shelf, countries like New Zealand have started to look at their own potential capabilities to address niche markets globally. As an example, the city of Christchurch has included aerospace as an industry focus as part of their regional strategic plan. The city is looking to leverage its already existing manufacturing base and potential for testing components and spacecraft as an important step in creating an aerospace hub in the country. Easier access to satellite data has also incentivized the creation of data

analysis, geographic information systems (GIS), and remote sensing application companies within the region.

Other countries like Luxembourg, who do not have a legacy of space activities and capabilities, have created funding incentives to attract start-ups and companies to set up research and development locally. Countries like Singapore and Japan have also created incentives in the form of challenges and start-up incubator/accelerator support to further develop their ecosystems. Less resourced countries like the Philippines have benefited from mission partnerships with other countries that have more advanced capabilities. These joint collaborations lead to technology and knowledge transfer which can then lead to locally developed hardware and a talent pool for fully developing space missions in the future.

While efforts are being made by countries, global organizations such as the United Nations Office of Outer Space Affairs have also been mandated to build global participation and increase capacity building through their different initiatives. There are not-for-profit organizations such as University Space Engineering Consortium (*UNISEC Global*) that are teaching students and teachers around the world satellite manufacturing as a step towards capacity building in developing and emerging countries. While established space consortiums like the European Space Agency are looking at collaborative efforts such as the Moon Village and open sourcing its satellite datasets in an effort to incentivize collaboration and utilization by other countries.

On a grassroots level, organizations like SpaceBase are focused on regional and global space ecosystem building. They are offering training workshops to help assess and understand a local region's strengths and needs for developing space related industries for international space markets. Others like Space Impulse are creating community platforms using block-chain based technologies to support the global commercial space ecosystem. While others like Disrupt Space are helping the space start-up ecosystems in Europe through event based conferences and pitch sessions.

Summary Recommendations

Different nations are working on their own capacity building initiatives while leveraging both local and global institutions for growing its space industry pool. Capacity building for the space industry needs a long lead time and allocated funding resources to be successful. Lessons learned from SpaceBase activities and initiatives over the past three years have led us to the following recommendations:

- Identifying Niche Markets - understanding the local capabilities in terms of adjacent industries and how this relates to opportunities in the global space market is the first step towards identifying a niche industry. In the case of SpaceBase, we created a national directory to be able to understand the distribution of existing space related companies and organizations within New Zealand. The next level to this market research is creating a directory of adjacent industries (manufacturing, sensors, data analysis).

- Identify unique competitive advantages - once local strengths and capabilities are identified, understanding the unique competitive advantage for growing a niche market and identifying a focus product or service that can be leveraged.
- Understanding the sociological, political, economic, and cultural considerations when building a local space industry. This assessment should be conducted to further understand the challenges and barriers for success.

Conclusion

In a hundred years' time, what we become as a space faring society and our future migration beyond Earth will depend on what we start today, and what societal changes we establish to create a truly equitable and sustainable future for all. In order not to end up in a totally dystopian world, we need to look ahead and think about what steps are needed to achieve the future we desire. We need to first create a mind shift of abundance and empowerment for any nation around the world to partake in a global space economy. Once we have done so, then we can leverage exponential technologies and growth to help create opportunities for niche industries that address global space related growth markets. And when we have managed to get every nation involved in contributing to humanity's outward migration and sustainability without leaving any nation behind, then we will be able to obtain a truly *Star Trek* universe for all.

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