WALT EVERETTS

SPACE;

-OPPORTUNITIES AND INVESTMENTS EMERGE,

-CONSUMER DEMAND AWAKENS,

-ACCESS COSTS DECREASE AND MARKETS FLOURISH.

11/28/2024

AGENDA

1. Who am I and why am I here?
2. The history of satellite-based communications.
3. The last 10 years have seen a healthy (and scary) growth.
4. What do consumers want and need.
5. Economic Predictions show explosive development in the space sector.
6. What we should be planning for and what should we be concerned about.

WHO AM I AND WHY AM I HERE?

"Scientists discover the world that exists; engineers create the world that never was" – Theodore Von Karman, Aerospace Engineer

WALT EVERETTS: WHY ME?

Bachelor of Science in Aerospace Engineering, The Pennsylvania State University (USA), 1984.

10 years: Integration and Test of Large Geostationary Satellites.

5 years: Manufacturing Manager for the first mass produced Low Earth Orbit (LEO) satellite constellation.

8 years: Worldwide New Product Introduction Program Manager with emphasis on terrestrial telecommunications.

15 years: Iridium VP of Space and Ground Services with previous experience in Satellite Manufacturing. Now retired but still passionate.

Passion:

- Understanding and anticipating trends.
- Space Sustainability: ensuring space remains available for future generations.
- Hiking, Learning, Space, Giving back: Science, Technology, Engineering & Math.

"There is only one good, knowledge, and one evil, ignorance" – Socrates

WHY ARE YOU HERE????

- Space is interesting and exciting. Think of rockets, lunar exploration and star wars type scenarios that entice our imaginations.
- Space is transformational to all of mankind. Just like airplanes, computers and mobile phones have transformed our daily way of life.
- Space is growing at an amazing pace (Greater than CAGR)
- Space will continue to impact our lives in so many ways. Thoroughly connected world in navigation, banks, asset tracking & remote sensing.
- Space generates an unmatched economic opportunity. Forecasted by WEF to support $1.8 trillion USD by 2035 with some predictions exceeding $2.3 trillion.
- Chile (and, in more general terms, LATAM) are positioned to grow and prosper. Op-ed | Running the Space Playbook in Chile – SpaceNews
  - Chile just signed the Artemis Accords for sustainable space exploration

SPACE NEWS OP-ED (7-DEC, 2022)

Some of the most important science in the field of astronomy has been possible because of Chile, from studying black holes to tracking the debris trail left after NASA's DART spacecraft when it slammed into the asteroid Didymos. By some estimates, Chile holds half or more of the world's astronomy infrastructure, which owes largely to the favorable Atacama Desert skies in the country's northern region.

But Chile's future in space is not just relegated to looking up (through observatories often run by foreign space organizations). While its astronomy sector is mature, there is a fast-moving effort to strategically build other components of the country's space ecosystem. Starting with a research project first launched nearly 30 years ago, today, Chile is implementing a national strategy to simultaneously develop space assets, the technical capacity to build and operate them, and the human capital that can sustain and grow space activities over time — all while bringing the rewards of space back to Earth to uplift Chileans in every region.

To be sure, Chile is running the space playbook that we can see in action (in a variety of forms) in spacefaring nations around the world: space initiatives are used to drive research, investment, and commercial activity that inspires education and technical development, creates jobs, fuels competitiveness, and injects innovation into adjacent industries. That model is unfolding in Chile today and without the institutional baggage and bureaucracy often found in long-standing space programs. As Chile's Minister of Science, Technology, Knowledge and Innovation Silvia Díaz Acosta said, "We have a great advantage. We are totally new to this."

(Satellite Program) Form Follows Function

Chile may be treading new ground in how it is developing its space ecosystem, but the country has long been on a steady and strategic path to space. For decades, Chile has used satellites as catalysts for establishing and improving space capabilities. In 1995, Chile's first satellite, FASat-Alpha, was launched as a pathfinder mission. The 110-pound microsatellite was built through a collaboration between the Chilean Air Force and Surrey Satellite Technology, Ltd., and the satellite was outfitted with experiments for Earth observation, GPS, and data capture and transmission. The launch coincided with the creation of the Mission Control Station in Santiago, and it was an important opportunity to build technical capacity among Air Force engineers.

When FASat-Alpha reached its end of life in 2000, it was replaced by FASat-Bravo, which was in turn replaced in 2011 by the Sistema Satelital de Observación de la Tierra (SSOT), otherwise known as FASat-Charlie. Each successive satellite helped Chile build domestic capacity to operate satellites and transfer and process the data they return. Now, Chile is pursuing the next iteration of these ongoing satellite programs, a constellation of 10 microsatellites dubbed the National Satellite System (SNSAT).

"All of the knowledge and experience the mission team gained by building FASat-Alpha, Bravo and Charlie was the base on which we created SNSAT," said General Luis Sáez, director of space for the Chilean Air Force. "In the strategy we defined as a government four years ago, we considered how every activity needs to boost and enhance the national space system of Chile. This was considered from the beginning as a national program."

In much of the documentation on the planned constellation, SNSAT is synonymous with the Chilean space program. This is apt, as the value to the country goes far beyond the space hardware. Under SNSAT, geospatial data will be processed at new facilities, including the National Space Center in Santiago and two additional stations. The domestic manufacturing of eight of the 10 satellites by the Chilean Air Force and Chilean universities will stir economic activity, invigorate supply chains, and build local capacity to produce space assets.

The constellation will yield a dedicated SATCOM service for Chile and promote international collaboration. For example, in 2020, Chile signed a strategic partnership with the Israeli company Imagesat, giving the country access to data from the company's 250 satellites.
Chile has already inked an agreement with SpaceX to place the SNSAT satellites in orbit in the coming years. That puts the nation on a tight timeline for developing the integrated features of Chile's new space ecosystem, among them, the human capital that makes its operations possible.

Taking a Decentralized Approach to Space Capacity

As all spacefaring nations have discovered, one of the most challenging elements in building a thriving space ecosystem is nurturing the talent to build, run and grow it. In this, SNSAT has an important role.

"In this comprehensive approach, we define human capital formation as one of the key issues," said Gen. Sáez. "For that reason, in the context of the National Space Program, we are running a program that we call the National School Space Program, which today is a pilot program running in 20 schools in different regions of Chile."

Yet, a clear quality of the Chilean space strategy is that it recognizes the importance of nuanced programming that plays to the country's strengths. Chile is the narrowest country in the world, and at 2,600 miles, it is about as long as the United States is wide. As a result of this geography, Chile has several regions that are each suited to a different aspect of space access and operation. The arid north provides pristine views for astronomy, while a launch facility in the south could give access to the hard-to-reach polar orbit. Near the center of the country is the Santiago Metropolitan Region, which hosts about half of the nation's population. Capitalizing on these regional differences requires a "decentralized" approach, according to Minister Díaz. That is, space activities in each region need to be aligned with those regions' inherent advantages and existing space infrastructure. Take education as an example.

"To become a leader in space, education is crucial," said Díaz. "Chile being such a long, extended country, education is different in the north, central and south. In the north, the focus will be on astronomy, the mining industry, human migration and climate change. In the south, it will also be related to climate change, as well as food security, territorial sovereignty and studying the ice melts in Antarctica."

This decentralized approach, alongside targeted investments in things like the National School Space Program and specialized university programs, is Chile's answer to the challenge of identifying, recruiting and developing skilled human talent. The Minister noted that international collaboration is crucial, saying that cooperating nations can implement strategic partnerships with Chile and build local capacity by exchanging knowledge, professors and students.
This stated focus on collaboration is cross-cutting as well as inspiring. As Díaz said, "We enter into new partnerships with like-minded countries focused on things like the fight against climate change, migration, and most importantly, we want to create a system that is safe and sustainable."
This perspective is an asset to the broader global space community. By building its space program with a vision for Earthly benefit, Chile is preparing to use its space capabilities to elevate and empower not just Chileans, but people the world over.

THE ARTEMIS ACCORDS

- The Artemis Accords are a series of non-binding multilateral arrangements between the United States government and other world governments that elaborates on the norms expected to be followed in outer space.
  - Affirm that cooperative activities under these Accords should be exclusively for peaceful purposes and in accordance with relevant international law.
  - Confirm a **commitment to transparency and to share scientific information**, consistent with Article XI of the Outer Space Treaty.
  - Call for a commitment to use reasonable efforts to utilize current interoperability standards for space-based infrastructure, and to establish standards when they do not exist or are inadequate.
  - Call for a commitment to take all reasonable efforts to render necessary assistance to personnel in outer space who are in distress and according to their obligations under the Rescue and Return Agreement.
  - Specify responsibility for the registration of objects in space, as required by the Registration Convention
  - Call for a commitment to publicly share information on their activities and to the open sharing of scientific data. While doing so, signatories agree to coordinate with each other to provide appropriate protection for any proprietary and/or export-controlled information, and this provision does not extend to private sector operations unless conducted on behalf of a signatory.
  - Include an agreement to **preserve outer space heritage**, which they consider to comprise historically significant human or robotic landing sites, artifacts, spacecraft, and other evidence of activity, and to contribute to multinational efforts to develop practices and rules to do so.
  - Include an agreement that extraction and utilization of space resources should be conducted in a manner that complies with the Outer Space Treaty and in support of safe and sustainable activities. The signatories affirm that this does not inherently constitute national appropriation, which is prohibited by the Outer Space Treaty. They also express an intent to contribute to multilateral efforts to further develop international practices and rules on this subject.
  - Reaffirm the signatories commitment to the Outer Space Treaty's provisions relating to due regard and harmful interference with other nations' activities, and to provide information regarding the location and nature of space-based activities. Signatories express an intention to contribute to multilateral efforts to further develop international practices, criteria, and rules to assure this. To implement this, the Accords provide for the announcement of "safety zones", where other operations or an anomalous event could reasonably cause harmful interference. The size and scope of these safe zones should be based on the nature and environment of the operations involved and determined in a reasonable manner leveraging commonly accepted scientific and engineering principles. Within their safety zones, the signatories commit to respect the principle of free access to all areas of celestial bodies by others and all other provisions of the Outer Space Treaty.
  - Include a **commitment to mitigate space debris** and to limit the generation of new, harmful space debris in the normal operations, break-up in operational or post-mission phases, and accidents.

THE HISTORY OF SATELLITE-BASED COMMUNICATIONS.

SCIENCE FICTION BECOMES REAL

- The concept was first introduced by Arthur C. Clark in 1945 who was supporting the UK's Royal Aircraft Fighters (RAF) and described the use of manned satellites in 24-hour orbits high above the world's land masses to distribute television programs.
- John R. Pierce of AT&T's Bell Telephone Laboratories who, in a 1954 speech and paper elaborated on the utility of a communications "mirror" in space, a medium-orbit "repeater" and a 24-hour-orbit "repeater."
- The idea behind a communications satellite is simple: send a signal into space and send it back down to another spot on the globe. The first satellite launched in 1960 (echo1) was really just a giant ball that enabled signals to bounce back to the planet.
- On April 6, 1965 COMSAT's first satellite, EARLY BIRD, was launched from Cape Canaveral. Global satellite communications begins. The 60's were also the foundations for Telstar (US), Anik (Canada) and RCA Satcom (Global)
- Satellites became bigger and had more "capabilities" or circuits to deliver communications as launch vehicles grew in size and proficiency to place items into space.
- The race is on, space becomes a vital part of everyday expectations in weather, video, defense, communications and monitoring. Space opens up a new opportunity to deliver services to enable human progress.

TRADITIONAL TO TRANSFORMATIONAL

- The 1990's was somewhat transformational for space-based systems when Motorola conceived of a low earth orbiting constellation to support personal communications.
- Other systems like Globalstar, Teledesic and Orbcom followed with different business plans and niche markets.
- Historically speaking, space-based activities have been led by governments with some commercial benefits but that seems to be reversing.

- Explosive growth of machine to machine, personal navigation and timing (PNT) and the need for a connected world via broadband have all contributed to a significant number of new systems being built and launched.
  - Starlink
  - OneWeb/Eutelsat
  - Kuiper (Amazon)
  - Lightspeed (Telesat)
- Mass manufacturing. Launch vehicle reusability/turn around time and demand drives continued growth.
- But… There is now a new factor. Consolidation & a multiorbital approach in use to deliver on demand using the best technology delivery mechanism to satisfy the requirements, often diverse, that support the consumer needs economically. Single service delivery solutions are not optimal and data aggregation drive the future.

THE LAST 10 YEARS HAVE SEEN A HEALTHY (AND SCARY) GROWTH.

IT'S GETTING BUSY UP THERE

Includes launches through **5/1/2023**

- **Total number of operating satellites: 7,560**
  - United States: 5,184
  - Russia: 181
  - China: 628
  - Other: 1,572
- LEO: 6,768
- MEO: 143
- Elliptical: 59
- GEO: 590
- **Total number of US satellites: 5,184**
  - Civil: 30
  - Commercial: 4,741
  - Government: 167
  - Military: 246

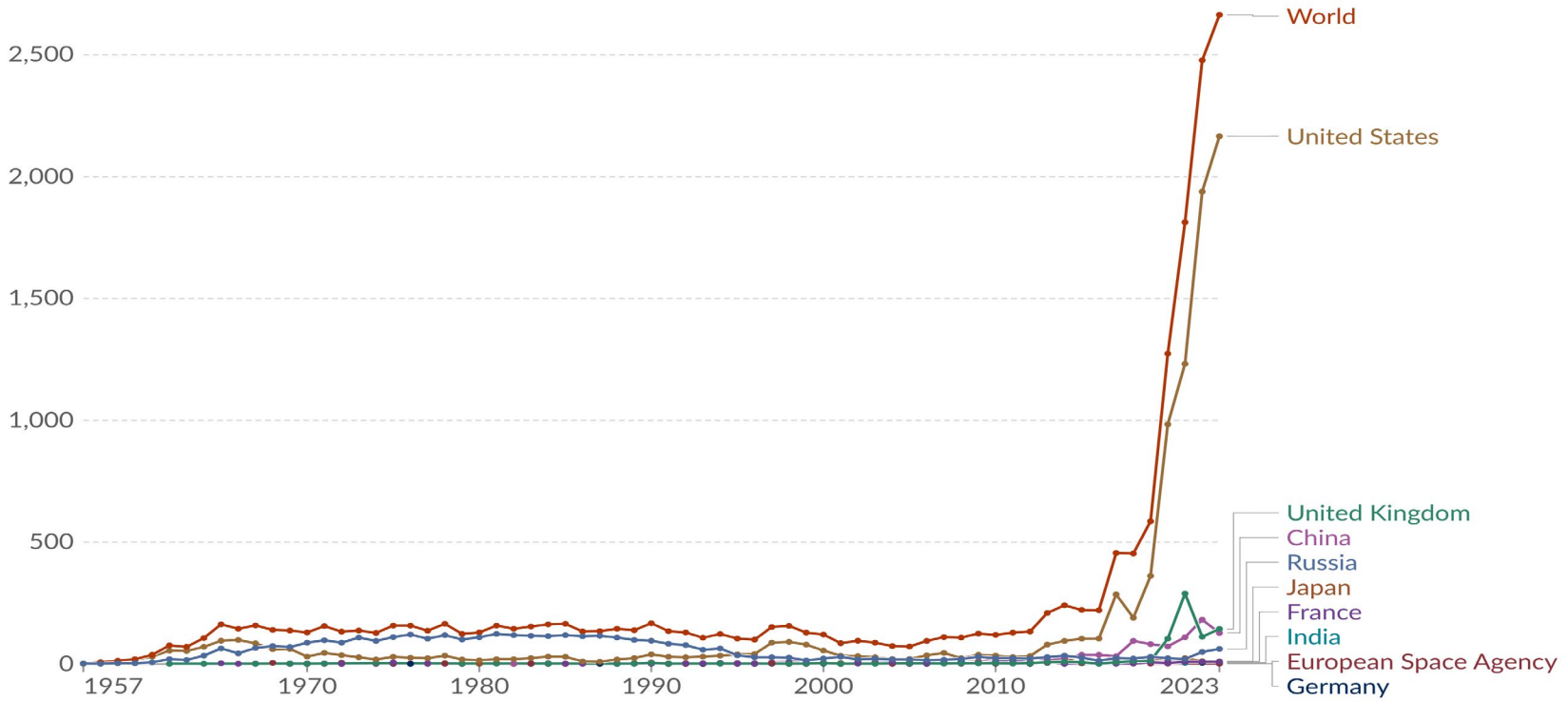
July 19, 2024 (Forbes magazine): For the first time in human history, there are now 10,000 functioning satellites above our heads, whipping around the Earth at high speed.

As of September 2024, there are 6,426 Starlink satellites in orbit, of which 6,371 are working, according to Astronomer Jonathan McDowell who tracks the constellation on his website.

Annual number of objects launched into space

This includes satellites, probes, landers, crewed spacecrafts, and space station flight elements launched into Earth orbit or beyond.

Our World in Data



Data source: United Nations Office for Outer Space Affairs (2024)

OurWorldinData.org/space-exploration-satellites | CC BY

Note: Where they differ, launch attributions are based on the commissioning country, not the country conducting the operations.

THE IMPORTANCE OF SPACE

What does this mean ……..

- The cost to access space is lower. Primarily due to the SpaceX Falcon 9.
- This increases the need for engineering, scientific and education disciplines.
- Primary suppliers are expanding – especially as secondary and tertiary needs mature.
- Supply chain issues continue to impact space-based system hardware deliveries.
- The infrastructure demands to move the increased data demands terrestrially.

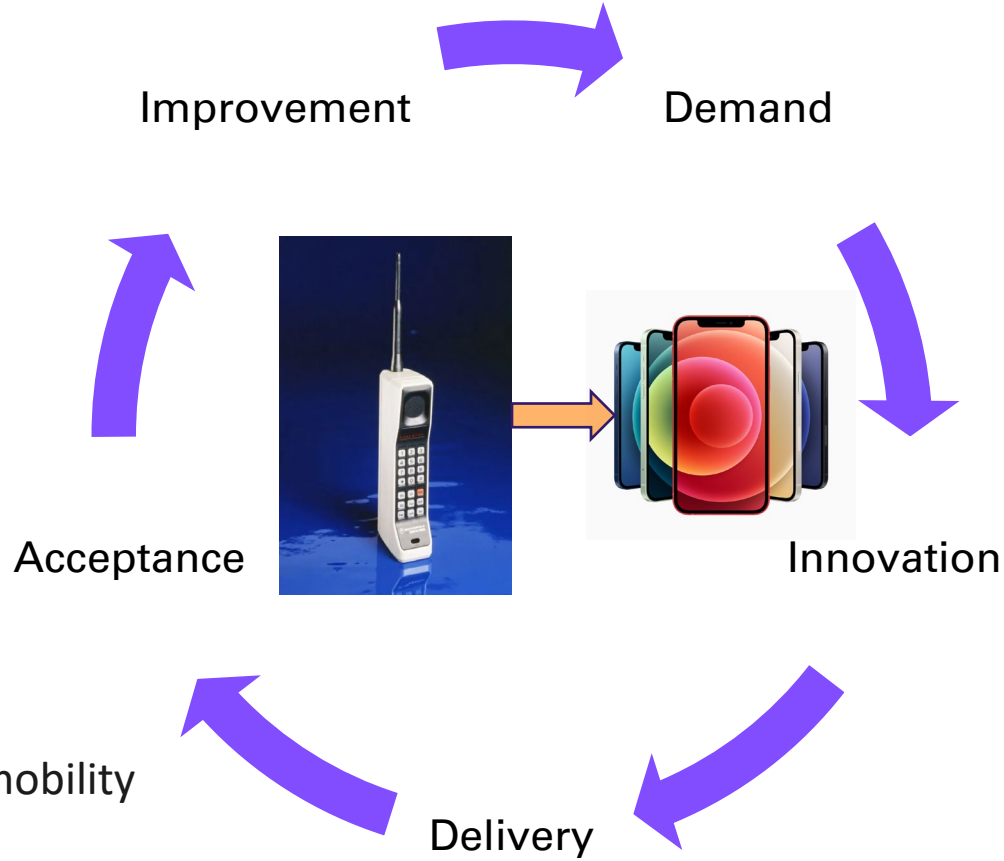
….And why does it matter

- Space is becoming a key part of our daily lives. global telephone calls->Television shows->embedded apps.
- We will continue to rely upon space as a communications capability and to enable information sharing.
- It currently is complementing terrestrial connectivity but I also see a growth market whereby the “unconnected’ become connected solely via space. O3B: Other 3 Billion.
- The markets of space will grow yielding more innovation, ideas, products, services and support demands.
- Space is a precious commodity, and we need to ensure availability forever.

WHAT DO CONSUMERS WANT AND NEED?

CUSTOMER EXPECTATIONS

- Availability
- Reliability
- Ubiquitous communications
- Ease of use
- Single billing
- Low latency
- High accuracy
- Familiar look and feel
- Increased connectivity and mobility



Consumers are increasingly demanding as expectations drive more innovations which, in turn, drive more demand and expectations

ECONOMIC PREDICTIONS SHOW EXPLOSIVE DEVELOPMENT IN THE SPACE SECTOR.

THE SPACE ECONOMY

- According to a report by the World Economic Forum, “The space economy is forecast to reach $1.8 trillion by 2035, up from $630 billion in 2023 and growing at an average of 9% per annum – well above the growth rate of global gross domestic product”
- It’s important to note that the impact created by the space economies are reaching far past the traditional aspects of satellites and rockets. They touch nearly every part of a local, federal and worldwide demand
  - Personal: Smart watches, mobile phones, mapping/directions
  - Industry and product costs: agriculture, remote sensing, asset tracking, fishing
  - Predictability: Weather, natural disasters, travel
  - A connected world: Aircraft, user equipment, maritime connectivity
- As the demand signal grows and the innovation continues, new businesses are created

Traditional market verticals

Maritime	Aeronautical	Land Mobile
Cargo Logistics	Passenger connectivity	Asset tracking
Mari-agriculture	Cockpit communications	Remote sensing
Safety, Distress & Rescue	Routing and avoidance	First Responders
Navigation	Position knowledge	Mining and Farming

WHAT MAKES UP THE $1.8 TRILLION?

- Space hardware and access to space including rockets, satellites, subcomponents
- Infrastructure like manufacturing and test facilities, launch and landing pads and the transportation/logistics companies, fuel,
- Ground support equipment to enable celestial to terrestrial linkages
- Terrestrial infrastructure including backhaul & fiber
- Service suppliers and last mile carriers including mobile phone operators
- Consumer equipment and e-commerce apps. Direct and indirect sales
- Federal/state/worldwide bodies to help regulate space
- Healthcare, banking, education, farming industries
- Defense industry
- Lunar and beyond cislunar exploration
- Orbital labs and habitats
- Humanitarian needs, disaster predictions/readiness and first responders
- Debris detection and removal
- On Orbit servicing
- Space Tourism
- Data analytics and aggregators ★

THE BUSINESSES OF SPACE

- The space economy is not just about satellites. Space businesses can really be broken down in to four distinct categories.
  - Space Segment. This is the sexy part (IMHO). Satellites, satellite subsystems, rockets and on orbit sensors
  - Consumer products like phones, watches, instrumentation, sensors. Anything that can become a value added product that uses the satellite “service” as a delivery mechanism.
  - Telecom and ground support. There needs to be a terrestrial to celestial link. Further, the data needs to originate and terminate at the user interface. This requires fiber, antennas, routers and racks and racks of equipment All data needs
  - Data and data “decisions”. I believe this is the fastest growing and most underappreciated part. Obtaining data is only part of the equation. Putting parts of data together to yield a solution is the next technology opportunity.

TURNING OBSERVATIONS INTO ACTIONS

- New opportunities are created by bringing in data derived from space and aggregating it to develop a solution. Can/Will this become a business?
- Example: Weather data, fuel costs, logistical needs and local availability of workers or product can be used to determine or alter a shipping route
- Example: Farm machinery requirements, global crop demands, predictive weather and shipping availability used to determine maintenance schedule.
- Example: Consumer product shortages, empty cargo availability and product replacement options can be used to determine soda dispenser replacements
- Example: Traffic patterns, navigation tools, accident data and a demand signal from a disaster can trigger logistics to deliver humanitarian aid

WHAT WE SHOULD BE PLANNING FOR AND WHAT SHOULD WE BE CONCERNED ABOUT?

HOW CAN YOU PROSPER

- What should we be planning for/what is the next demand signal.
  - That is the question that remains to be answered and is, quite honestly, impossible to answer in an ever changing world.
  - Some things to think about:
    - Consumers are demanding
    - Consumers are addictive
    - The world is getting smaller
    - Autonomy and robotics will continue to drive markets
    - Space is a fundamental capability that drives innovation
  - Everyone can prosper in this market. Whether that is in:
    - Observation of the celestial bodies.
    - Consideration that some solutions that have traditionally been “terrestrial based” can now be done “celestial”.
    - Driving new solutions to worlds problems that can be assisted by the use of space-based communications.
  - Think of combining or aggregating data to derive a consumer solution.

SPACE SUSTAINABILITY

- Responsible space behavior is necessary
- Current & future space actors must use responsible space behavior to ensure space accessibility is there for future generations.
- The livelihood of the worlds craving for space ecosystem depend on all space actors to consider sustainability in all decisions from cradle to grave.
- Rules of the Road, guidelines, regulations, policies all have a place in “enforcement” of the use of space, but it really boils down to, in my opinion, the need for all space actors to be:
  - Responsible
  - Transparent
  - Cognizant

THE IRIDIUM EXAMPLE AND RESPONSE

- A real-world example and the subsequent results:
  - In 2009, an abandoned, uncontrolled satellite crashed into one of Iridium's active communication satellites.
  - This event served as a wake-up call for the space industry to improve information-sharing on the orbit of satellites and debris. Thanks to greater industry collaboration, today satellites can operate safer than ever, with new practices to prevent future collisions.
  - Whole industries, companies and organizations (Secure World Foundation) have been established to
  - There is now a greater awareness of the need to develop and enhance best practices by owners, manufactures, regulatory authorities and international groups. It isn't completely universal across all nations and companies, but it seems to be gaining traction
  - It is imperative that all owner/operators maintain close & constant communication with appropriate commercial, civil and governmental entities. This includes information sharing & transparency on position, maneuvers and deorbit effort
  - Enhanced mitigation & maneuvering abilities, sharing of best practices coupled with procedures to de-orbit satellites at their end-of-life are real world examples used help prevent additional debris from congesting space.

THANKS AND QUESTIONS