

SMALLSAT FINANCIAL CONSIDERATIONS

FEBRUARY 3RD, 2020





STARBURST HAS RAPIDLY GROWN TO REACH A GLOBAL PRESENCE

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WE ADDRESS THE ENTIRE AEROSPACE VALUE CHAIN

STARBURST STARTUP SCOPE

SPACE MOBILITY

- Satellites
- Launchei

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- Data communication
- Earth observation

REGIONAL MOBILITY

- New concepts (supersonic, hybrid)
- Connectivity
- Energy management

URBAN MOBILITY

- UAS
- Autonomous flight
- eVTOL
- Energy Management







INFRASTRUCTURE

- Passenger Experience
- Airport security
- Automation
- Airport retail

ENABLING TECHNOLOGIES

- Cybersecurity
- Connectivity/Sensors/Antennas/IoT
- Big data, AI, Machine Learning
- Industry 4.0, Robotics





STARBURST COMBINES 3 COMPLEMENTARY ACTIVITIES FOR A UNIQUE VALUE PROPOSITION

STARBURST SERVICE OFFERING



ACCELERATOR

- > INNOVATION SCOUTING
- > MATCHMAKING BETWEEN STARTUPS AND Corporates

CONSULTING

- > GROWTH (NEW PRODUCTS, NEW MARKETS)
- > DIGITIZATION BY INNOVATION
- > INNOVATION PERFORMANCE
- > AGILE TRANSFORMATION
- > CUSTOM SCOUTING

VENTURES

- > GLOBAL AEROSPACE FUND
- > LIMITED PARTNERS INVESTMENT OPPORTUNITIES

A RANGE OF SERVICES FULFILLING THE NEEDS OF ALL BUSINESSES INTERESTED IN AEROSPACE INNOVATION: Startups, corporates, investors

SUPPORTING STARTUPS FROM IDEATION TO GROWTH

WITH 4 MAIN EQUITY-BASED VEHICLES Tailored to different maturities



INVESTMENT

AD-HOC

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SERIES A

GROWTH

GLOBAL

ACCELERATOR

9 TRENDS IN THE CURRENT SPACE INDUSTRY



MICRO-LAUNCHERS COME TO MATURITY & EASE ACCESS TO SPACE FOR NEW PLAYERS

| New Space / ICT | Country | 1st flight | Details |
|-----------------|---------|---|---|
| | | 2017 (founded 2006) | Rocketlab was founded in New Zealand in 2006 by Peter Beck. The micro-launcher, Electron, has flown 9 times since 2017 carrying about 40 satellites to Low Earth Orbit. |
| Брлсе | 0 | 2019 (founded 2016) | Maiden flight of the Hyperbola rocket on July 2019 marking the first flight of a Chinese private firm to Low Earth orbit. Other Chinese players include OneSpace which attempted a flight in early 2019. |
| | ١ | 2019 (pending) (founded 2017) | Virgin Orbit developed an aircraft-carried rocket that is undergoing final tests before first orbital flight at the end of 2019. The company, created by the billionaire Richard Branson, has raised more than \$380M to date. |

However, two additional trends are emerging :

• There are more than 100+ projects around the world developing launcher systems and a **consolidation** is foreseen in coming months and years as the first entrants grab the market shares

- Major launch operators of large launcher system now offer competitive rideshare options:
 - Arianespace introduced in GO-1 mission : the first microsat mission going directly to GEO
 - SpaceX is now offering rideshare opportunities at a very competitive price



SPACEX





THE ADVENT OF CONSTELLATIONS AND NEW SERVICES

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| Players | Country | Founded | # sats (Oct 2019) | Details |
|-----------------------------------|---------|---------|----------------------|---|
| planet. | | 2010 | >140 | Planet is an imaging company that operating 120+ Doves, 14 SkySats and 5 RapidEye satellites. The company is now capable to observe every location on Earth at least once a day. |
| ∆ spire | | 2012 | >70 | Spire had built a constellation of over 70 satellites to track maritime and aviation assets and provide data for weather forecasting. They closed in September 2019 a \$40M round (Total of \$200M). |
| OneWeb | | 2017 | 6 | OneWeb plans to launch 600 LEO Satellite for global communication services. They successfully launched six satellites and planning to launch a total of 2000 satellites at a 1200km altitude. |
| HawkEye ³⁶⁰ | | 2015 | 3 | Hawkeye360 and UnseenLabs develop a commercial satellite constellation for RF signal monitoring to reveal hidden and previously uncharted activities across land, sea and air. |
| unseenlabs - THE BRIGHT SIGHT | | 2015 | 1 | Hawkeye360 raised \$70M to complete constellation deployment Unseenlabs, backed by French DGA, plans 20-50 satellites |
| STARLINK | | 2015 | 60 | Starlink is already planning the world's largest Low Earth Orbit broadband constellation, filed paperwork in recent weeks for up to 30,000 additional Starlink satellites (Oct 2019) on top of the 12,000 already approved by the FCC. |



THE GROUND SEGMENT AS THE NEXT BOTTLENECK

- With constellations coming to maturity, huge volumes of data are now generated in space from hundreds of satellites and need to be transmitted to the ground in a timely and efficient manner.
- The existing ground stations are now the bottleneck and several trends are appearing to improve timeliness and lower costs.

150 Tb/day

Daily volume of data generated by the sole Copernicus program (ESA) in 2019

Mutualization of ground station capabilities



- Infostellar (Japan) and RBC signals (USA) are building Airbnblike software infrastructure for ground stations and constellation operators to optimize the station capacity, increase data timeliness and lower costs.
- Both companies are growing fast in suppliers and funding.

Consolidation between ground segment and data storage



In 2018, Amazon Web Service and Lockheed Martin announced a key partnership to provide ground stations as a service using the Verge network created by Lockheed Martin and leverage the cloud capabilities of Amazon. This move is especially interesting because if combines both data transmission and data storage.



Development of high-speed laser communication

Development of in-orbit processing capability

See later slide on laser communication

See later slide on Artificial Development



LASER COMMUNICATION (DIRECT)

| Opportunity | High data rate and long-distance wireless data transmission Global high-speed internet connectivity | | |
|-------------|---|--|--|
| STARLINK | Starlink is planning the world's largest LEO broadband constellation, filed paperwork in recent weeks for up to 30,000 additional Starlink satellites on top of the 12,000 already approved. 60 satellites were deployed in 2019 in a single Falcon9 launch The satellites use laser technology to communicate among themselves and with the ground | | |
| mynaric | Mynaric was founded in 2009 (Germany) and raised \$15.7M to date. Laser for high-speed internet (10Gbps laser technology) from satellites & airborne platforms | | |
| Telesat | Canada-based Telesat is designing a constellation of around 300 satellites for global internet connectivity. The company plans to begin offering regional | | |



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Mynaric develops laser communication to communicate with satellites and aircrafts

global internet connectivity. The company plans to begin offering regional service that will include Canada in 2022, with global service following in 2023.



Starlink : 60 satellites stacked under a Falcon9 fairing (left) before launch (center) and orbit insertion (right)



LASER COMMUNICATION (DATA RELAYS)

| Opportunity | Inter-satellite data relay network for Earth Observation, Internet of Things and broadband constellations, launch vehicles and deep space missions. Data rates at least 10-100x faster than conventional antennas |
|-------------|--|
|-------------|--|

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Audacy (USA, 2015) offers ground-based teleport stations and space-based relay satellites placed in MEO to increase data transfer between satellites (software-defined radio) and end-users (Laser downlink). The company secured more than \$100M commercial commitments.

Skyloom \$

Skyloom Global (USA, 2017) is developing a data relay infrastructure in GEO to relay data from LEO via laser communication. The advertised performance would be 100Tb/day/sat and the company plans launching 6 payloads in GEO for world coverage.

GOLBRIAK

Golbriak Space (Estonia, 2018) is developing an unique LEO-to-LEO laser communication device compatible with cubesats and enabling duplex communications. The technology will be demonstrated in 2019 as part of the FSScat demonstrator from ESA



Golbriak Space's developed the first full duplex optical terminal for cubesats



Audacy data relay architecture using 3 platform in Medium Earth Orbit with a capacity of 1000 concurrent users, a coverage of 100% and a latency <1s



ARTIFICIAL INTELLIGENCE DEVELOPMENTS

In-orbit operations

- Autonomous station keeping
- Debris collision avoidance maneuver
- In-orbit treatment of EO data to maximize the value of data downlinked (e.g. remove cloud and fog from optical imagery, focus on boats when observing the seas, ...).

Examples

- Chinese constellation "Xingshidai" of 192 AI-powered EO satellites announced in 2019 (after successful test in early 2019)
- European FSScat mission scheduled for 2019

Ground control

 Optimization of the satellite tasking (e.g. observation requests...) and ground segment optimization (which satellites to be targeted, network optimization)

Analytics & data fusion

 Data analytics beyond change detection such as: data fusion of multiple sources, advanced image recognition, capacity to integrate space and non-space data to deliver insights, low energy and low training sets methodologies...











STARBURST 2019 COHORT

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STARBURST

SPACE PORTFOLIO

Momentus

In-space flights for satellites between orbits





Product & USP

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- destination, allowing customers to launch from the ISS or LEO to reach higher orbits.
- The propulsion system is based on proprietary water plasma technology, lending Momentus a considerably higher specific impulse than chemical propulsion, such that 3x less propellant is needed to deliver payloads to their target orbits.
- Water provides a cheap and readily available fuel source, and the Momentus system provides higher thrust than comparable ion propulsion systems.
- approach potential customers to shorten the timeline to actionable contracts instead of Letters of Intent
- Introducing Momentus to target customers within the Starburst network
- Assisted in the Series A raise



Vigoride[™] is Momenuts' first propulsion system, set to debut in 2019.



Vigoride™Extended is capable of launching up to 300 kg from LEO to GTO, or up to 100 kg directly from LEO to GEO. Lunar orbit, and beyond



SpaceIT

Cloud-based mission control system for small satellites



Product & USP

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- Spaceit offers Mission Control as a Service (MCAAS), a one stop solution for satellite ground communications. It includes a cloud-based Mission Control System (MCS), access to a worldwide network of ground stations, professional satellite control and consultations whenever needed.
- Spaceit platform operates as a ground station service brokerage for the satellite operators. Satellite missions are matched with ground stations and the process of finding, buying and selling radio communication is simplified. At the same time, ground station operators can monetize their spare capacity and maximize their efficiency via the platform.



Orbit prediction / contact time planning



Dashboard: scheduling of the data uplink/downlink activities can be simplified through the platform

Starburst actions

 Starburst is helping SpaceIT creating partnerships with ground stations services (including Amazon) and acquiring world class users among constellation operators

Space Communications

 Starburst is also working with SpaceIT on the best timing and type of capital needed in the next 12 months for a quick scaling of the company services





Prime Lightworks

Propellant-less electric propulsion for Satellites



Product & USP

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- Prime Lightworks is developing a RF resonant cavity thruster for satellites propulsion. The
 Physical principle is the following: a radiated EM field's reflection on a conductive surface
 creates an EM radiation pressure. With carefully selected cavity and EM field parameters, it is
 possible to create a resonating asymmetric field and thus an asymmetric pressure that will
 finally generate thrust, eliminating the need for a propellant.
- Prime Lightworks boast the disappearance of the need or dependencies to propellant with EmDrive's property of full electric propulsion systems. RF electronics and RF resonant cavities could replace satellite propellant mass and conventional satellite propulsion systems. A shift in propulsion would increase satellite payload mass and orbital velocities, while lowering fuel emissions and launch costs to orbit. Satellites' lifetime would be increased by making it only limited by their components failure, and not anymore by propellant capacity.



Simplified schematic drawing of an EmDrive prototype

Starburst actions

To be onboarded



Eagleworks' EmDrive in its test chamber



Satellites

X

Skyloom Global

Global network for space-to-Earth communications



Product & USP

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- Skyloom will facilitate a Space-to-Earth telecommunications network which will enable a transfer capacity of several hundred of terabytes per day based on small, geostationary relay satellites which transfer data via optical communication.
- Skyloom plans to operate two geostationary relay satellites that will enable 100% visibility to Earth.
 Skyloom also develops the optical uplink terminals to be payloads on customers' satellite platforms.
- Skyloom's relay satellites will feature higher transfer rates and capacity (currently targeting 2 petabytes per day), and lower power needs compared to radio systems and other competitors.

Starburst actions

 Starburst is helping Skyloom work through a unique bridge round, advising how to ensure maximum value while entering the next round of funding

Communications

- Focusing on initial customer development



Skyloom's first relay satellite, Uhura 1, will use optical communication to transfer information between customer satellites and optical ground stations.

Skyloom's 2 geostationary satellites take advantage of a higher-orbit relay configuration, attaining global coverage.



Source: Company, Starburst