United Nation-South Africa Symposium on Basic Space Science Technology

Panel Discussion

on

Fostering Cost effective and need-driven Space program in Africa towards reduction in satellite mission cost

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UNITED NATIONS

Content

1. **Small satellite as a driver for the advancement of satellite missions** for societal benefits and scientific experiments

2. **The Lean Satellite project model** (low cost, minimum development time and fast delivery)

a. Switching from the traditional satellite development approach lean satellite development.

3. **Spotlight on Joint Inter-University Space Programs**

Using Collaborative satellite projects in the African region for effective and low cost satellite missions.

4. **Availability and accessibility of satellite Assembly, Integration and Testing facilities** in the African region.

5. **Low cost of small launchers** as a tool for reducing satellite mission cost

The UN Basic Space Technology Initiative (BSTI) Goal & Objective…

Enhancing access to space application tools for ***Capacity Building*** for sustainable space program

By;

- *Exploring* **small (nano-) satellites** *technology for education, technology transfer, basic space science and for operational applications.*
- *Promoting international cooperation exchange for basic space technology*

Satellite Size Definition

http://deepspaceindustries.com/think-small/

Principles In Reducing Space Mission Cost

Mission

-**Flying at Lower Orbit** such as LEO instead of GEO for earth coverage. Lower altitude helps lower the mass and cost of spacecraft missions.

-**Making use of service-provided systems:** Using already existing ground segment reduces mission operational cost for better coverage

-**Short mission life design** reduces mission redundancy, complexity and cost

Traditional Satellite Development Program

Traditional Satellite Technology:

The major philosophical approach for space exploration and applications since the space age

They involve:

-Large Size, Complex & Fewer Missions,

High Cost with Large Budget,

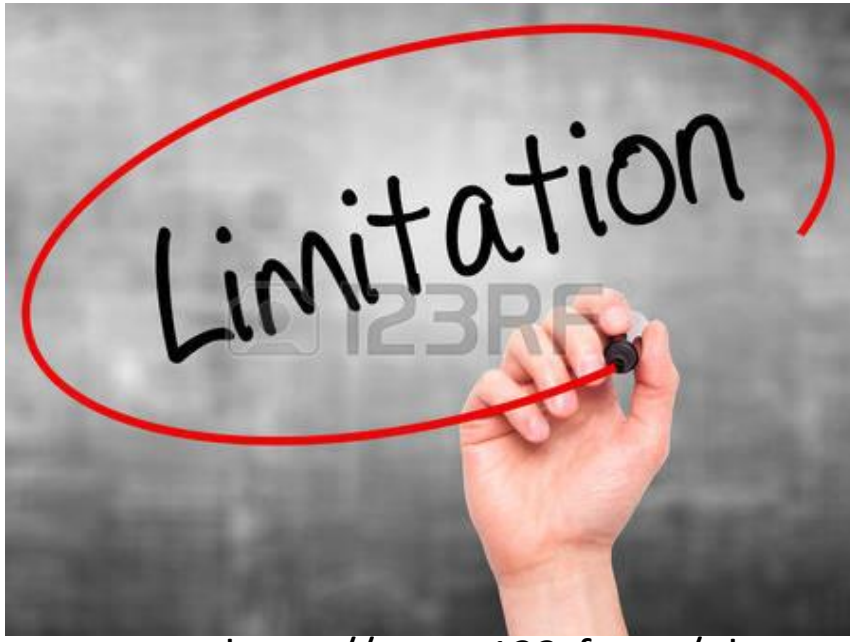
-Longer Development Schedule

Intelsat 34

http://spaceref.biz/company/intelsat-34-satellite-fuelled-for-arianespaces-august-20-ariane-5-launch.html

Limitations of Traditional Satellite Program

- It prevent new scientific technology into space
- Reduce frequency of large satellite projects due to long period of development time
- Economically not a suitable venture for developing and non space faring nations.
- Limits space education and technology transfer
- Allows only few countries “Americans, Russians, Europeans etc.” to venture into space exploration and to benefit from its applications



https://www.123rf.com/photo

Small Satellite Development Program and benefits

- Advance space science, technology and research
- Provide hands on training opportunities for students and space enthusiasts
- It promotes specialized scientific investigations and modern technological innovations
- Provide frequent access to space for outstanding science missions
- Pass on knowledge accrued by experience engineers to the new generation and for technology transfer…Small Explorer Program
- Provide the platform for international collaboration and capacity building

Two Scopes of Small Satellite Technology for sustainable space program

Small Satellite Procurement: Procuring a satellite for societal benefits.

-Mission Operation

-Mission Application: Quick response to user demand (acquiring data and analyzing for user needs..some level of cost benefit, reliability…)

Satellite Development and Launch: Designing, Developing and Launching of small satellite for societal benefits.

-Technology transfer and capability building

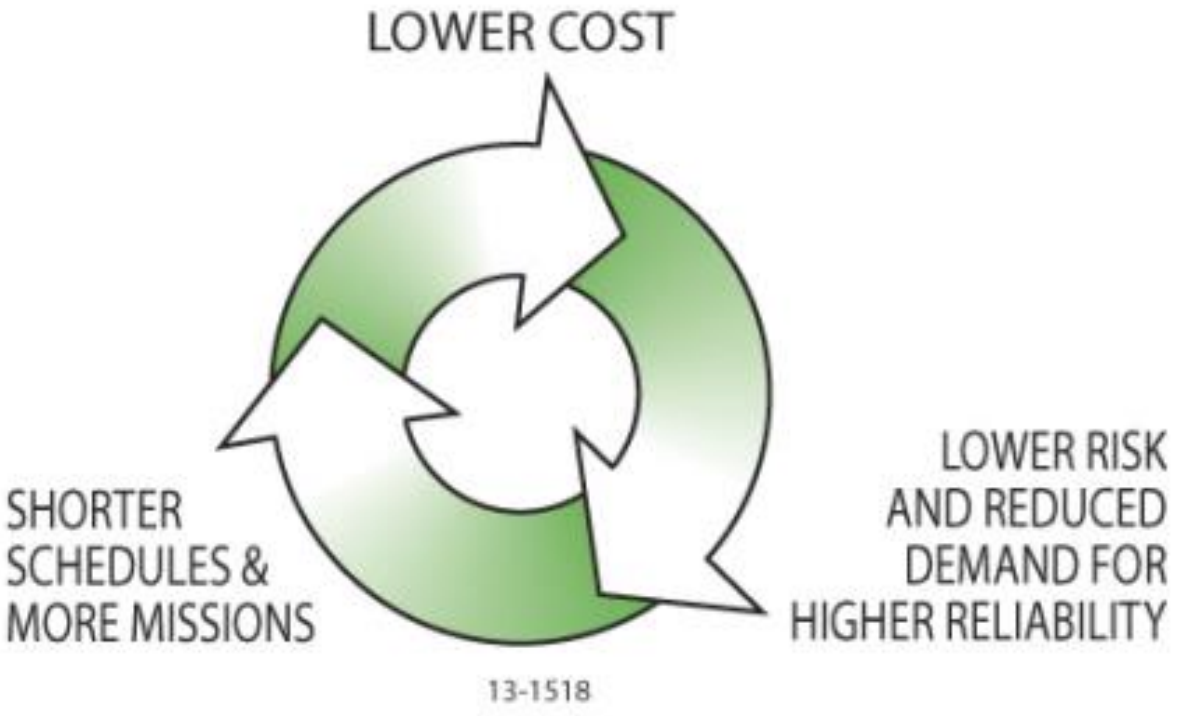
-Mission operation

-Mission Application

Traditional & Small Satellite Comparison

- **Traditional Satellite**
- Extensive design for high capabilities (High Power, Large Antenna Aperture)
- High quality assurance &Testing for increased reliability
- Higher level of redundancy and Margins
- For Long-Life Missions

- **Small Satellite**
- Reduced level of extensive design
- Make use of current/better technology
- Multiple quantity constellation makes it robust against on-orbit failures
- For Quicker-Response Missions & shorter development schedule



Lean Satellite Approach

Switching from the traditional satellite development approach to lean satellite development

The Lean Satellite project model concept is about seeking:

- A low cost,
- Minimum development time &
- Fast delivery small satellite projects

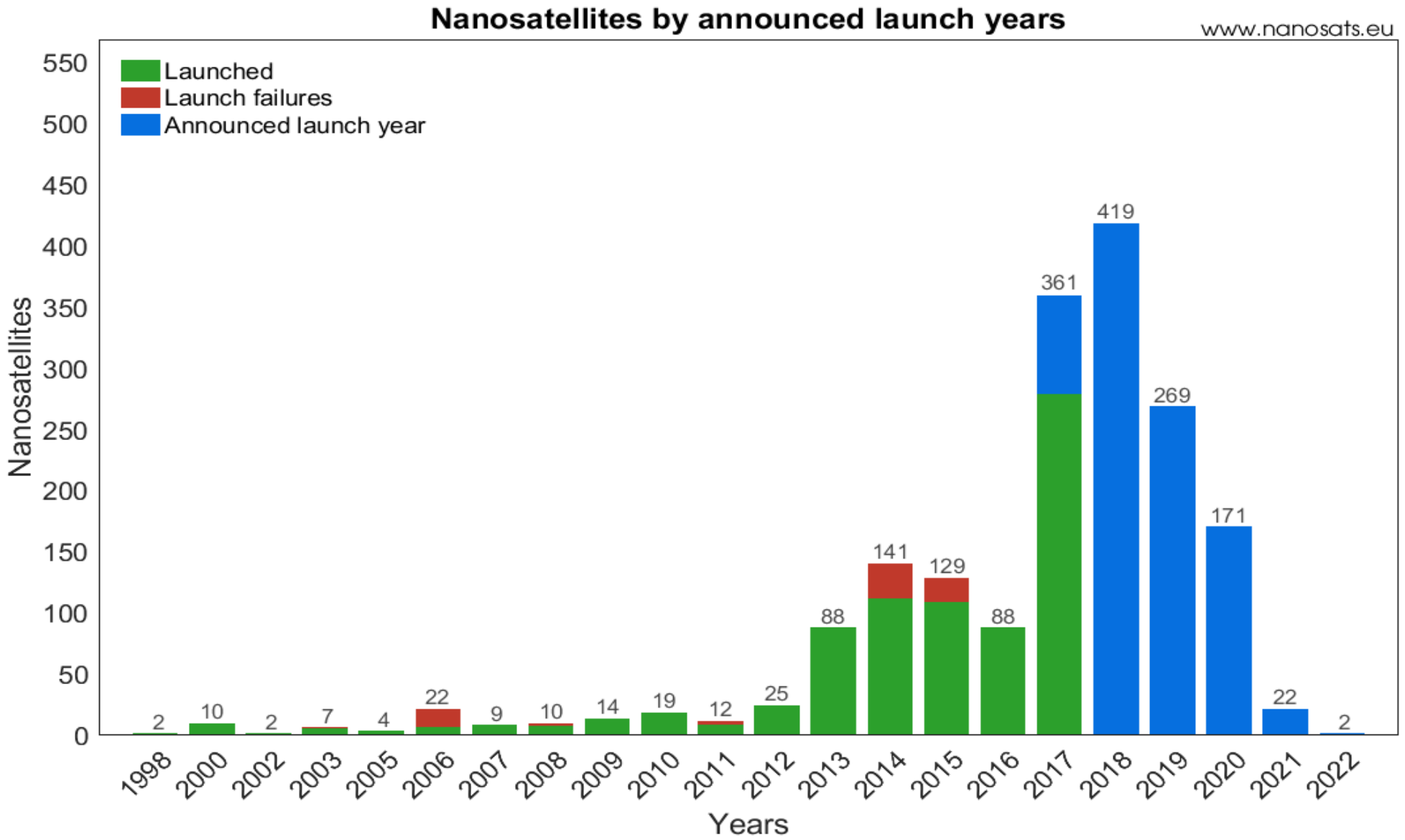
BIRDS Project

The Lean Satellite Concept Defines

The small satellite lean concept defines the following categories such [as development cost and etc.] by the scale value for low cost, minimum development time, fast delivery satellite missions

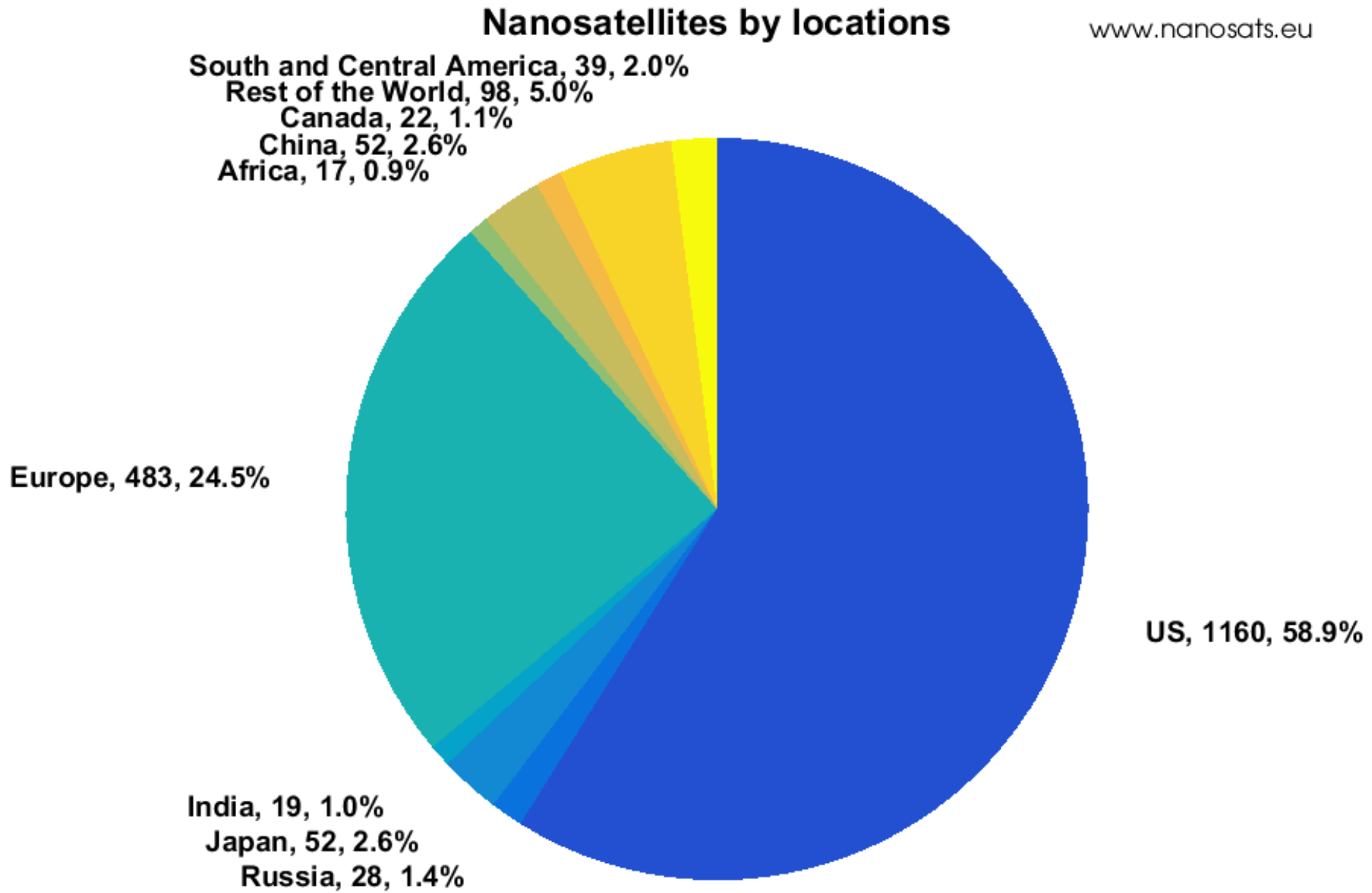
Category	Scale
Total cost [Most Single satellite program with infrastructure investment, launch and operation]	Majority of satellites cost less than **3 MUSD**
Satellite delivery time	Many satellites take **2 years** or longer to build (not fast-delivery!) Non-academic satellites faster. Due to more experience.
Simple satellite Number of mission payloads	**Less than two**
Number of people engaged in satellite development	Between **10 and 20 persons** or less
Percentage of **non-space qualified COTS** parts/material usage [risk taking]	**90 %** for academic missions
Satellite Mission Duration,	Less than **1 year or 2 years**
Waste minimization [Human & Hardware Transportation time] Nearness of satellite development/integration/testing activities integration and satellite developing team	It very necessary to reduce it

The trend of Nanosatellites launch in the spotted years



Source: http://www.nanosats.eu/img/fig/Nanosats_years_2017-11-18.png

The trend of Nanosatellites program among nations and continents



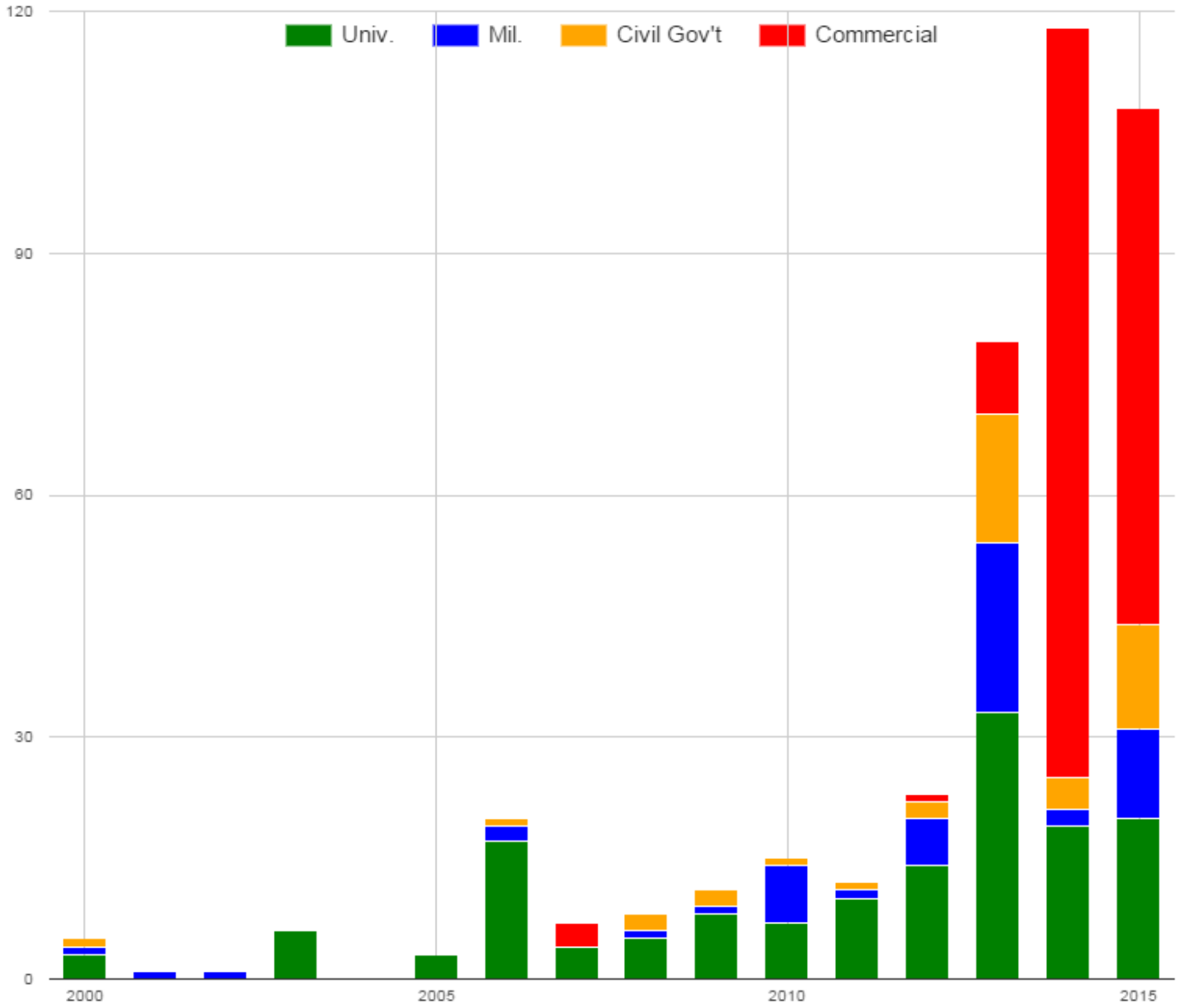
Source: http://www.nanosats.eu/#launch-providers

CubeSats Mission Types

From 2000 to present

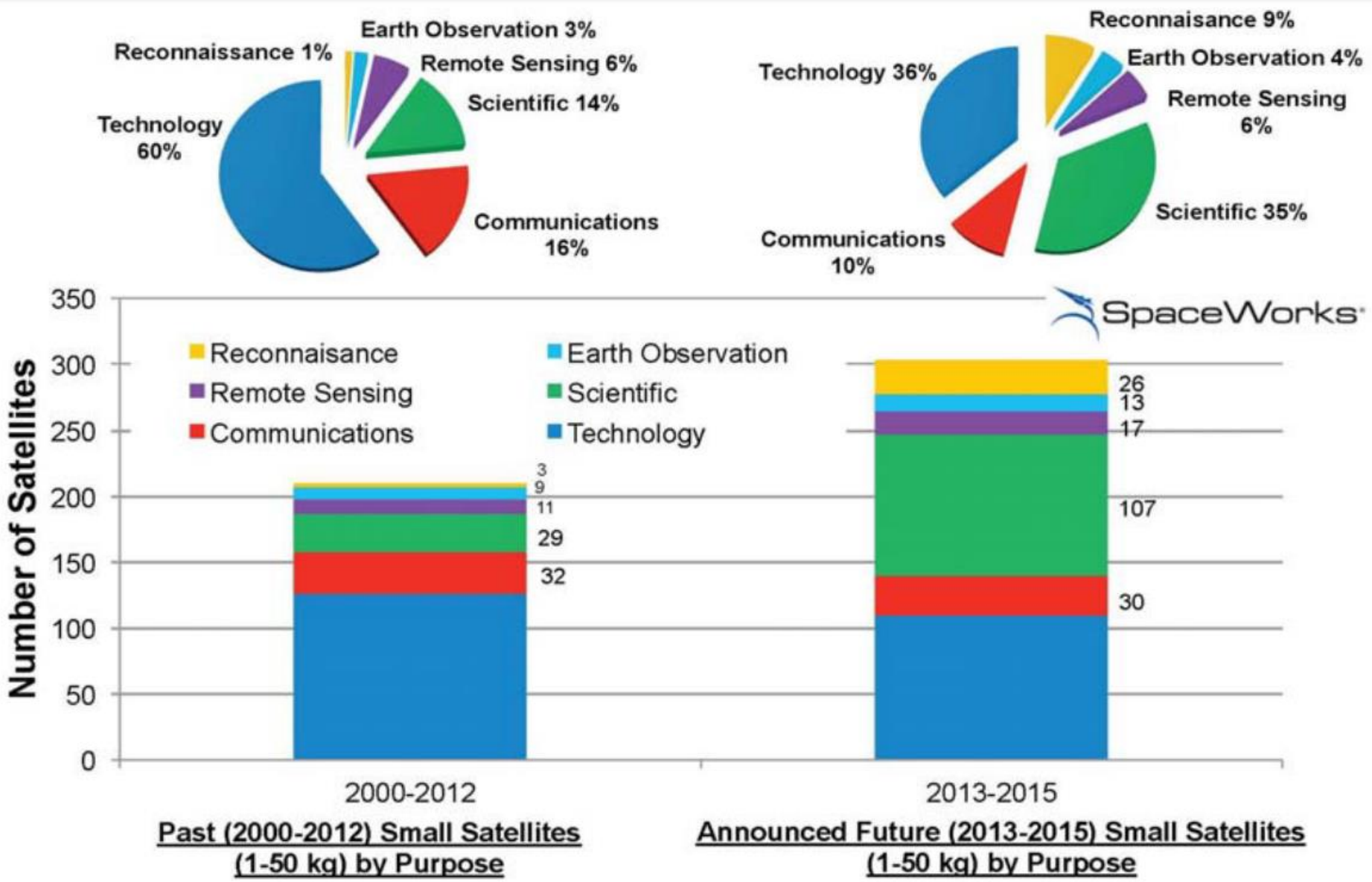
- *University*
- *Military*
- *Government*
- *Commercial*

Technology Demonstration, Scientific Research, Educational Projects, Earth Observation, Deep Space Explorations



Source: https://channels.theinnovationenterprise.com/articles/cubesats-changing-the-way-we-use-satellites

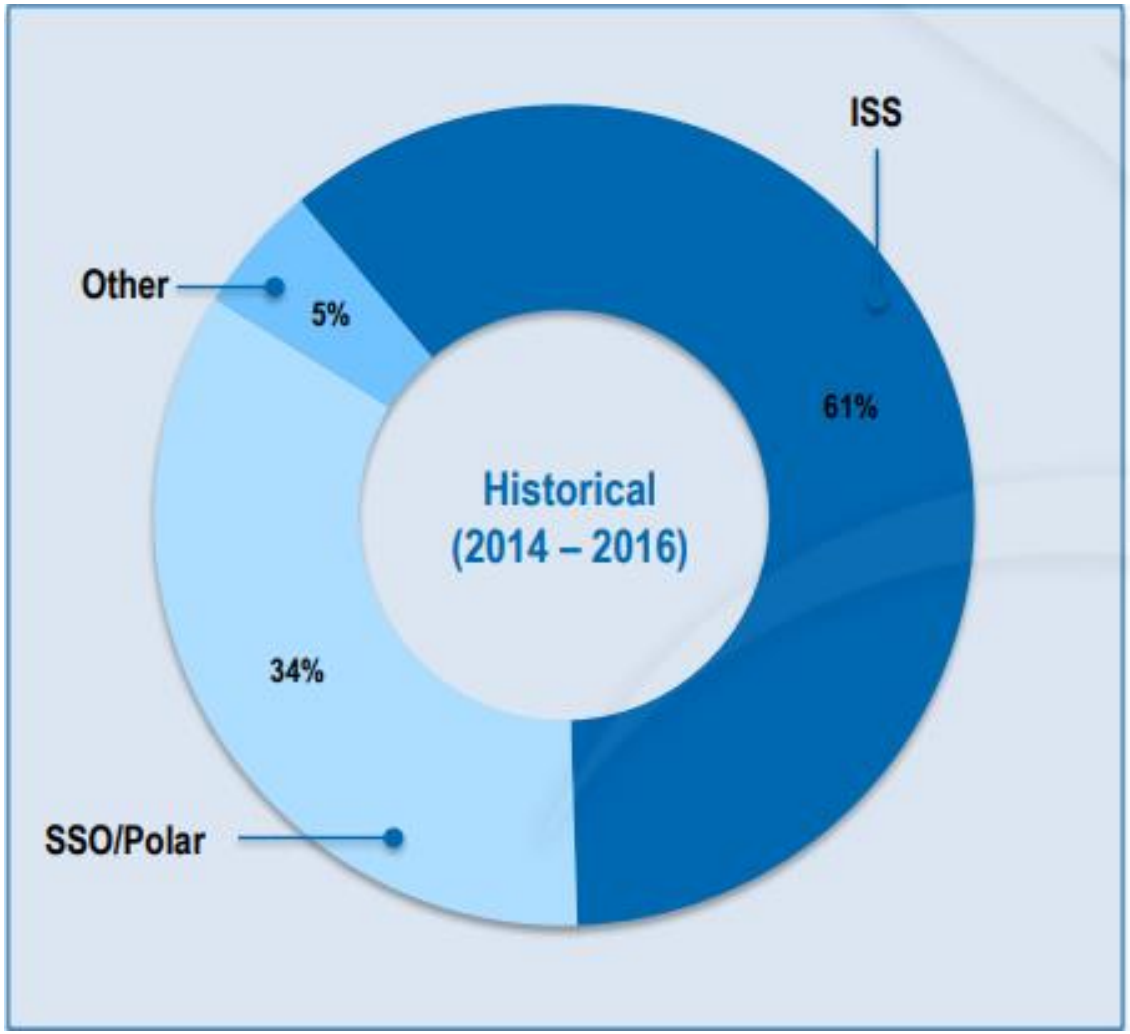
Evidence of Small Satellites application beyond technology demonstration for societal benefits



Source: https://www.omicsonline.org/open-access/nanosatellites--the-tool-for-a-new-economy-of-space-opening-spacefrontiers-to-a-wider-audience-2168-9792-1000192.pdf

Launch and Orbit Destination

- ISS orbit historically serves as the orbit most satellites most Nano/Microsatellite are launched to
- This is due its convenience and the launch opportunity being offered
- The ISS orbit is expected to decrease as dedicated launchers emerge for nano/microsatellites



Source: http://spaceworksforecast.com/docs/SpaceWorks_Nano_Microsatellite_Market_Forecast_2017.pdf

Successful University Programs

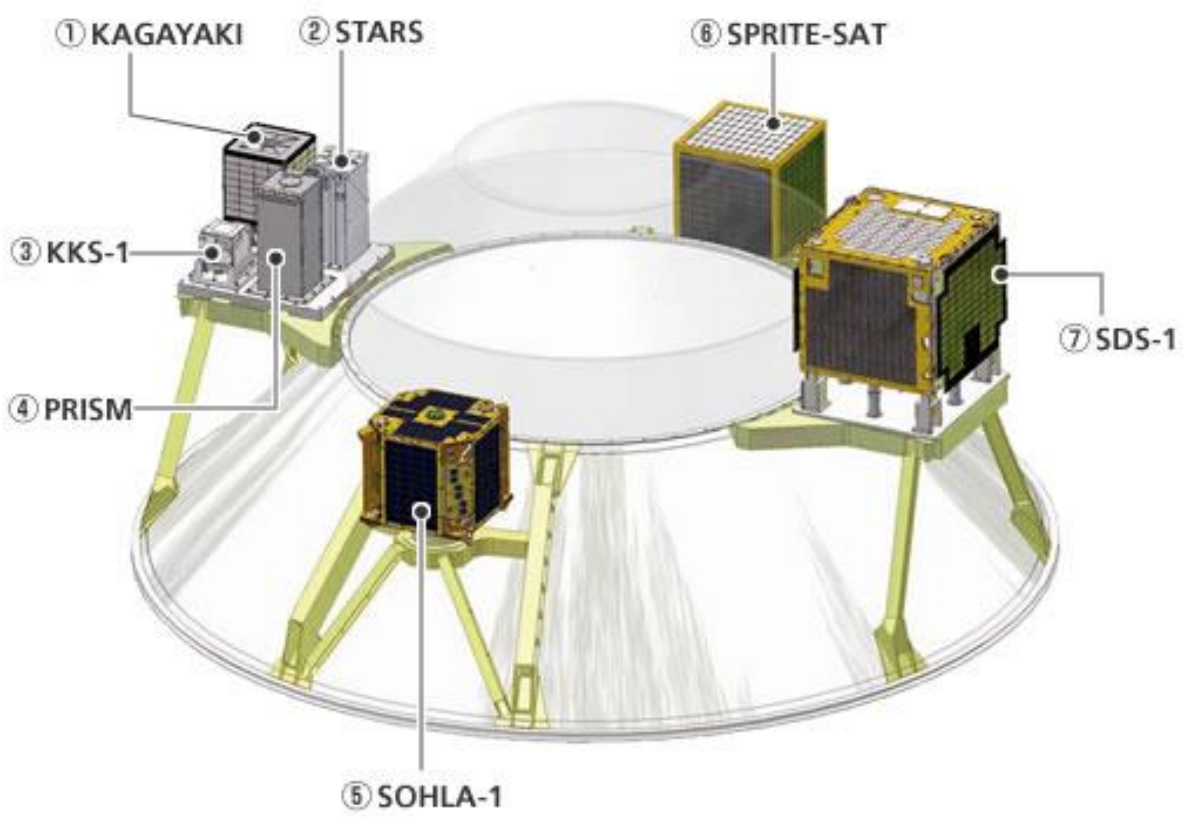
- University Students Engineering Consortium (UNISEC)

Low Cost Launch Opportunities for Small Satellites Program

Low cost small launchers as a tool for reducing satellite mission cost

- Rideshare

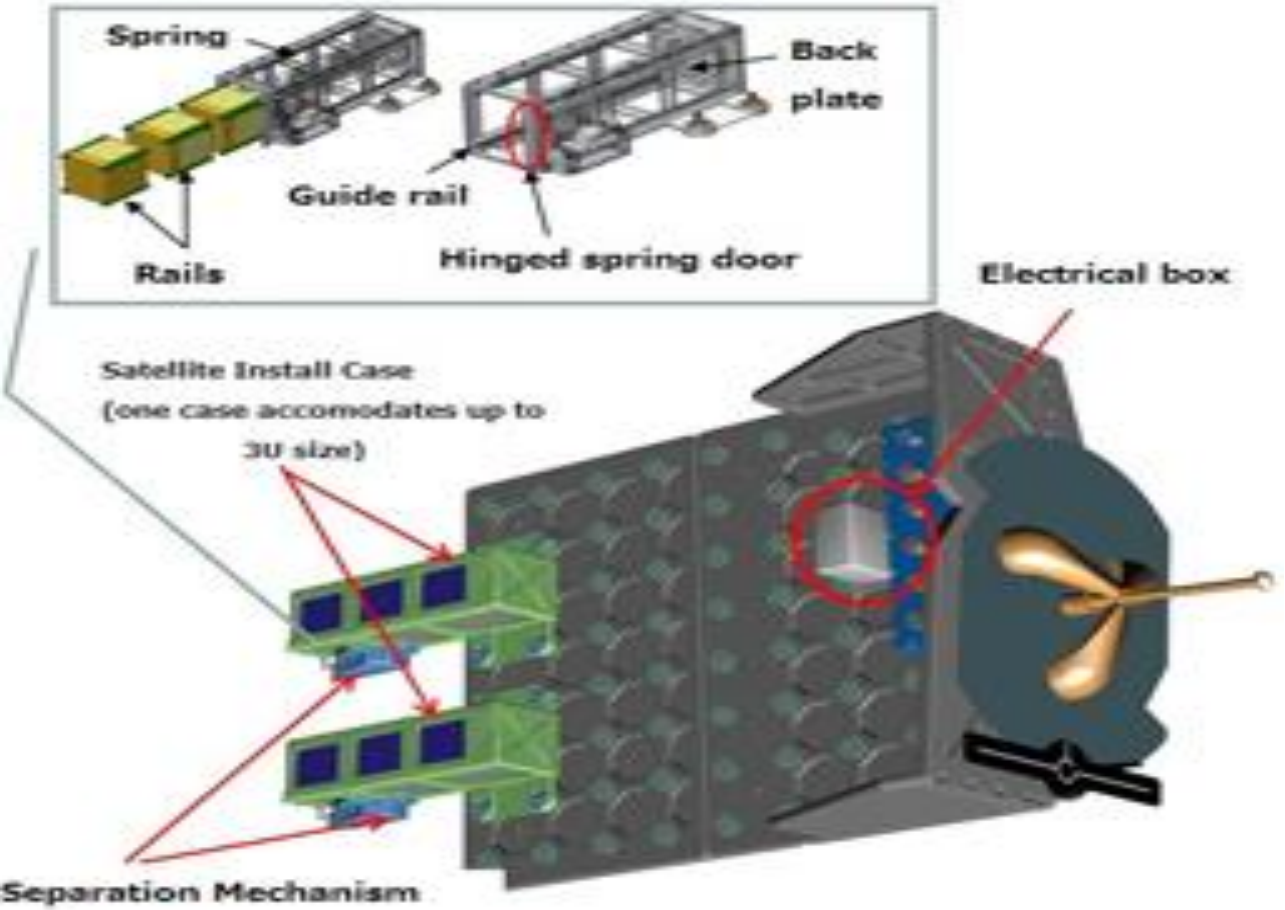
(Piggyback)

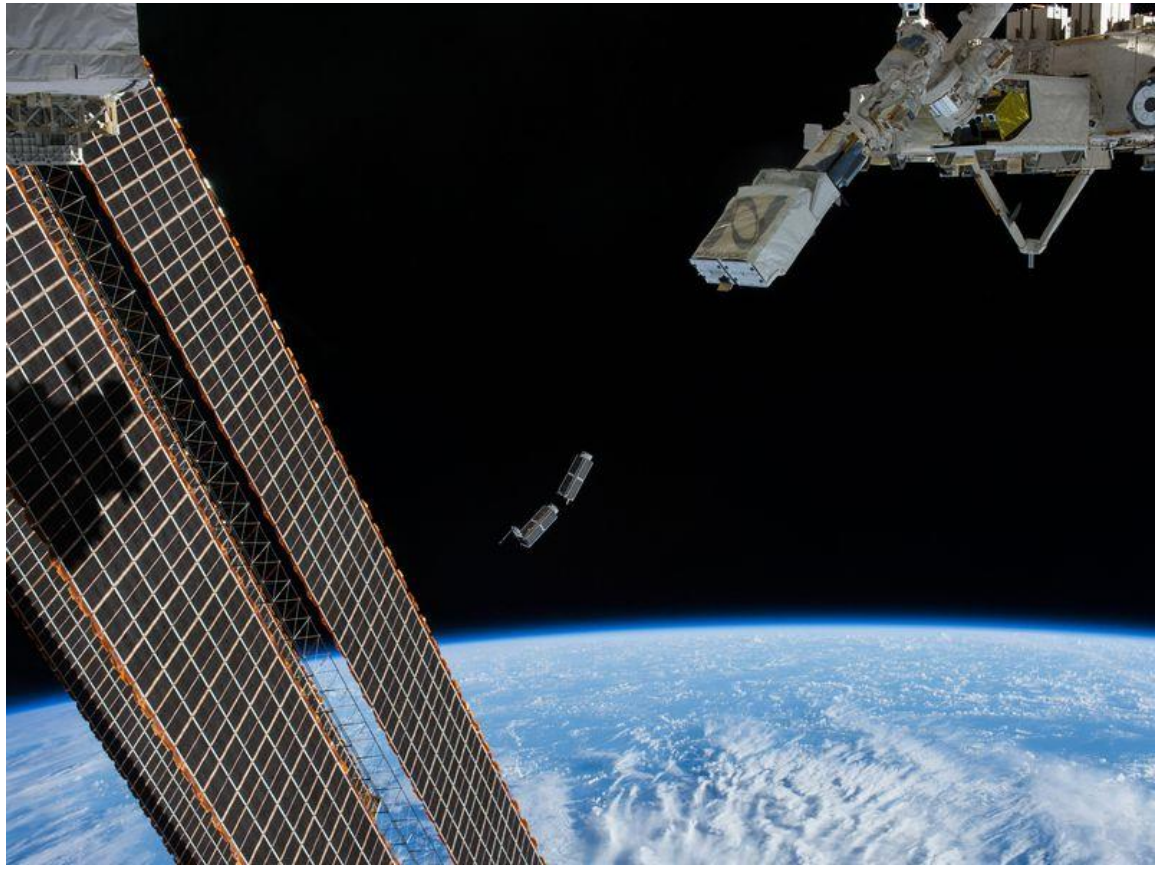


Source: http://global.jaxa.jp/countdown/f15/overview/sub_payload_e.html

Low Cost Launch Opportunities for Small Satellites Program

Small satellites launch from the International Space Station(ISS)
Using Japan- JEM Small Satellite Orbital Deployer (J-SSOD) is a mechanism for deploying small satellites designed with CubeSat design specification **(10cm×10cm×10cm)**





http://iss.jaxa.jp/en/kiboexp/jssod/

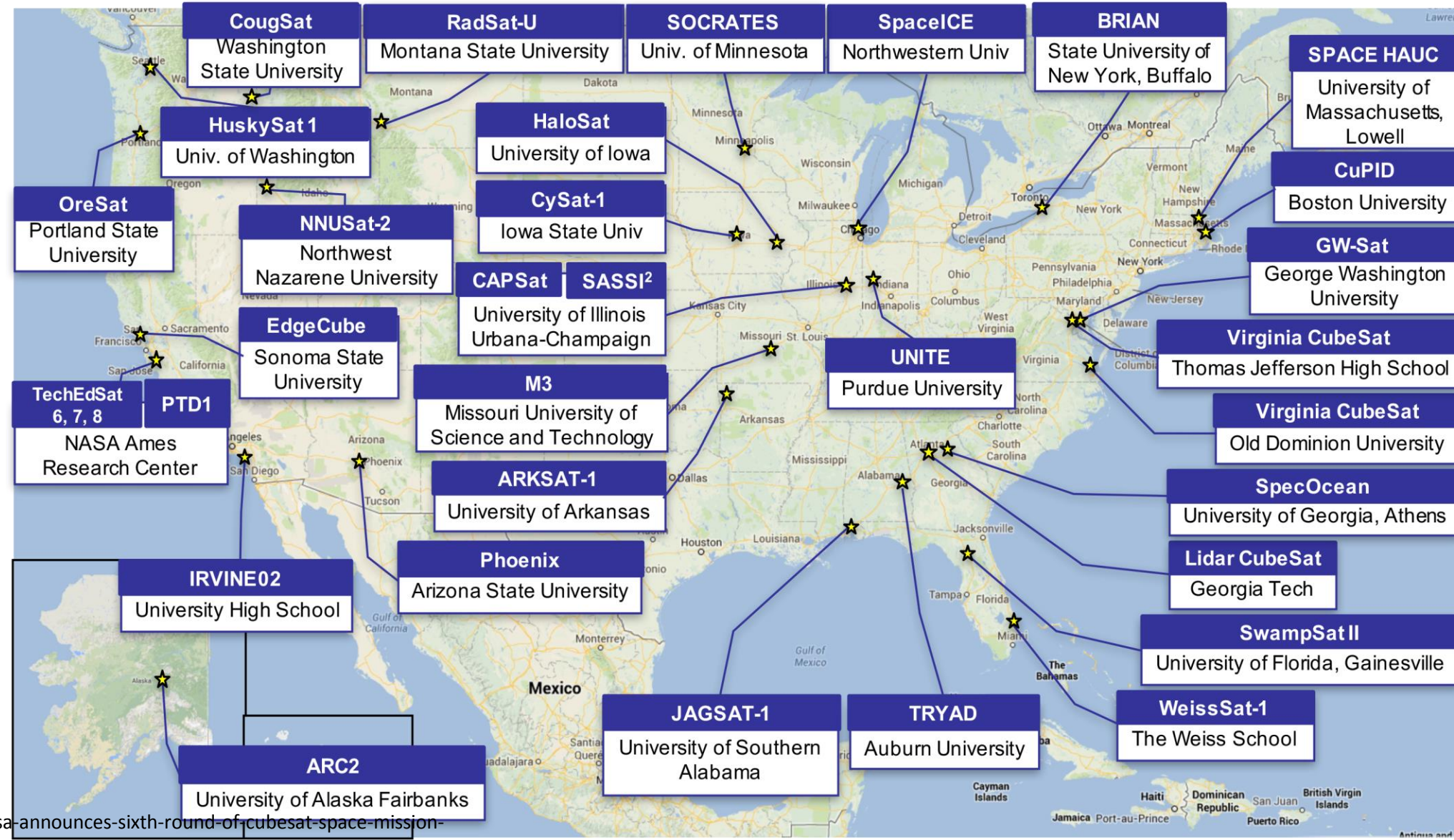
CubeSat Launch Initiative 2017 Selections

NASA University CubeSat Launch Initiative

For advancing its space exploration goals

Launching 50 satellites from 50 states within 5 years

To leverage a growing community of space enthusiasts for national benefit



Source:https://www.nasa.gov/content/nasa-announces-sixth-round-of-cubesat-space-mission-

JAXA to try again with world's smallest satellite-carrying rocket to

- The rocket size: 10 meters long and 50 cm in diameter
- Developed by JAXA to launch micro mini satellite to orbit on 25 Dec.
- "micro-mini" satellite weighing about 3 kg

Developed by the University of Tokyo to Earth imagery.

Source: https://www.japantimes.co.jp/news/2017/11/13/national/science-health/japan-try-worlds-smallest-satellite-carrying-rocket/#.Wig0_FVl-Ul

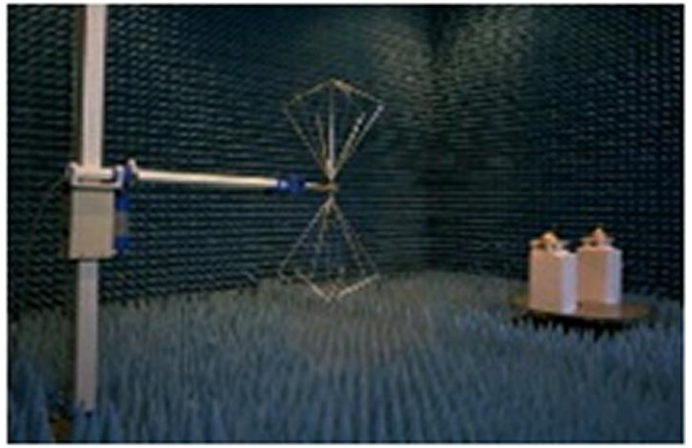
Infrastructure Development

Availability of Assembly, Integration and Testing facilities will help;

- Promote the advancement of space research and technology in the region.
- Reduce time resource waste
- Reduce cost of testing using other facilities outside the region
- Building Human expertise in space & launch environment testing facilities, and assembly & integration facilities
- Reducing space mission cost and increase system reliability through testing

Vibration Test Machine

Thermal Vacuum Test Machine



Anechoic chamber

http://cent.ele.kyutech.ac.jp/activity_e.html

Small Satellite Spotlight on Joint Inter-University Space Programs In Africa

- Small Satellite Astrophysics Projects: Research, design and development of scientific payloads to be flown to space.
- Inter-University CubeSat Constellation Programs
- University Rocket development projects
- Inter-university ground station network for effective mission operation
- Small Satellite Technology & Innovations: Designing and development of small satellite subsystems
- Satellite Assembly, Integration and Testing Facility for the region

https://channels.theinnovationenterprise.com/articles/cubesats-changing-the-way-we-use-satellites

References

- https://www.nasa.gov/content/nasa-announces-sixth-round-of-cubesat-space-mission-candidates
- http://smad.com/wp-content/uploads/RS-Paper_Final.pdf
- https://link.springer.com/chapter/10.1007/978-94-015-9395-3_17
- http://csse.usc.edu/new/wp-content/uploads/2014/04/Leveraging-Perfrmance-Based-Cost-Modeling-A-Shao.pdf
- http://smad.com/RSP/files/5002P.pdf
- http://www.unoosa.org/oosa/ourwork/psa/bsti/
- https://www.nasa.gov/sites/default/files/atoms/files/nac_march2017_blal_ida_sstp_tagged.pdf
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