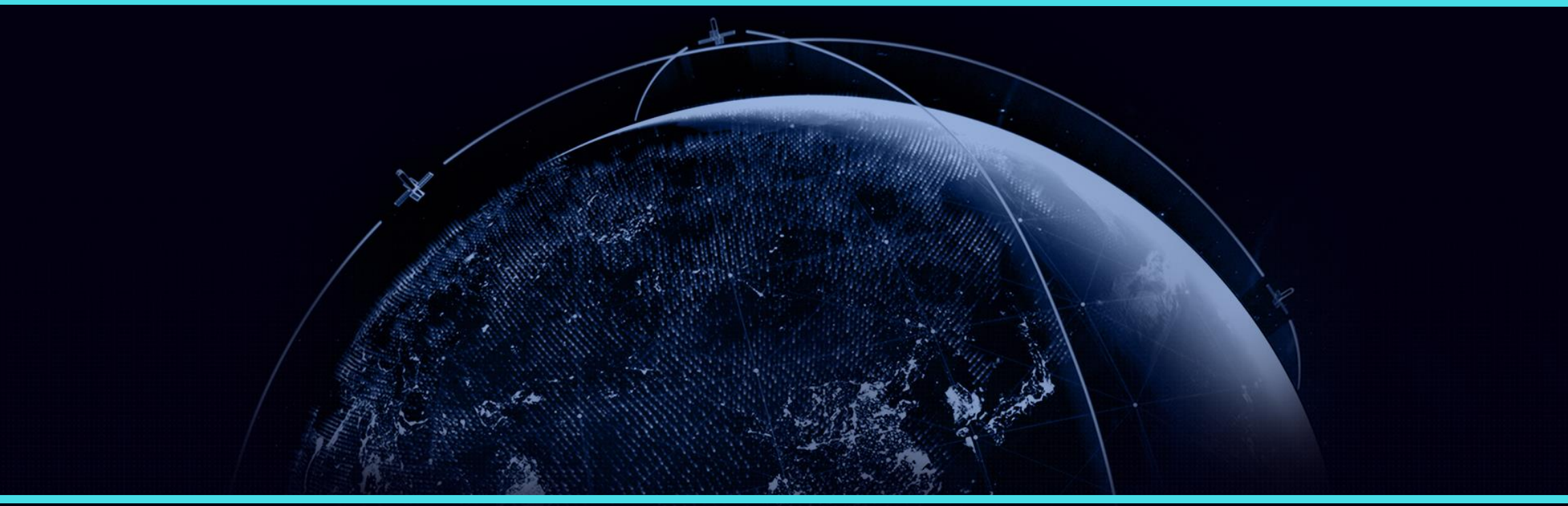
2018
Nano/Microsatellite Market Forecast, 8th Edition



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SpaceWorks helps government and commercial customers evaluate the economic and operational impact of future space programs

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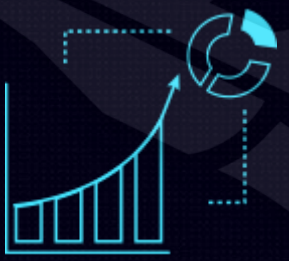

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- Market Forecasting
- Competitive Benchmarking
- Market Positioning
- Trend Analysis
- Market Simulation

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- Technical Concept Review

Since 2008, SpaceWorks has actively monitored companies and economic activity across both the satellite and launch sectors

0 - 50 kg | 50 - 250kg | 250 - 1000kg | 1000 - 2000kg | 2000kg+

Custom market assessments are available for all mass classes

2017

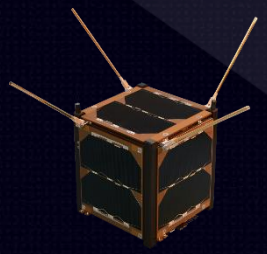
Over 300 nano/microsatellites were launched in 2017, shattering analyst' expectations and surpassing even SpaceWorks "full market potential" prediction from last year. 2017 represented a 205% increase in nano/microsatellites launched compared to 2016. The global launch market demonstrated broader acceptance of small satellite rideshares and traditional launch vehicles accommodated a record number of small satellites awaiting launch, significantly reduced the backlog that has been building since 2015.

2018+

SpaceWorks' 2018 projections have been increased compared to our 2017 5-year forecast to reflect an increase in small satellite launch opportunities, the continued maturation of emerging small satellite operators, and a strong influx of venture capital financing into the space sector. This year's SpaceWorks Forecast predicts 263 nano/microsatellites will be launched in 2018, slightly lower than the record set in 2017.

Nano/Microsatellite Definition

Picosatellite
(0.1 – 0.99 kg)



Nanosatellite
(1 – 10 kg)

Microsatellite
(10 – 100 kg)

Small/Medium Satellite
(100 – 1000 kg)

0 kg | 1 kg | 10 kg | 100 kg | 1000 kg

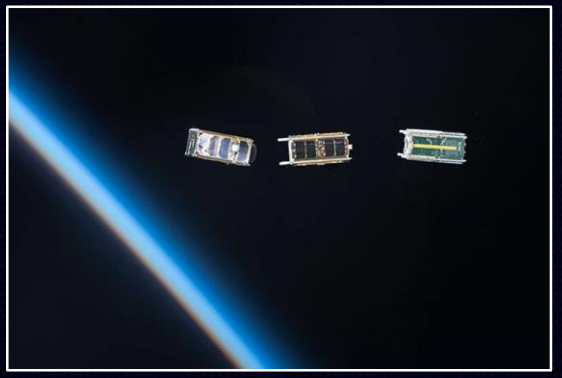
This report bounds the upper range of interest in microsatellites at 50 kg given the relatively large amount of satellite development activity in the 1 – 50 kg range.

Image Credits: University of Malta, space.skyrocket.de

2017 Highlights

- The global launch vehicle market demonstrated its ability to meet the growing demands of the nano/microsatellite segment **without the presence of dedicated small satellite launch vehicles**
- **PSLV C37 launched a record 104 satellites** in a single launch in February, the vast majority of which were nano/microsatellites
- 2017 was also a record setting year for Planet, who **acquired Terra Bella**, **launched 146 satellites**, and finally **achieved their goal of daily revisit coverage**
- The **QB50 academic constellation officially launched**, marking a major milestone for international cooperation in the nano/microsatellite arena; in all **36 QB50 satellites** were deployed

PSLV-C37 launches a record-breaking 104 satellites

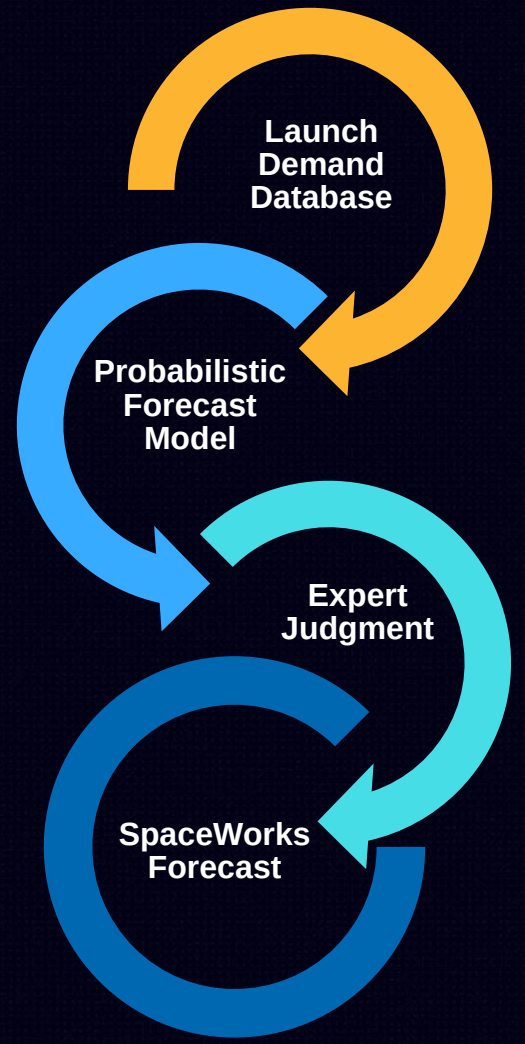


QB50 satellites after deployment from the ISS

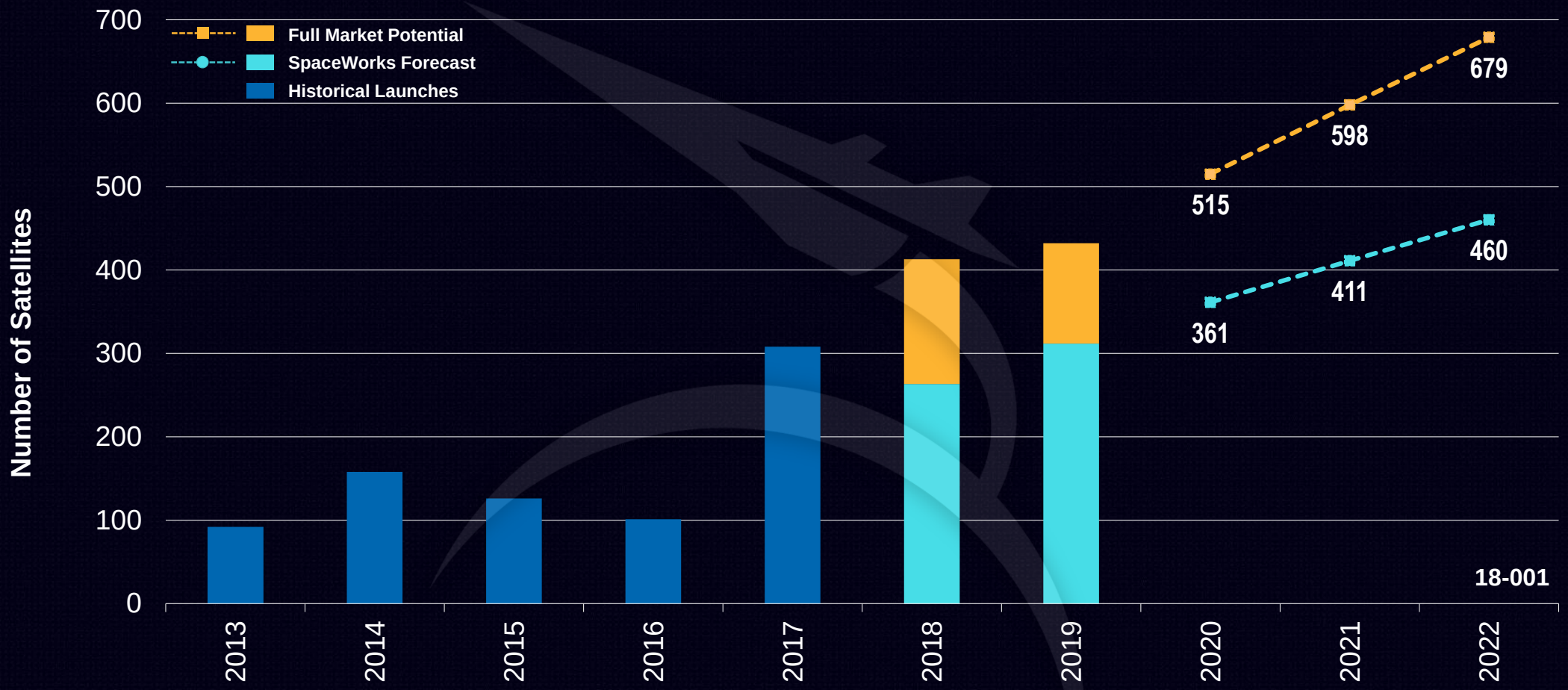
Image Credits: ISRO, NASA

SpaceWorks Forecasting Methodology

- SpaceWorks' **proprietary Launch Demand Database (LDDB)** serves as the data source for all satellite market assessments
- The LDDB is a **catalogue of over 10,000+ historical and future** satellites containing both public and non-public satellite programs
- **SpaceWorks Probabilistic Forecast Model (PFM)** is used to generate best-case estimates for future market potential based on expected market size, announced satellites/constellations and historical trends
- PFM results are further interpreted and refined using expert knowledge, historical indicators, and value judgements to create the **SpaceWorks Nano/Microsatellite Forecast**



2018 Nano/Microsatellite Launch History & Market Forecast (1 - 50 kg)



SpaceWorks' estimates up to 2,600 nano/microsatellites will require launch over the next 5 years

2018 Nano/Microsatellite Operators & Associated Examples

Military

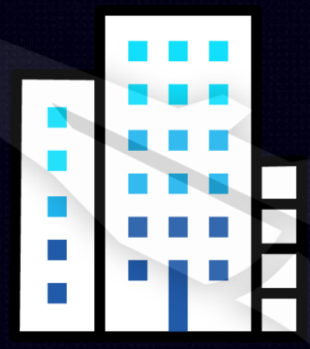
Operators whose primary satellite purpose is to support national defense activities.

Examples

US Naval Research Laboratory

DARPA

Colombian Air Force



Commercial

Operators whose primary satellite purpose is for-profit revenue generating activities.

Examples

Planet Labs

Spire

Astro Digital

Civil

Operators whose primary satellite purpose is non-military or non-profit activities.

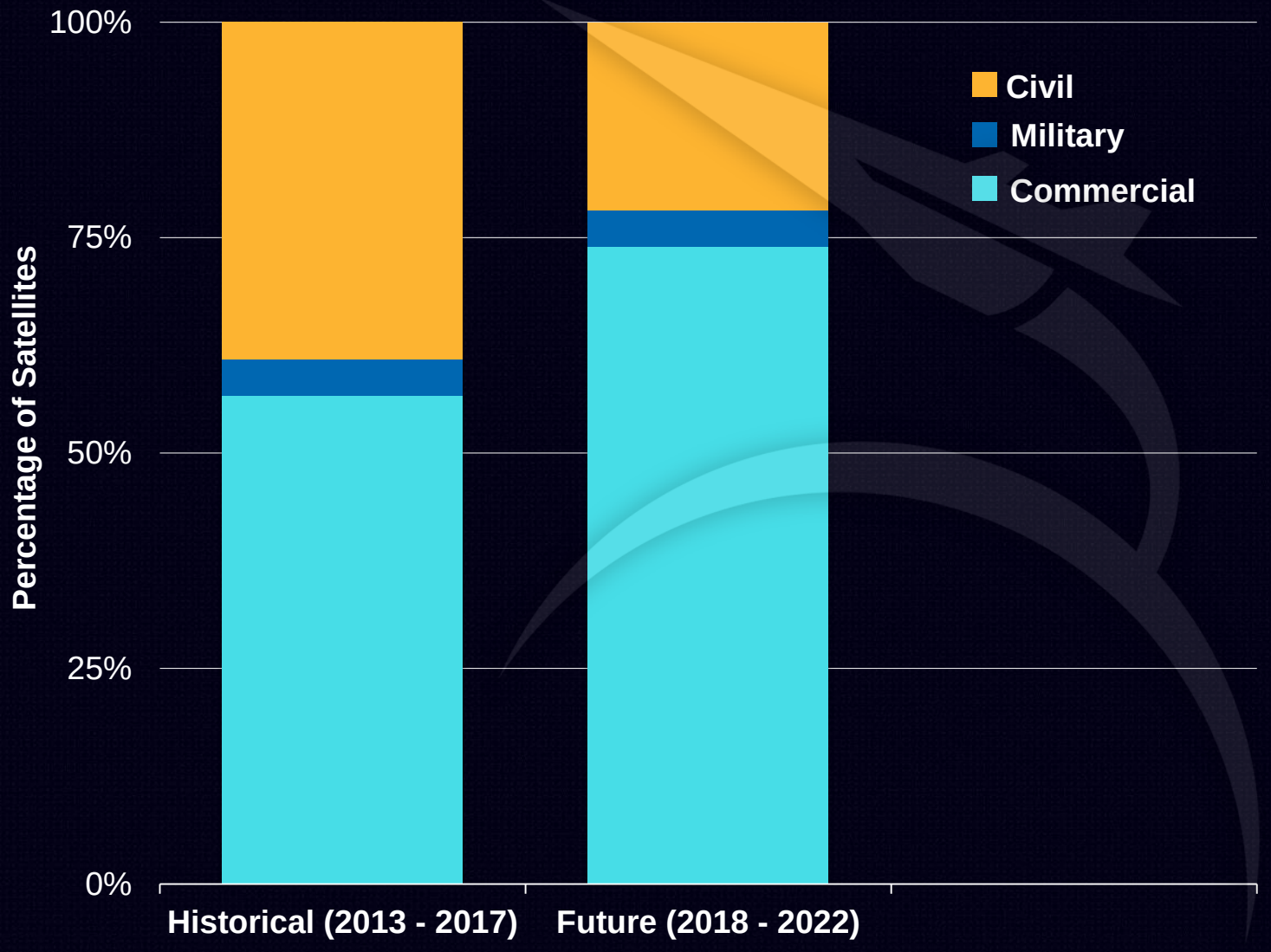
Examples

NASA

Kyushu Institute of Technology

The Aerospace Corporation

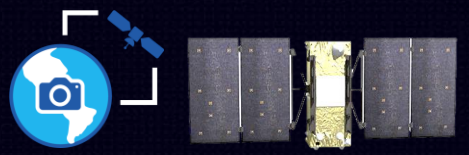
Nano/Microsatellite Operator Trends (1 - 50 kg)



Commercial operators are expected to encompass over 70% of nano/microsatellites launched in the next 5 years

Despite rapid commercial market share growth, civil and military operator demand is expected to remain consistent over the next 5 years

2018 Nano/Microsatellite Applications & Associated Examples

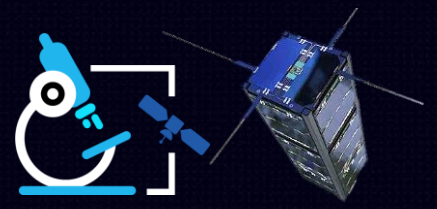


Earth Observation / Remote Sensing

HEDE-1 (Head Aerospace)
Mass: 45 kg
Launch: 11/2017

Communications

3-Diamonds (Sky & Space)
Mass: 6 kg (ea)
Launch: 06/2017



Scientific

DIDO 1 (Space Pharma)
Mass: 5 kg
Launch: 02/2017

Technology

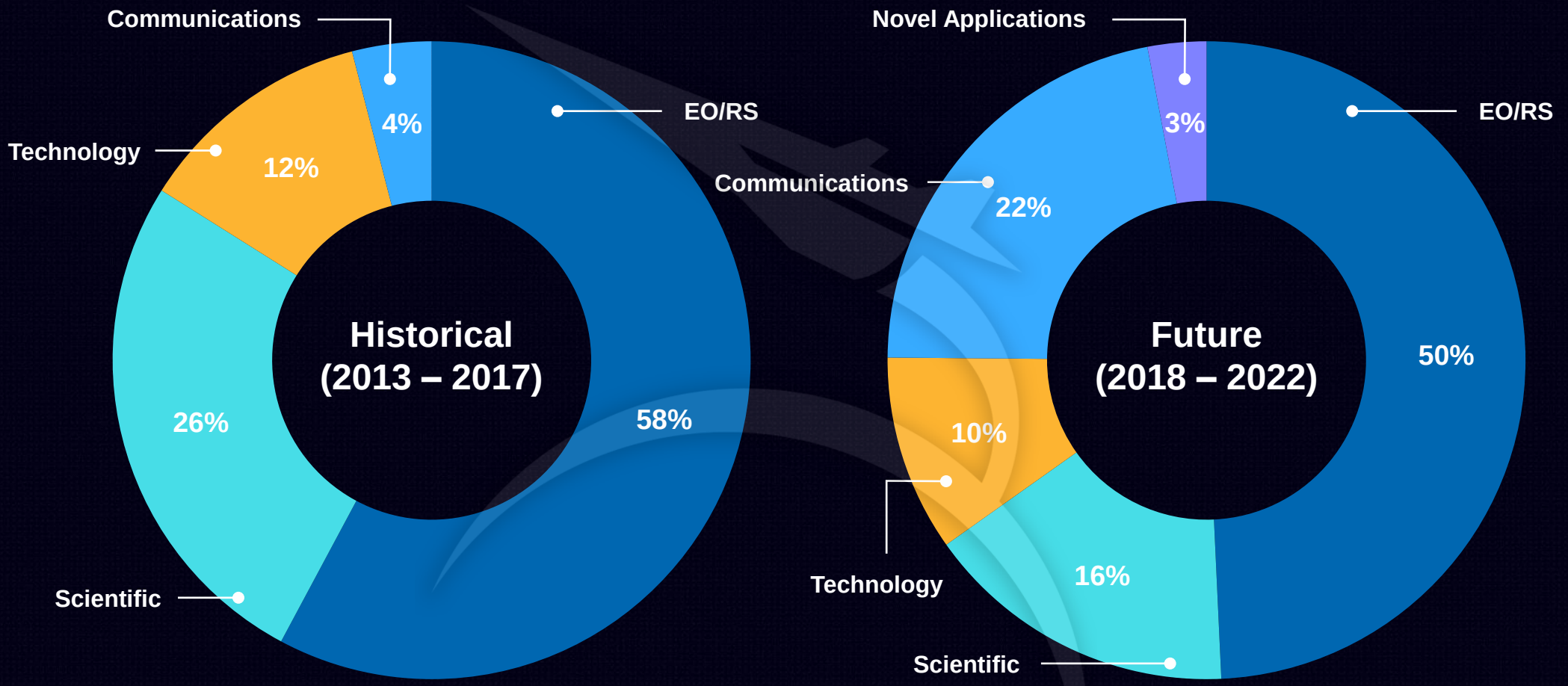
D-Sat (Deorbital Devices)
Mass: 5 kg
Launch 06/2017

Novel Applications

Mayak (MSUME)
Mass: 4 kg
Launch: 07/2017

Image Credits: space.skyrocket.de, spaceflight101.com, Deorbital Devices

Nano/Microsatellite Trends by Application (1 – 50 kg)

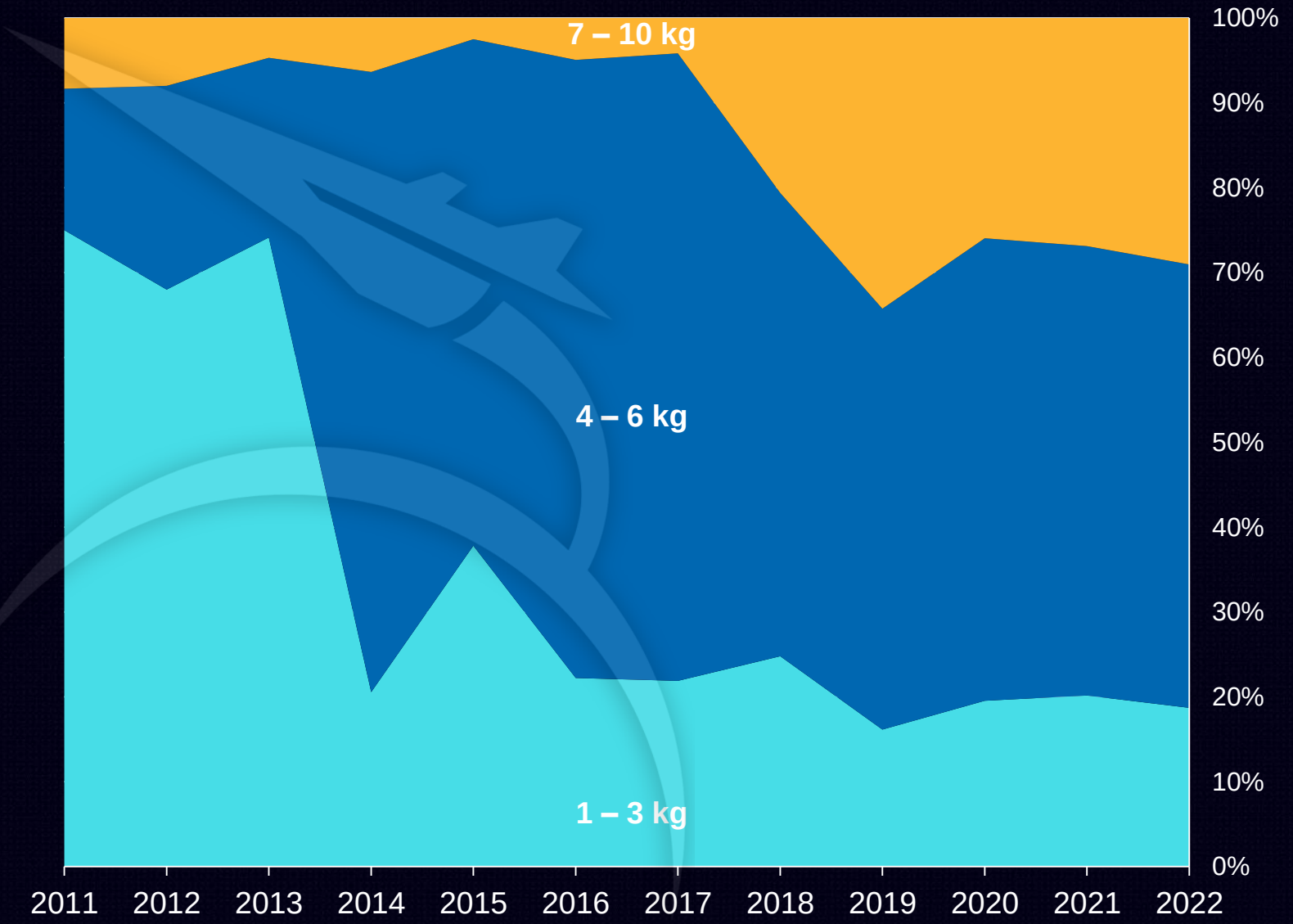


Communications satellites are expected to make up over 20% of the nano/microsatellite market in the next 5 years

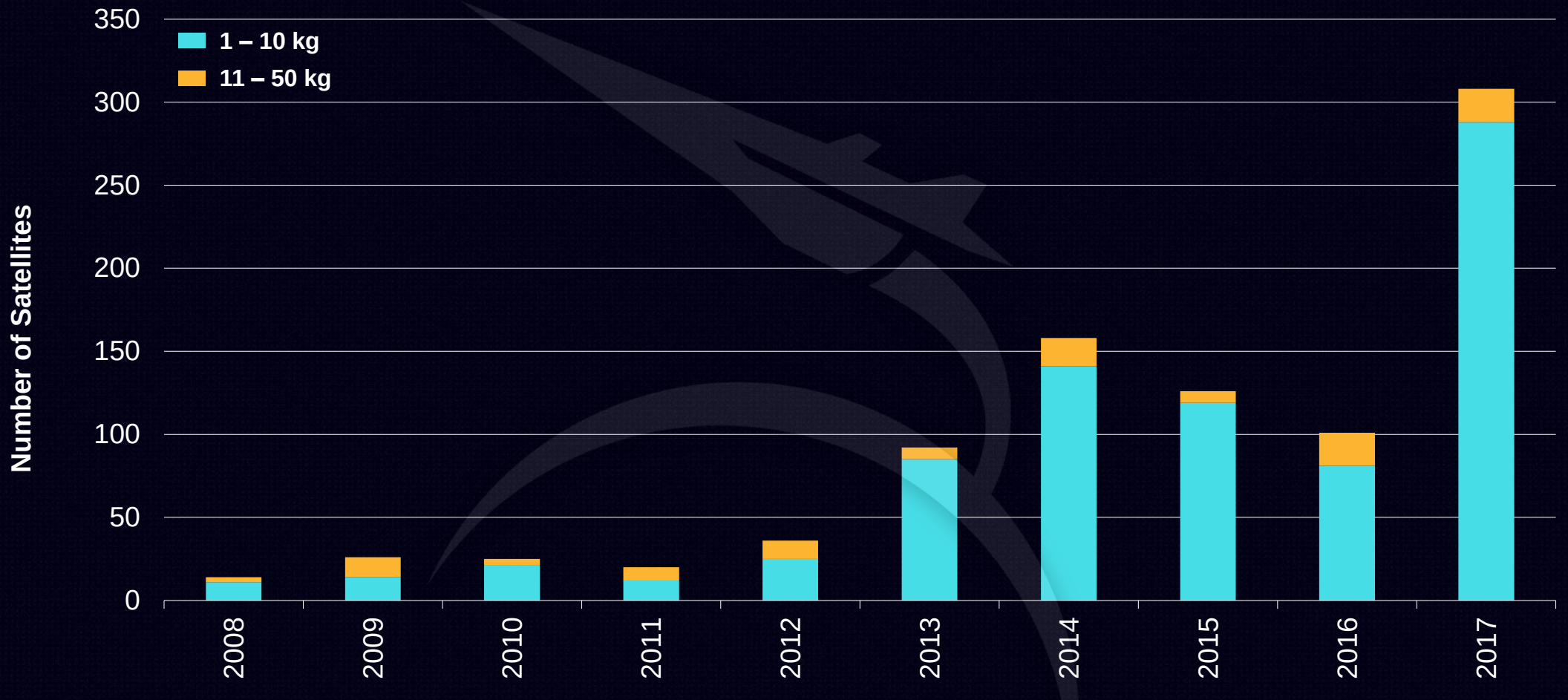
Nanosatellite Size Trends (1 - 10 kg)

Overall sizes in the nanosatellite market are increasing to accommodate demand for additional payload capabilities

The 3U form factor is still expected to remain the standard in the market over the next 5 years

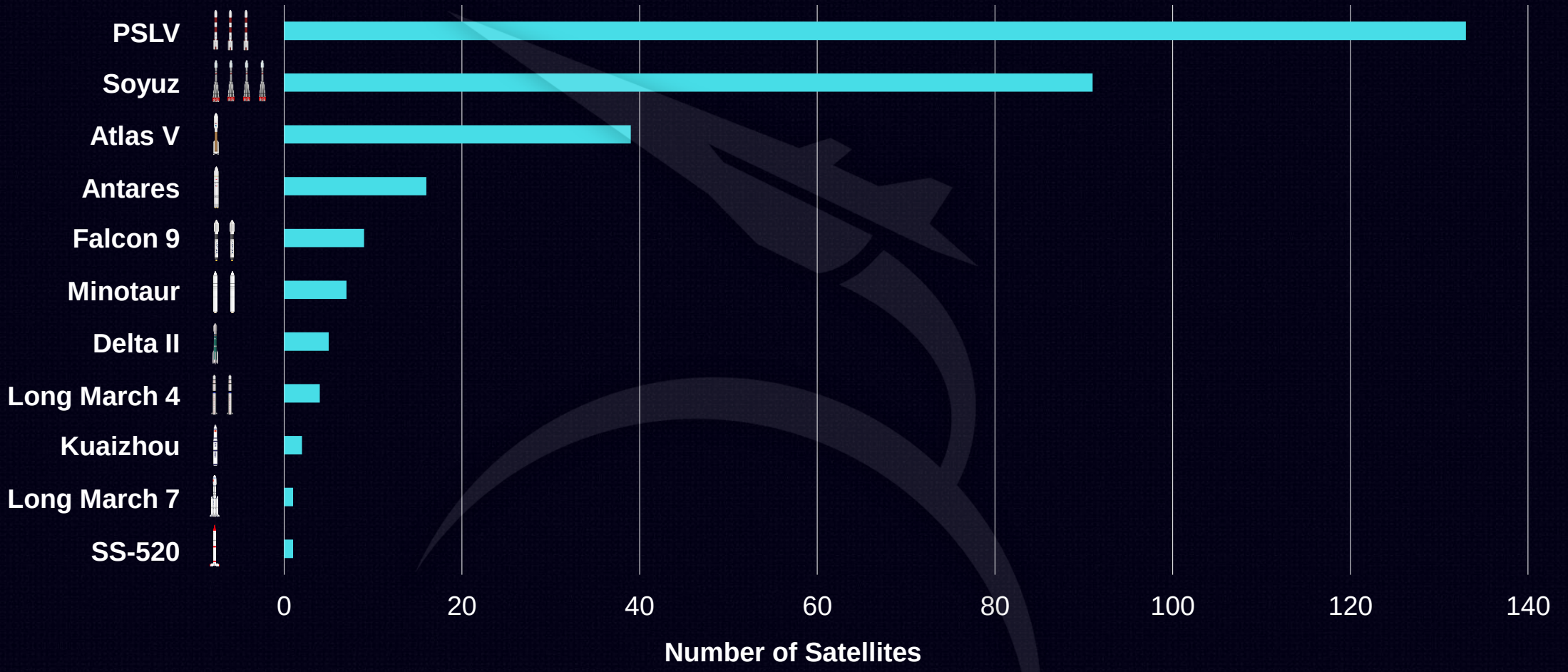


Historical Nano/Microsatellites Launched: 2008 - 2017 (1 - 50 kg)



The nanosatellite (1 – 10 kg) segment is still largely favored by operators, but the 11 – 50 kg and higher range is increasing in popularity

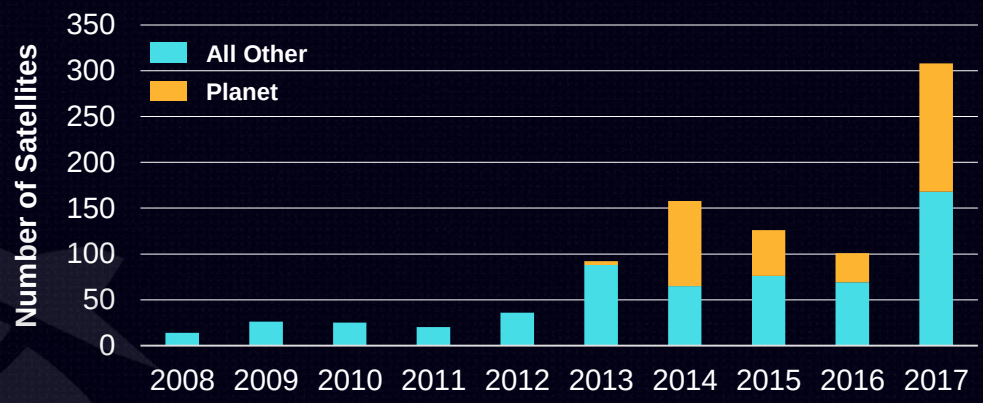
2017 Nano/Microsatellite Rides to Space

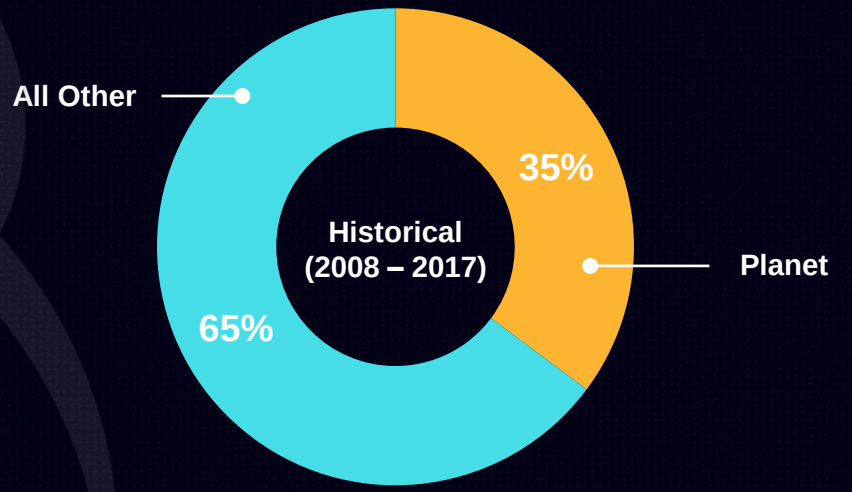


The PSLV is rapidly positioning itself as the go-to rideshare launch vehicle and delivered a record setting 104 satellites in a single launch this year

2018 Case Study #1: The Planet Effect

- Planet has launched **over 300 nano/microsatellites** since its inception in 2010
- The nano/microsatellite market shows **substantially less exponential growth when Planet is omitted**, highlighting just how much a single company can raise market expectations
- If Planet were to increase their satellite size outside the nano/microsatellite range, it would have a **dramatic impact on expected market growth** in the 1 – 50 kg segment





As Planet's constellation reaches sustainment phase, it will be up to new operators to fuel the projected exponential growth in the market

2018 Case Study #2: Small Satellite Launch Vehicle Leaderboard

Rank[1]		Name	Stated IOC	Payload to SSO (kg)[2]	Target Launch Price[3]	Major Recent Milestone
1		**Electron**	2018	150	$33K/kg	Successful orbital launch and satellite deployment
2		**Kuaizhou 1A** ⬆	2017	250	$57K/kg	Successful orbital launch and satellite deployment
3		**LauncherOne**	2018	300	$40K/kg	Secured $1B investment from Saudi Arabia Public Investment Fund
4		**Small Satellite Launch Vehicle (SSLV)** ⬆	2019	700	$12K/kg	Development announced by Indian Space Research Organization
5	VECTOR	**Vector-R**	2018	28	$54K/kg	Successful suborbital flight demonstration
6	PLD SPACE	**Arion 2** ⬆	2021	83	$38K/kg	Secured $2.5M grant from the European Commission

Of the 25+ companies pursuing the development of new small satellite launch vehicles, only five are expected to fly customer payloads by 2020

[1] Rankings based on SpaceWorks' Launcher Maturity Index, a subjective assessment of launch vehicle operators based on a variety of factors – please see end notes [2] SSO payload normalized from available data when necessary [3] Estimated

2018 Case Study #3: Communications Constellations

- Communications constellations are expected to encompass over **20% of the nano / microsatellite market in the next 5 years**
- Much of the activity in this space is centered around serving the rapidly growing **Internet-of-things (IOT) / Machine-to-Machine (M2M)** market
- Communications operators are still in the **technology demonstration phase** and will need to **secure additional capital** to execute on their deployment plans

Name	Service Offering	Stated IOC	Satellites Launched
Sky & Space Global	Data/Voice	2017	3
Kepler Communications	Data Relay	2018	1
Hiber (Magnitude Space)	IOT/M2M	2017	0
Helios Wire	IOT/M2M	2018	0
Astrocast	IOT/M2M	2018	0
Blink Astro	IOT/M2M	2018	0
Fleet Space	IOT/M2M	2018	0
Myriota	IOT/M2M	2018	0

SpaceWorks estimates as many as 700 communications nano/microsatellites will require launch over the next 5 years

Image Credits: Sky & Space Global, Helios Wire, Astrocast, Fleet Space, Blink Astro, Kepler Communications, Hiber

2018 Nano/Microsatellite Market Forecast Conclusions

- SpaceWorks projects 2018 will be a strong year for nano/microsatellite launches, with **263 satellites expected to launch**, a 15% decrease from 2017, but an overall **increase of 160% from 2016**
- Projections for Full Market Potential indicate up to 2,600 nano/microsatellites will require launch over the next 5 years
- This year's forecast has been revised upwards from 2017 as analysts gained further confidence in the market due to an **increase in small satellite launch opportunities**, the **continued maturation of emerging small satellite operators**, and a **strong influx of venture capital** financing into the space sector
- Commercial **Earth observation and remote sensing** constellations are expected to make up **50% of the market** over the next 5 years; rapidly growing **communications constellations** are expected to account for an **additional 20% of the market**
- The future of the nano/microsatellite market will depend largely on the ability of operators to **secure capital** in the near term and **create sustainable customer relationships** in the long term

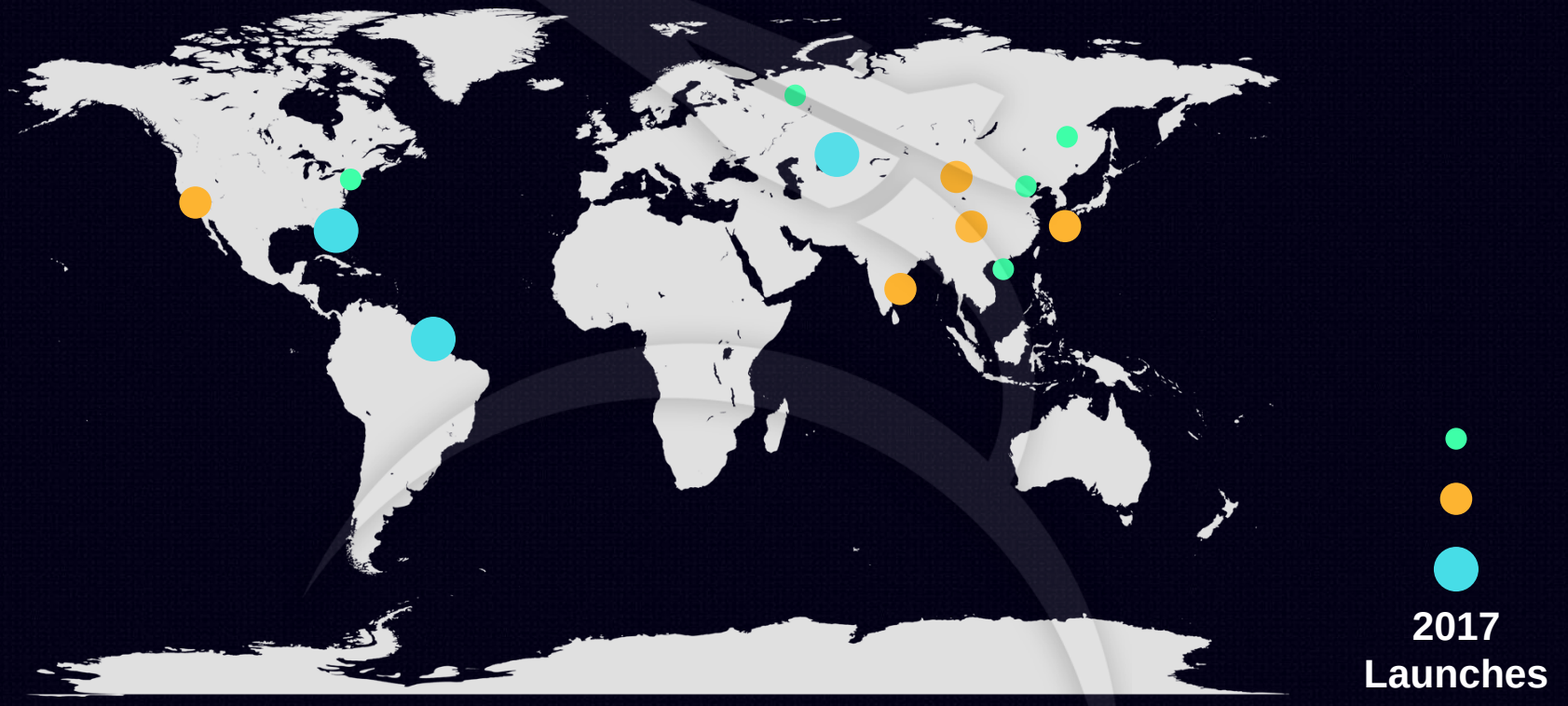
INSIDE LOOK!

SpaceWorks performs market research for clients across the space industry, from government agencies to satellite manufacturers.

This year, SpaceWorks is providing an exclusive INSIDE LOOK! at questions answered through other SpaceWorks market research.

INSIDE LOOK! Spaceports

SpaceWorks actively monitors spaceport usage across the globe



Cape Canaveral was 2017's top spaceport by number launches, but third by number satellites launched – how will the historic site fare in the future?

INSIDE LOOK! GEO Satellites

SpaceWorks actively tracks satellite manufacturing activity across all mass segments

2017's Most Popular GEO Satellite Bus[1]

Tie between BSS-702 and SSL-1300

As GEO satellite orders continue to fall, competition is heating up – who will claim the title for *Most Popular GEO Satellite Bus* in 2018 and beyond?

[1] Based on number of satellites launched in 2017 Image Credits: ViaSat, Space Systems Loral/SpaceWorks Studios

INSIDE LOOK! Mega Constellations

SpaceWorks actively monitors 100+ planned satellite constellations

Teledesic[1]
Announced: 1990

x 840+

700 kg[2]

OneWeb[1]
Announced: 2012

x 720+

125 kg[2]

SpaceX[1]
Announced: 2015

x 4425+

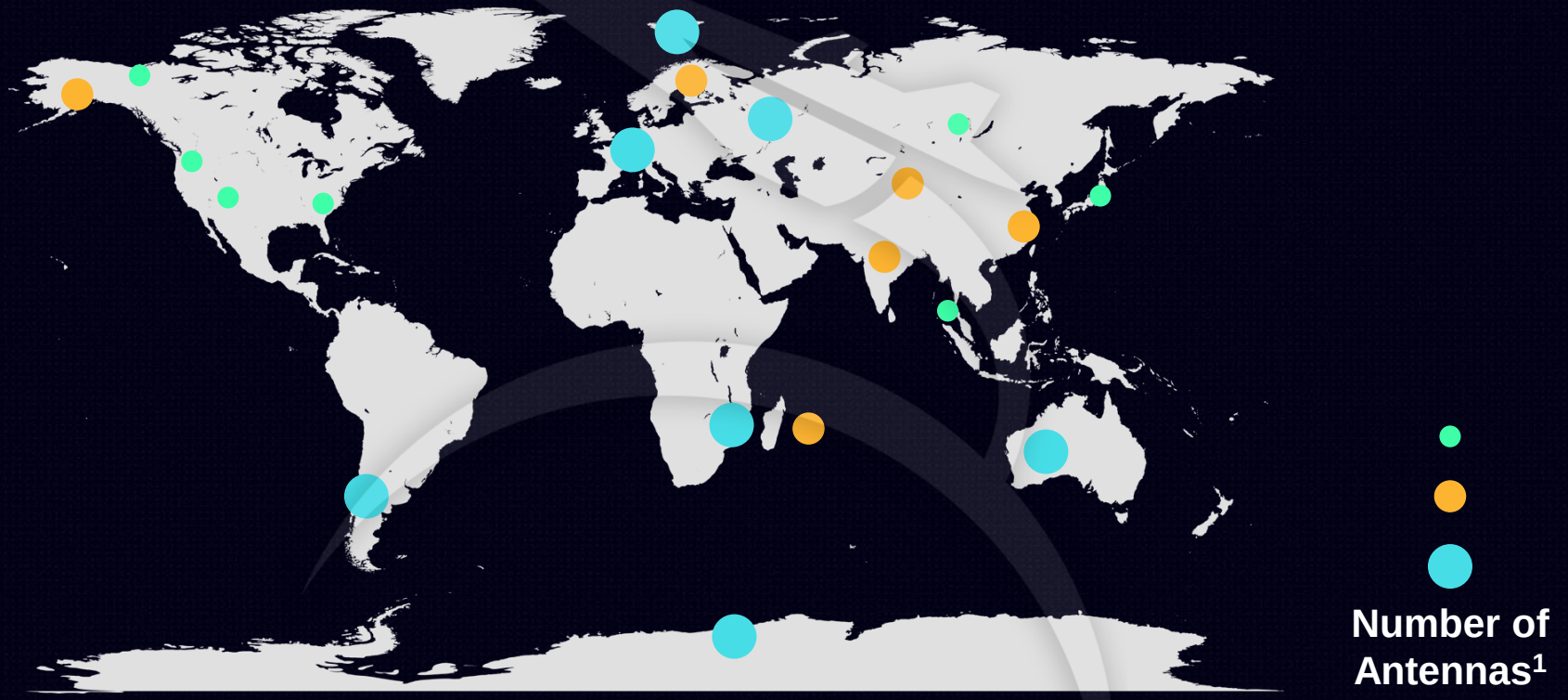
400 kg[2]

Emerging mega constellations are even more ambitious than their 90s counterparts – are they destined for success or headed for the same fate?

[1] Based initial announced constellation plans [2] Estimated

INSIDE LOOK! Ground Stations

SpaceWorks actively tracks private and commercially available ground stations



Traditional ground station usage around the world is increasing – will vertical integration and new business models disrupt their way of life?

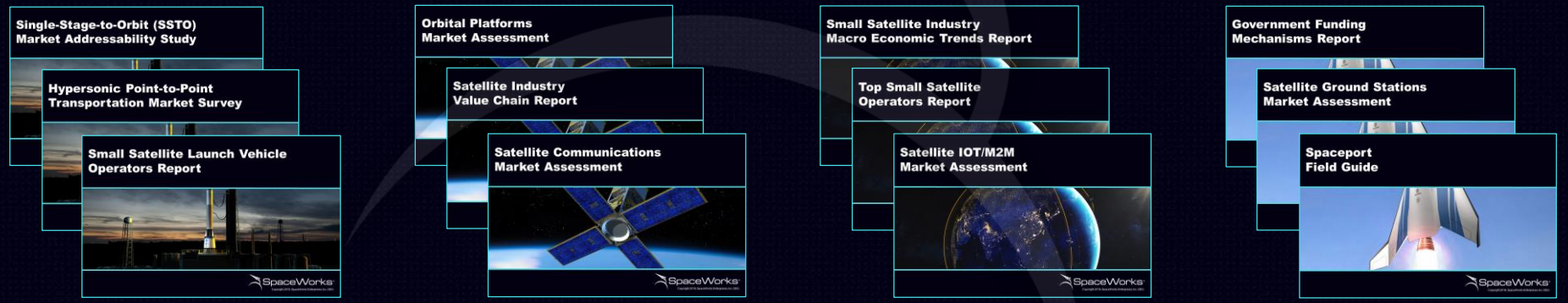
[1] Non-exhaustive list, only a subset of ground stations tracked in SpaceWorks Ground Station Database (GSDB) shown

SpaceWorks Market Forecasting & Competitive Intelligence Services

Since 2008, SpaceWorks has monitored global economic activity in the satellite and launch sectors and routinely completes custom market and competitive assessments for customers across the space industry.

Our Market Forecasting & Competitive Intelligence services provide valuable insights into the changing space market landscape, helping clients understand the competitive market forces at play and enabling them to make sound strategic investment decisions.

SpaceWorks is proud to have been the trusted partner for space industry market research for nearly 10 years. Prior custom SpaceWorks Market Forecasting and Competitive Intelligence reports include:



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End Notes

1. The number of satellites may not equal the number of launches since many small satellites are multiple-manifested (i.e., more than one satellite co-manifested on a particular launch vehicle). Historical data includes failed launch attempts.
2. The data used throughout this presentation (both historical and future) may not represent all global nano/microsatellites
3. The SpaceWorks Forecast and Full Market Potential datasets include some known nano/microsatellite programs for which a specific launch date has not been announced. The satellites belonging to these programs are distributed across the period (date range) for launches according to the announced program objectives and expected launch schedule.
4. Future projects are determined by Gompertz curve “best fit” regression with a set market saturation point based on expected customers demand.
5. The Full Market Potential dataset contains all currently known past and future nano/microsatellites from the SpaceWorks LDDB, with the addition of inflating factor for known unknowns plus assumed sustainment of certain projects and programs and the continued emergence and growth of numerous existing commercial companies. The SpaceWorks Forecast dataset reflects SpaceWorks’ expert value judgement on the likely market outcome.
6. Graphs are based on the SpaceWorks Forecast dataset only, and do not include the additional satellites contained in the Full Market Potential dataset
7. Nanosatellites are binned by rounding mass to the nearest whole number. Picosatellites less than 1 kg are not included
8. SpaceWorks’ Launcher Maturity Index is a qualitative assessment of Small Satellite Launch Vehicle operators based on a number of factors, including historical performance, funding and licensing status, team composition and completeness, operator potential to capture global market share, and SpaceWorks’ overall expert judgement of the operator’s credibility for executing their launch plans within their stated IOC targets.
9. SpaceWorks’ Ground Station Database includes 200+ entries of historical and planned ground stations, not all of which are presented within this report
10. SpaceWorks wishes to attribute image credits for images not cited inline to the following entities: Planet Labs, Astrocast, Capella Space, Aerial & Maritime Ltd., Satellogic, HawkEye360, Spire Global, SpaceQuest, Astro Digital, OneWeb, EarthI, Iceye, Axelspace, SpaceX, Iridium, Urthecast, SpaceBelt, Globalstar, AMOS, SES, ABS, Intelsat, Echostar, ArabSat, Hispasat, ViaSat, Turksat, Inmarsat, Digital Globe, RocketLabs, China Great Wall Industries, Virgin Orbit, Indian Space Research Organization, Vector Space Systems, and PLD Space