Nano/Microsatellite Market Assessment

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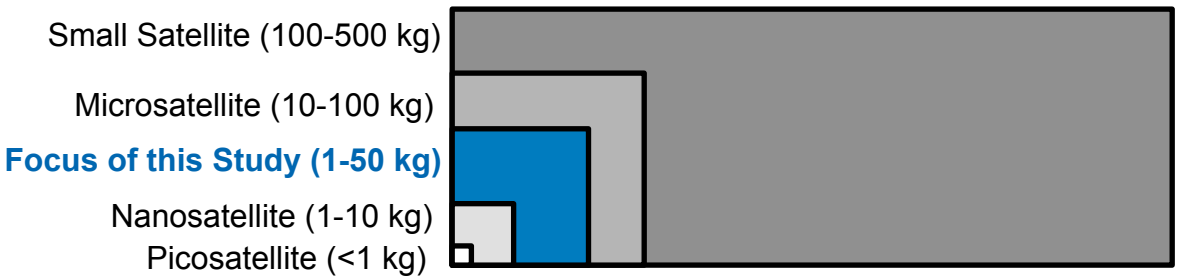
Overview

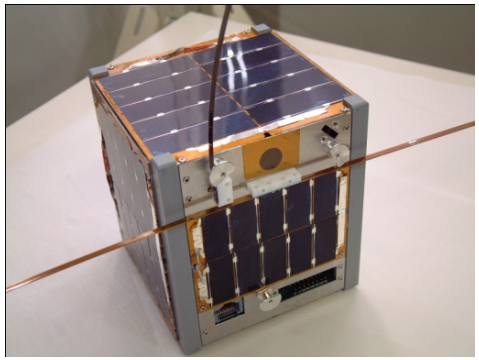
- SpaceWorks presents the February 2013 update to its nano/microsatellite market analysis and launch projections
- The data source for this study is the **SpaceWorks Satellite Launch Demand Database (LDDB)**
  - The LDDB is a database of all known historical and future satellite projects, including all known nano/microsatellites
  - Currently 377 known future nano/microsatellites (1-50 kg) in the LDDB
  - Currently 47 known future picosatellites in the LDDB(not included in this study)
- This study focuses on nano/microsatellites with masses between 1 kg and 50 kg
  - Pico satellites with masses below 1 kg are not within the scope of this study
- SpaceWorks has projected global launch demand in the nano/microsatellite market according to a Gompertz logistic curve from 2013 to the year 2020
  - Note this is not a "forecast" in that SpaceWorks places no value judgment on whether developers will successfully meet their announced launch date or not
- Two projections were developed from "Announced" and "Optimistic" data sets
  - "Announced" data set contains all publicly announced nano/microsatellite projects and programs
  - "Optimistic" data set consists of the announced plus quantitative and qualitative adjustments to account for the expected sustainment of current projects and programs (e.g. follow-on to EDSN, CubeSat Launch Initiative, DARPA SeeMe)
- Projections indicate strong growth in nano/microsatellite launches, with **an estimated range of 121 to 188 nano/microsatellites (1-50 kg) that will need launches globally in 2020** (versus 33 in 2012)

Nano/Microsatellite Definitions

- Generally accepted definitions of satellite mass classes under 500 kg
  - Small (100-500kg), Micro (10-100 kg), Nano (1-10 kg), and Pico (<1 kg)
- Many nanosatellites are based on the "CubeSat" standard
  - Developed in by California Polytechnic State University and Stanford University in 1999
  - Consists of any number of 10 cm x 10 cm x 10 cm units
  - Each unit, or "U", usually has mass close to 1 kg and not to exceed 1.33 kg (e.g. a 3U CubeSat has mass between 3 and 4 kg)
  - Standard allows for ease of design and integration
- This study limits the upper end of microsatellite mass to 50 kg given the relative large amount of satellite development activity in the 1-50 kg range by comparison to the 50-100 kg range.

Visual Display of Small to Pico Satellite Scale

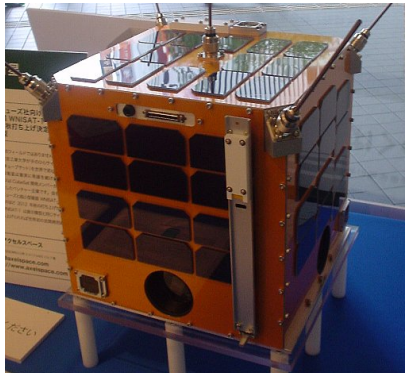




University of Tokyo's XI-IV CubeSat

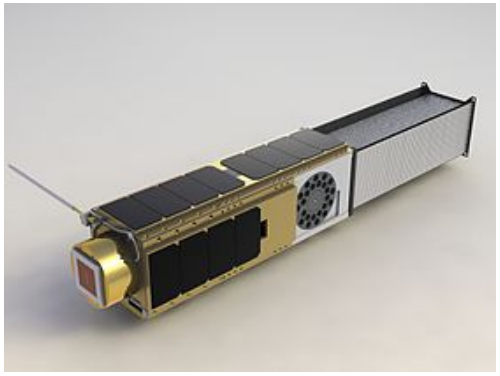
Nano/Micro Satellite Applications and Associated Examples

Communications
HAMSAT
Mass: 46 kg

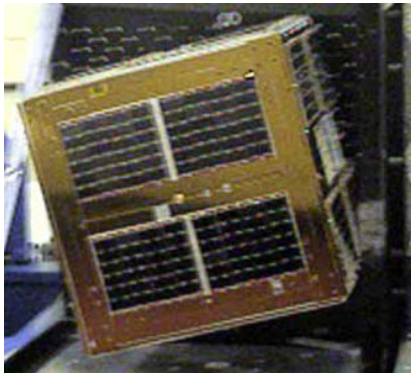


Remote Sensing
WNISAT
Mass: 10 kg

Scientific Research
UNISAT
Mass: 1.5 kg

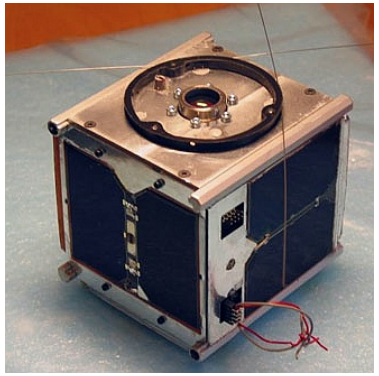


Biological Experiments
O/OREOS
Mass: 5.5 kg



Technology Demonstration
FalconSat 1
Mass: 50 kg

Military Application
SMDC-One
Mass: 4 kg

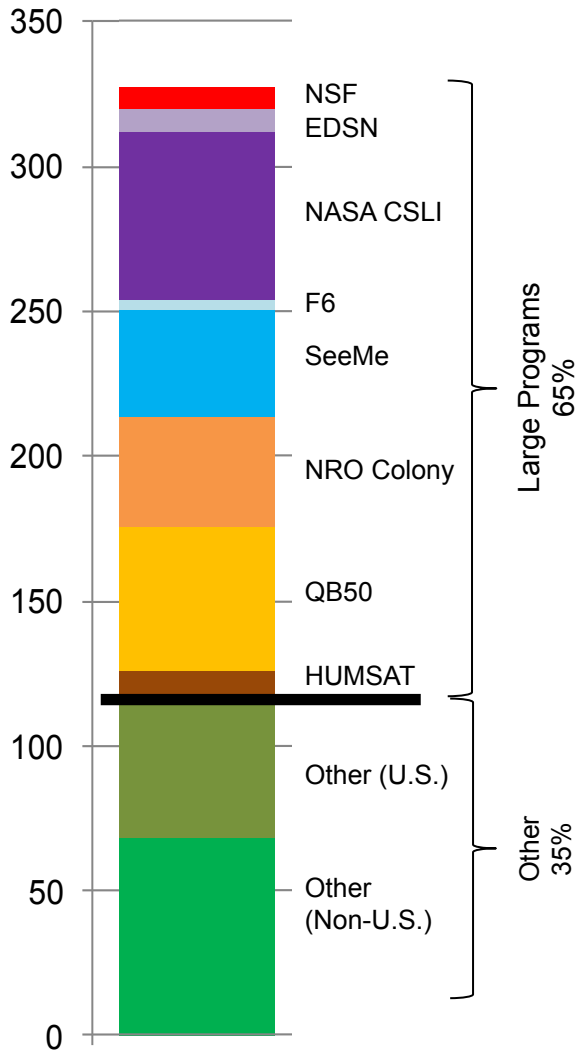


Academic Training
AAUSAT 2
Mass: 1 kg

Nano/Microsatellite Future Program Summary (1-50 kg)

Name of Program	Time	Organization	Country	Mass (kg)	No. Launched	Total Number
NSF Geospace & Atmospheric CubeSat	2010-2015	NSF	USA	1-3	4	12
NASA EDSN	2013-2014	NASA Ames Research Center	USA	3	0	20
NASA CubeSat Launch Initiative	2011-2014	NASA	USA	1-8	13	71
F6	2015	DARPA	USA	45	0	4
SeeMe and ALASA payloads	2014 -2015	DARPA	USA	45	0	36
NRO Colony I & II	2010-2016	NRO	USA	3-5	4	62
QB50	2015	Von Karman Institute / Various	Various	2	0	50
HUMSAT	2013 - 2014	University of Vigo / Various	Various	1	0	10

Large Program Breakdown for Announced Future Launches

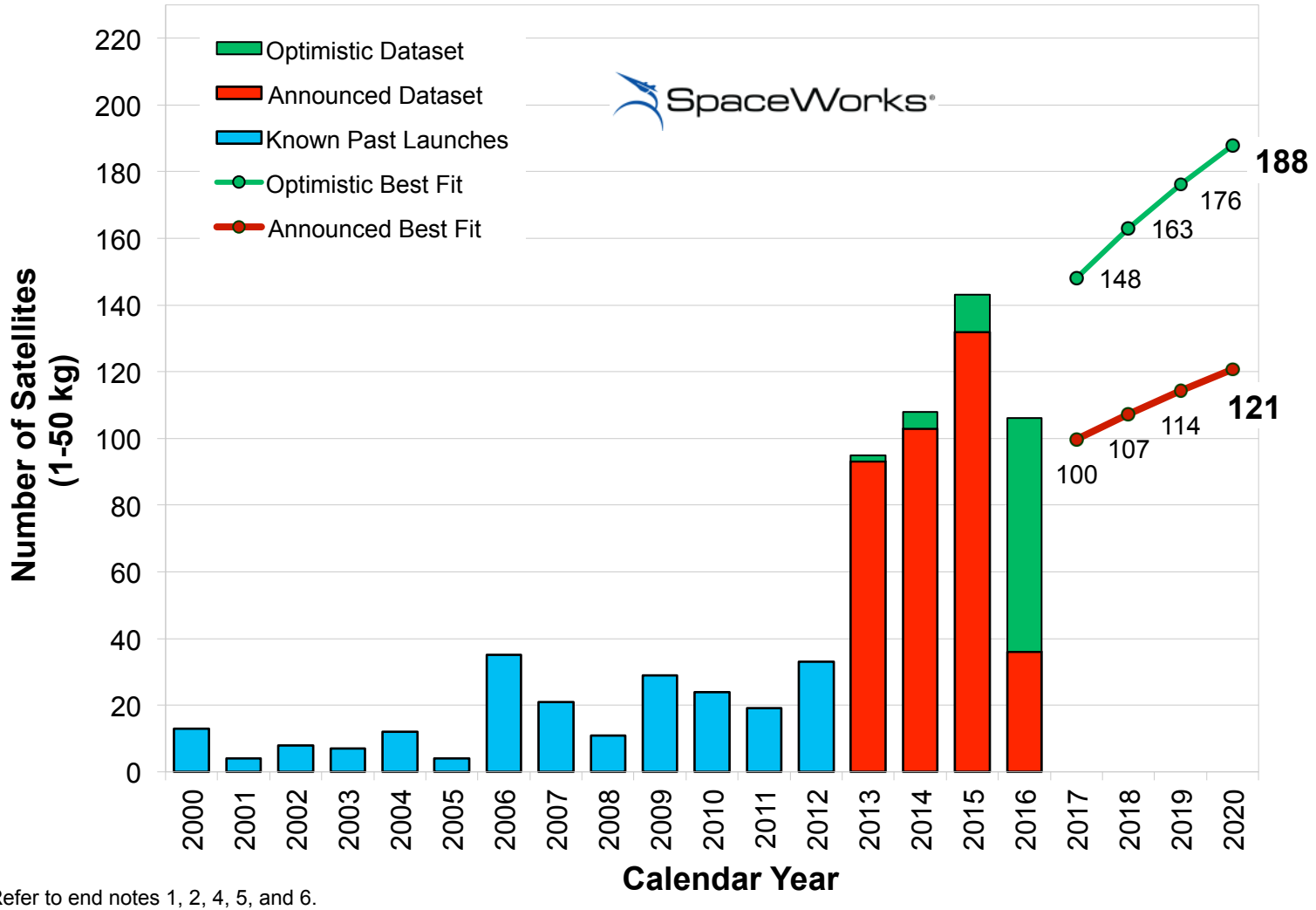


Announced Future Launches 2013-2015

Notes: Refer to end notes 1, 2, and 3.

Nano/Microsatellite Launch History and Projections

Projections based on the announced plans of nano/microsatellite developers and programs indicate a range of 121 to 188 nano/microsatellites requiring launch by 2020

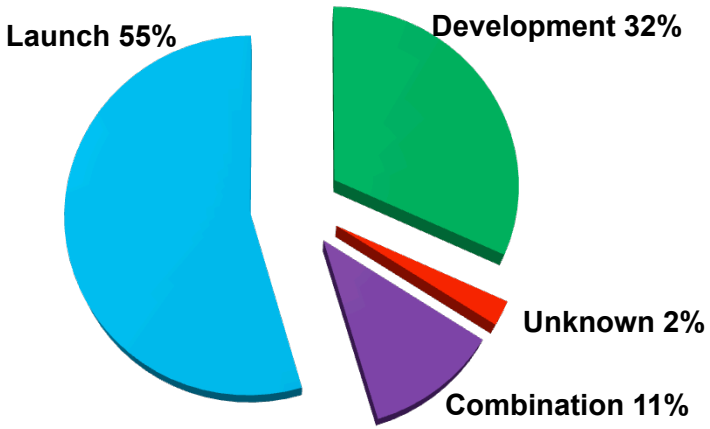


Notes: Refer to end notes 1, 2, 4, 5, and 6.

Nano/Microsatellite Launch Delays: 2012 Case Study

Launch delays/challenges were the leading cause for delay of launches in 2012

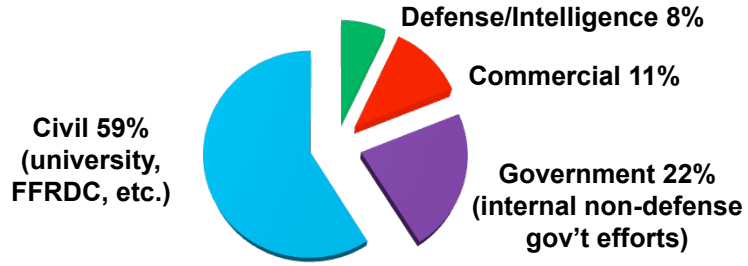
- Fewer satellites are expected to actually launch than the number projected in future years
  - Projections are based on the announced plans of nano/microsatellite developers, but delays often occur
- SpaceWorks previously released nano/microsatellite projections in November of 2011
  - Number of satellites (1-50 kg) planning launch in 2012 according to November 2011 Announced Dataset: 58
  - Number of satellites (1-50 kg) actually launched in 2012: 35
- Identified reasons for delay in anticipated launch date of nano/microsatellites include the following:
  - **Launch:** A slip in schedule of the launch vehicle, delay in schedule of the primary payload, delay in development of the launch vehicle, inability of the satellite developer to identify or contract with a suitable launch provider
  - **Development:** Satellite development technical or management challenges, delays in funding, delays due to suppliers, testing and qualification challenges, delays in government approvals (e.g. ITAR)
  - **Combination:** Both launch and satellite development delays occurred
  - **Unknown:** The reason for delay cannot be readily determined
- None of the nano/microsatellite projects from the announced dataset anticipating launch in 2012 were cancelled or ended

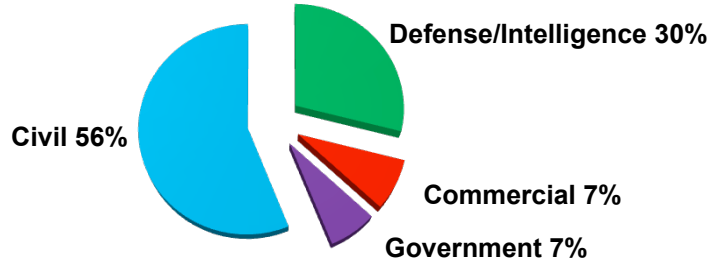


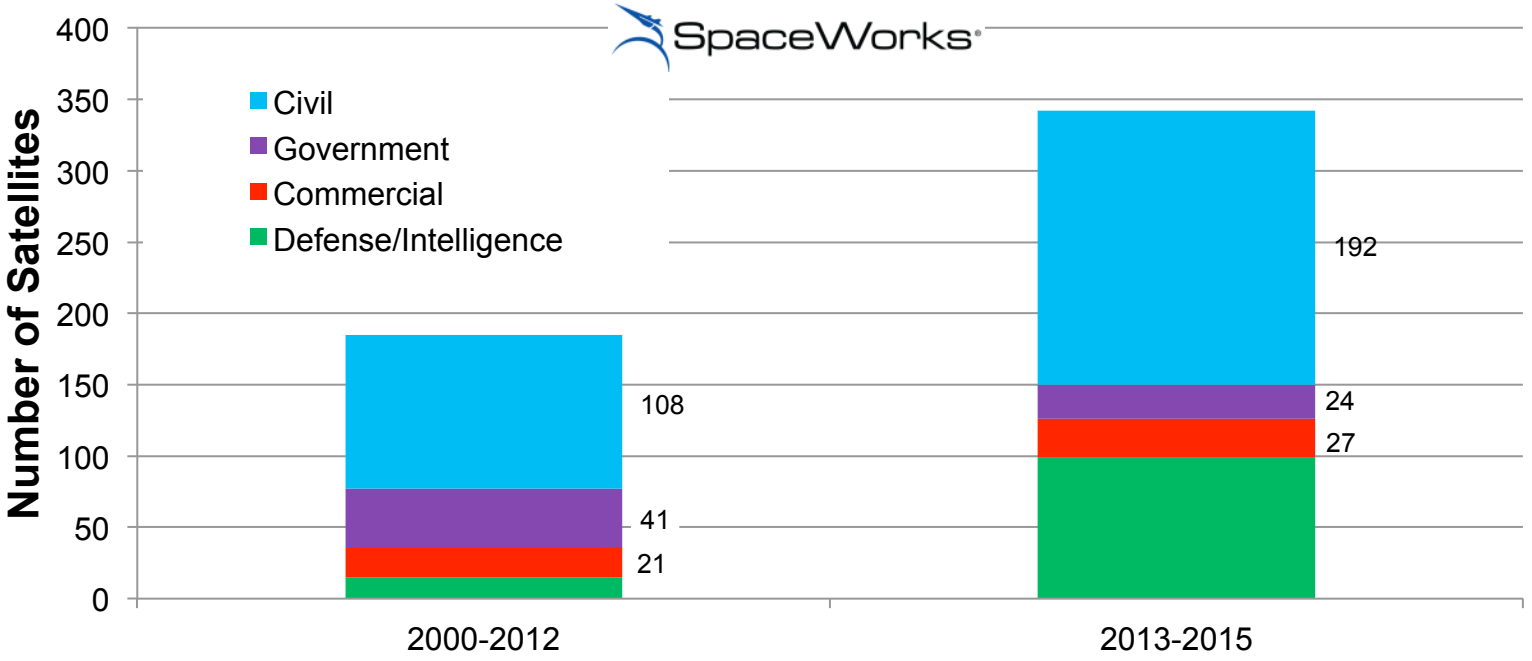
Reasons for Delay in Anticipated 2012 Launch Date of November 2011 Announced Dataset

Nano/Microsatellite Trends by Sector

Evidence of increased defense/intelligence sector interest in nano/microsatellites







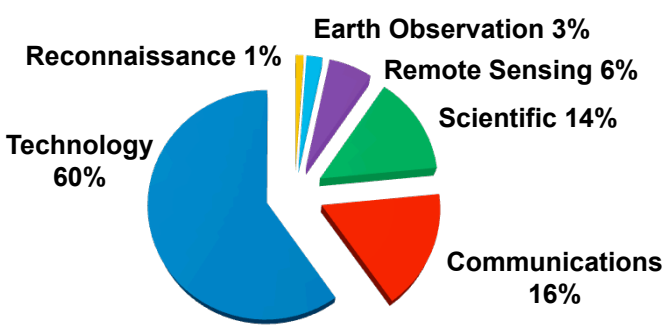
Past (2000-2012) Small Satellites (1-50 kg) by Industrial Sector

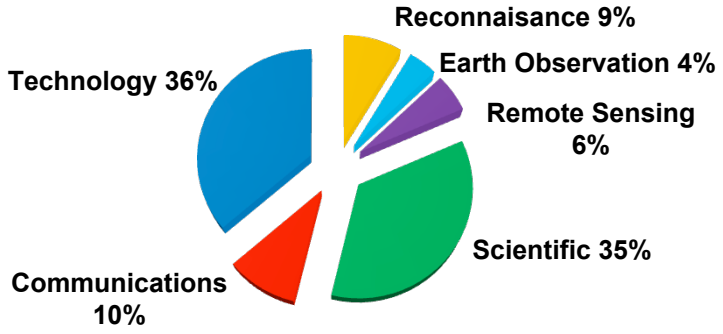
Announced Future (2013-2015) Small Satellites (1-50 kg) by Industrial Sector

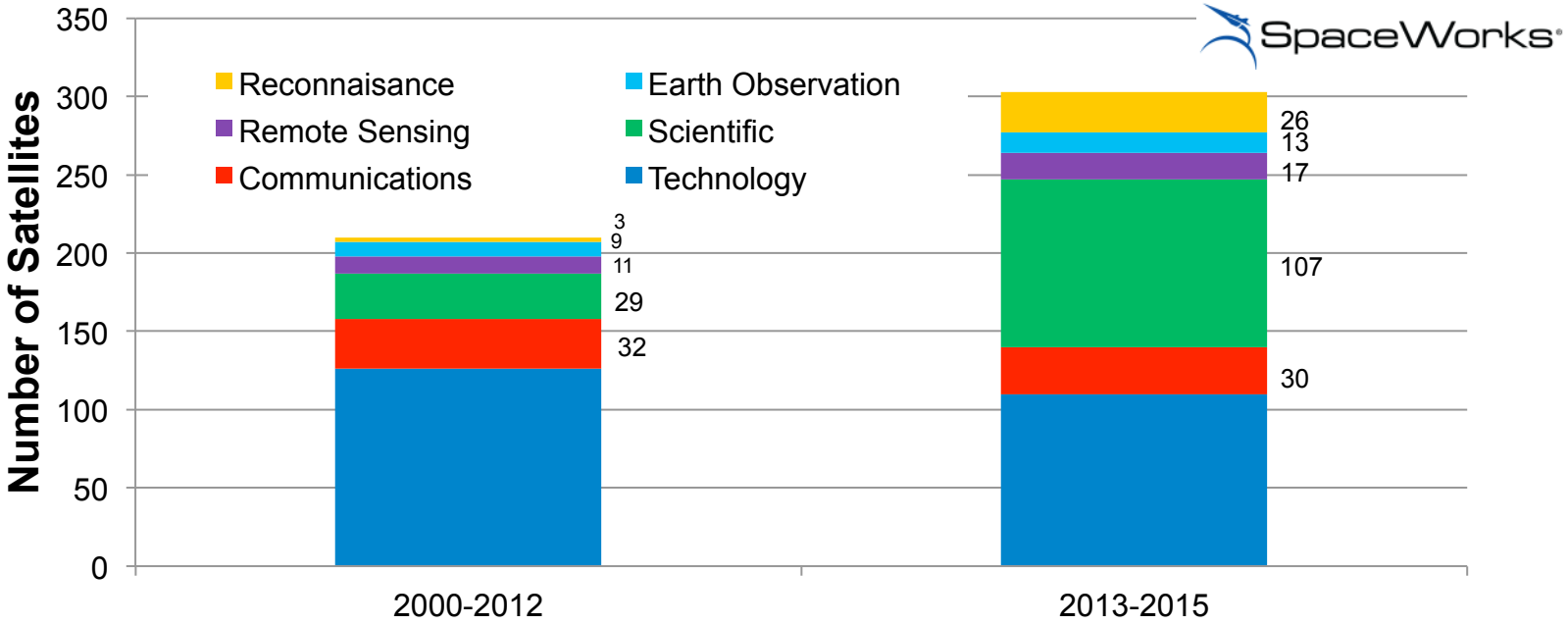
Notes: Refer to end notes 1, 2, 7, 8, 9, and 10.

Nano/Microsatellite Trends by Purpose

Evidence of adoption of small satellites for applications beyond technology demonstration







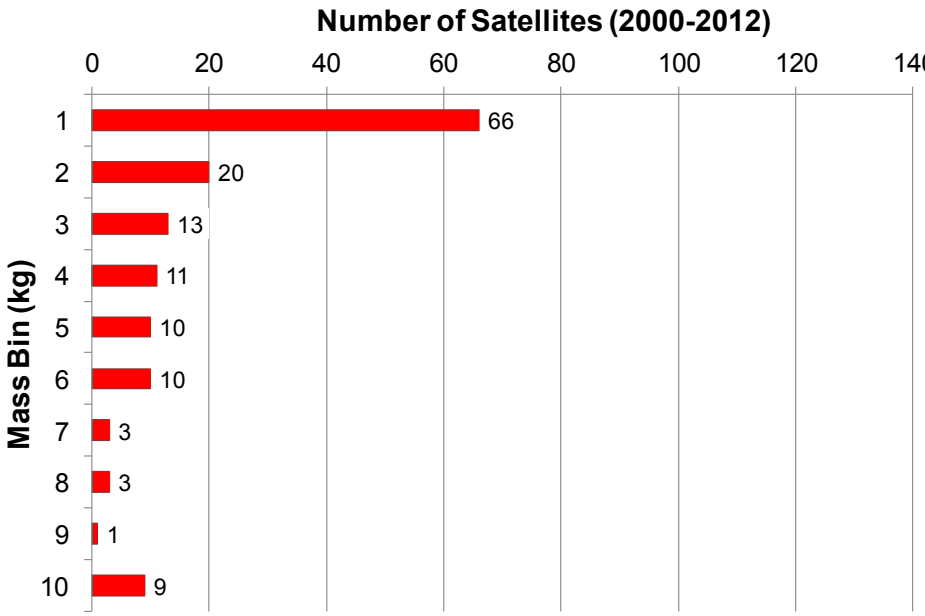
Past (2000-2012) Small Satellites (1-50 kg) by Purpose

Announced Future (2013-2015) Small Satellites (1-50 kg) by Purpose

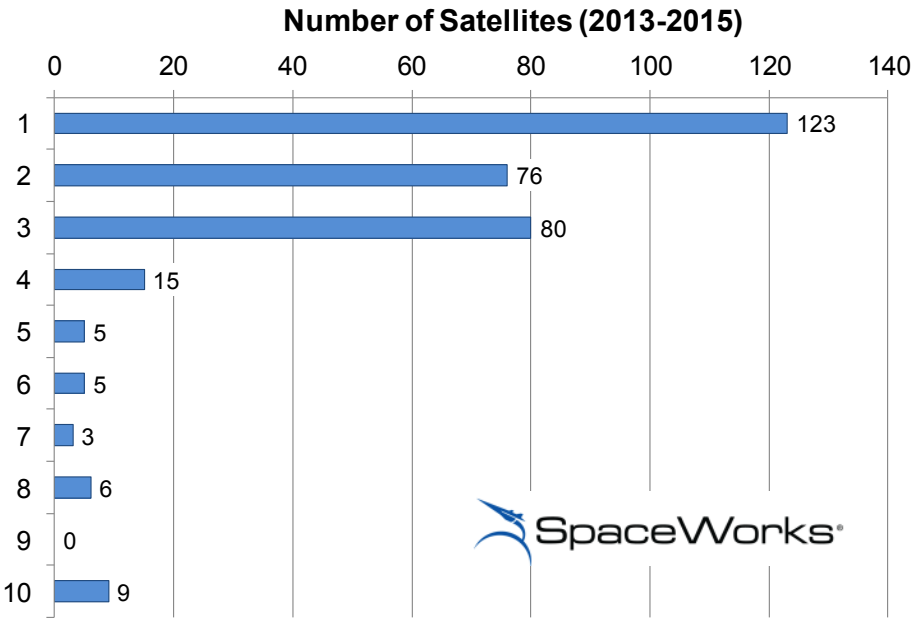
Notes: Refer to end notes 1, 2, 7, 8, and 9.

Nanosatellite Size Trends

Announced future nanosatellites suggest sustainment of the historically popular 1U (1 kg) CubeSat as well as the emerging 2U and 3U nanosatellites



Past (2000-2012) Nanosatellites (1-10 kg)

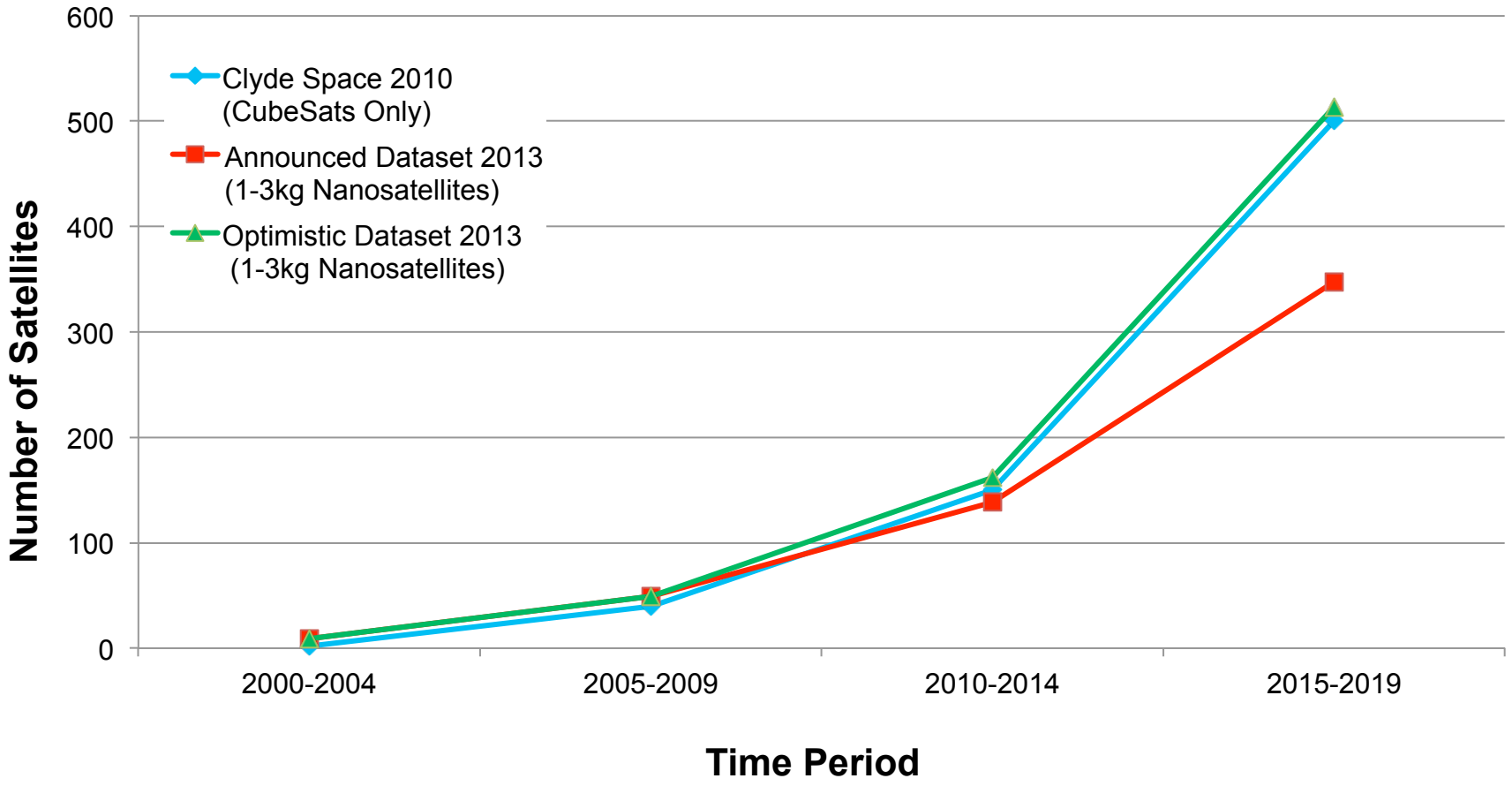


Announced Future (2013-2015) Nanosatellites (1-10 kg)

Future growth of 6U (8 kg) class is speculated based on current dispenser development efforts and anecdotal evidence

Notes: Refer to end notes 1, 2, 7, 8, and 11.

Projections for Small Nanosatellites (1-3 kg)

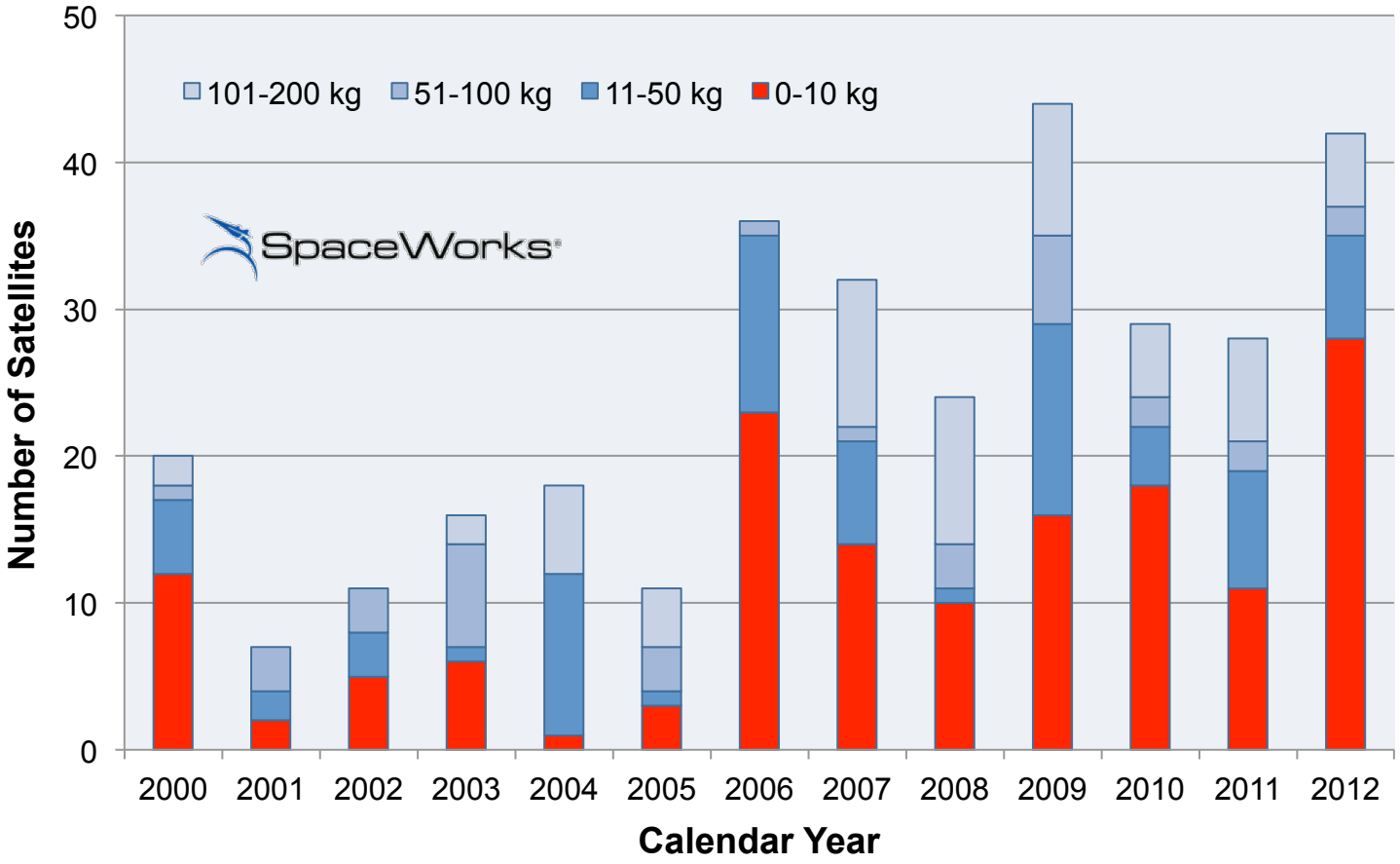


SpaceWorks Nanosatellite Projections (1-3 kg)
Compared with Clyde Space 2010 Forecast

Notes: Refer to end notes 1, 2, and 12.

Historical Global Small Satellites Launched: 2000-2012

Signs of an emerging and sustained launch market

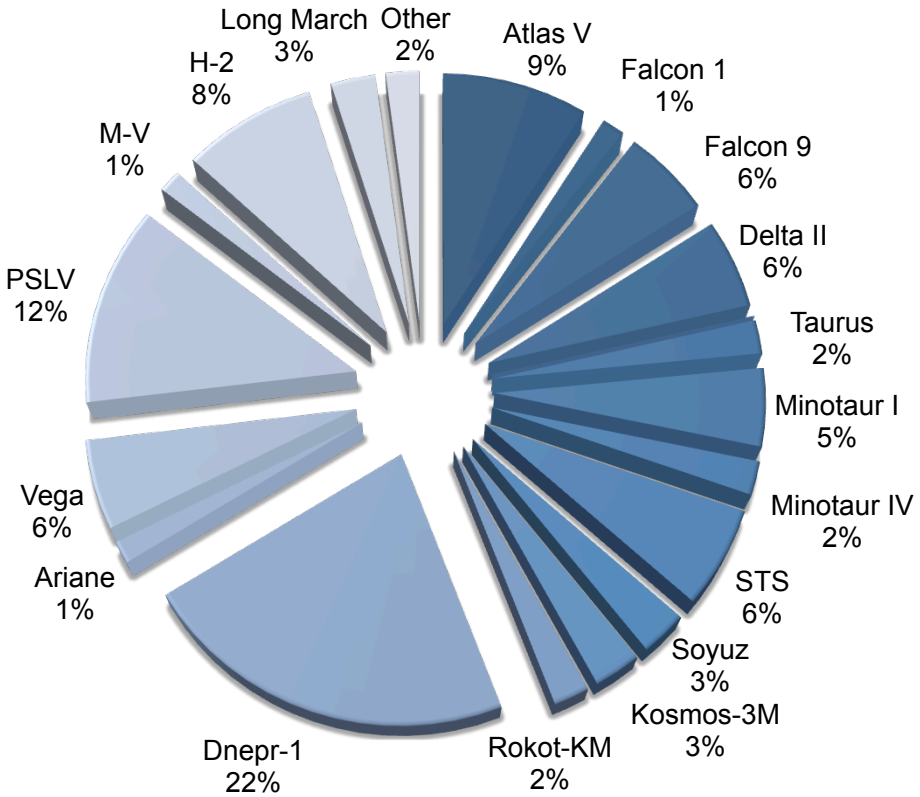


Number of Attempted Small Satellite Deliveries: 2000-2012 for 0-200 kg Satellite Class (Includes Picosatellites < 1 kg)

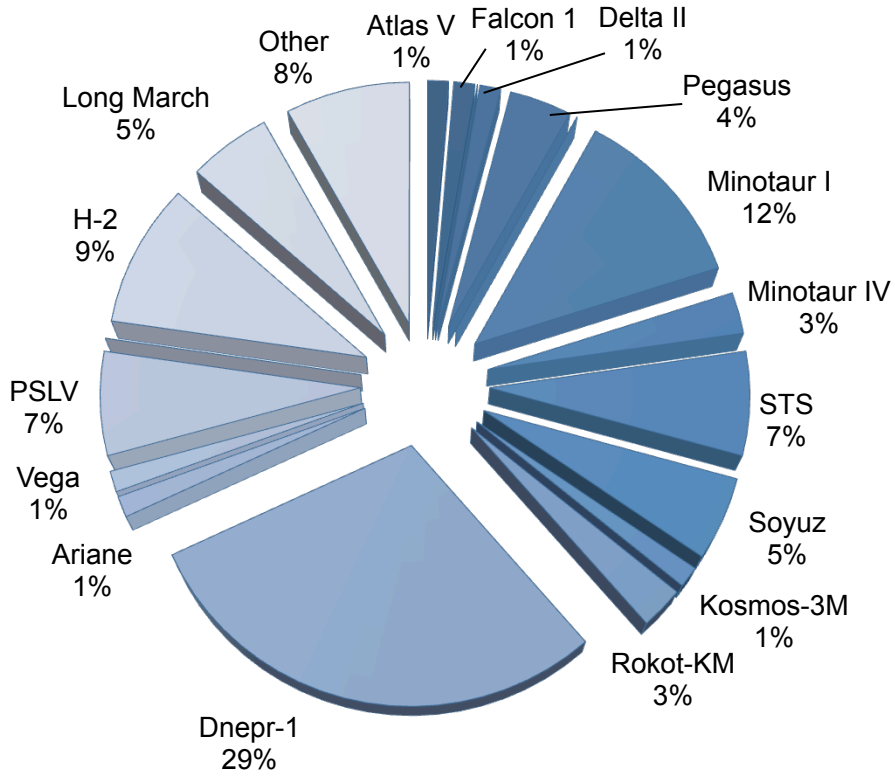
Notes: Refer to end notes 1 and 2.

Historical Nano/Microsatellite Trends by Launch Vehicle (2000-2012)

Low cost piggy-back opportunities have historically attracted small satellite payloads to international launch vehicles



Launch Vehicles: 2000-2012 for 1-10 kg Satellite Class (As a Percentage of Global Satellites Launched)



Launch Vehicles: 2000-2012 for 11-50 kg Satellite Class (As a Percentage of Global Satellites Launched)

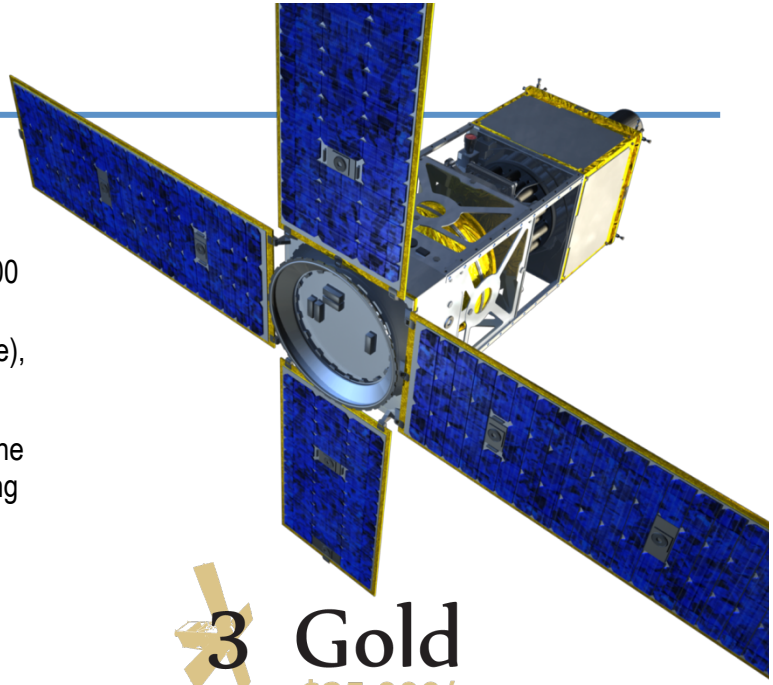
Notes: Refer to end notes 1, 2, 8, and 9.

Conclusions

Custom analysis and more detailed assessment are available from SpaceWorks for nano/microsatellites and larger satellite classes

- The nano/microsatellite market has grown considerably with the adoption of the CubeSat standard, microelectronics and other technology development, entrance of new developers, new government programs, and furthering of applications
- Projections based on announced plans of developers indicate **121-188 nano/microsatellites requiring launch in the year 2020**
- Nano/Microsatellite CAGR (Compound Annual Growth Rate):
  - **Historical average growth of 8.6% per year** over the last 12 years (2000-2012)
  - **Announced Dataset average growth of 16.8% per year** over the next 7 years (2013-2020)
  - Optimistic Dataset average growth of 23.4% per year over the next 7 years (2012-2020)
- Historical and announced future data set suggests that the **average number of nano/microsatellites launched per year triples with every five year period** (2001-2005, 2006-2010, 2011-2015)
- Nano/microsatellite (1-50 kg) development continues to be led by the civil sector, but the defense/intelligence community is showing increased interest and involvement
- Applications for nano/microsatellites are diversifying, with increased use in the future for science, Earth observation, and reconnaissance missions

Satellite Launch Demand Database



SpaceWorks Enterprises, Inc. (SEI) maintains an internal database of past and future orbital satellites with emphasis on small satellite launch demand. The database is compiled from public sources and serves as the basis for SEI's annual Nano and Micro-satellite Market Assessment summary. The database contains all satellites launched since 2000 and over 900 announced future spacecraft development efforts. Data fields within the database include satellite mass, orbital destination, expected launch date, preferred launch vehicle (if available), intended use category, development organization, and country of origin.

Customers desiring 24/7 access to the most current database and the ability to manipulate the data for their own purposes may purchase annual access subscriptions in one of the following three tiers:

1 Bronze
$5,000/year

Access to a subset of the data in the standard 1 kg to 50 kg mass range via our iDashboards interface. Permission to use the resultant search results and demand graphs internal to the customer's organization only.

2 Silver
$10,000/year

Access to a broader range of spacecraft launch demand data in the 0 kg to 1,000 kg mass range via our iDashboards interface. Permission to re-publish the resultant search results and demand graphs with proper acknowledgment to SpaceWorks (for proposals, technical papers, website use, etc.). In addition, SpaceWorks will provide up to 10 labor hours annually for technical support and limited market analysis.

3 Gold
$25,000/year

Access to the full SpaceWorks dataset (0 kg to 10,000+ kg) via our iDashboards interface. Permission to re-publish the resultant search results and graphs with proper acknowledgment to SpaceWorks. Up to 100 labor hours annually of technical support, proprietary market analysis assistance, and proprietary drill-down market research from SpaceWorks' staff.

For additional information on our standard subscription tiers, or to request a quote for our custom support packages and market forecasting services, please contact:

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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). Data includes failed launch attempts.
2. All data for nano/microsatellite projects and programs is from publically sourced information. This may not represent all global nano/microsatellite activities.
3. All NSF satellites thus far have launched through the NASA CSLI. In the table, these historical NSF satellites are included in both the count of number launched for NSF and the count for CSLI (double counted in this sense). The bar graph of future launches shows only those NSF satellites that expected, but currently not manifested (thus they are appropriately single counted for future launches).
4. The Announced data set includes 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
5. Future projections from 2016-2020 are determined by Gompertz logistic curve “best fit” regression with market saturation point (asymptote for number of satellites) set at 170 nano/micro satellites in a year for Announced Dataset and 250 for Optimistic Dataset.
6. The Optimistic data set contains all currently known past and future nano/microsatellites from the SpaceWorks LDDB, with the addition of an inflating factor for known unknowns plus assumed sustainment of certain current projects and programs (e.g. follow-on to NASA Ames EDSN, CubeSat Launch Initiative, DARPA SeeMe).
7. These graphs are based on the Announced data set only, and do not include additional satellites contained in the Optimistic data set.
8. The sum number of future nano/microsatellites shown in this chart may not equal the sum shown on other charts. Nano/microsatellites for which the subject data of interest is unknown have been excluded from this chart.
9. Percentages may not sum to 100% due to rounding.
10. By some traditional definitions of space industrial sectors, non-defense government space activities are a subsector of the civil sector. Here we break out non-defense government activities into a separate sector. “Government” refers to those nano/microsatellite development efforts that occur within/by the government agency or organization (e.g. NASA, JAXA). Civil refers to all other non-defense development activities (e.g. universities, federally funded research institutions), though the funding source may be a government agency.
11. Nanosatellites are binned by rounding mass to the nearest whole number. Picosatellites less than 1 kg are not included.
12. 70 percent of future satellites in the Announced Dataset are under 3kg. This percentage is applied to the projections for 2012-2019 to arrive at the estimated number of satellites under 3 kg for each data point in the projection.

SPACE IS GO

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