



Promoting Cooperative Solutions for Space Sustainability

Opportunities & Challenges for New Actors in Space

Krystal Wilson, Director of Space Applications Programs

Secure World Foundation

15th Annual CubeSat Developers Conference

San Luis Obispo, California

May 2, 2018



Promoting Cooperative Solutions for Space Sustainability

Secure World Foundation

Secure World Foundation is a **private operating foundation** that promotes cooperative solutions for space sustainability

- Why **space sustainability**? Increasing reliance on space assets coupled with potentially destabilizing trends
- **Our mission:** To work with governments, industry, international organizations, and civil society to develop and promote ideas and actions to achieve the secure, sustainable, and peaceful uses of outer space benefiting Earth and all its peoples



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What We Do

- The Foundation acts as a **research body, convener and facilitator** to examine key space policy topics
 - To promote **international cooperative governance** for increased space sustainability
 - To increase **human and environmental security** by promoting improved governance of the delivery of information gathered from space systems in ways that promote its utility
 - To assist in the **development of effective national and international space policies and laws** both in established and emerging space nations
- Offices located in Broomfield, CO & Washington, DC with 10 staff members



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Activities and Partners



UNITED NATIONS
Office for Outer Space Affairs



INTERNATIONAL
ASTRONAUTICAL
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15th CubeSat Developers Conference

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Trends in space

- Space is becoming more **globalized**
 - Growing access to space technology
 - Growing interest by many countries in utilizing space for national benefits (socioeconomic development, prestige, national security)
- Space is becoming more **diverse**
 - Space began as part of competition between governments (US and USSR)
 - Influx of technology, talent, and capital from other sectors (IT, analytics, etc)

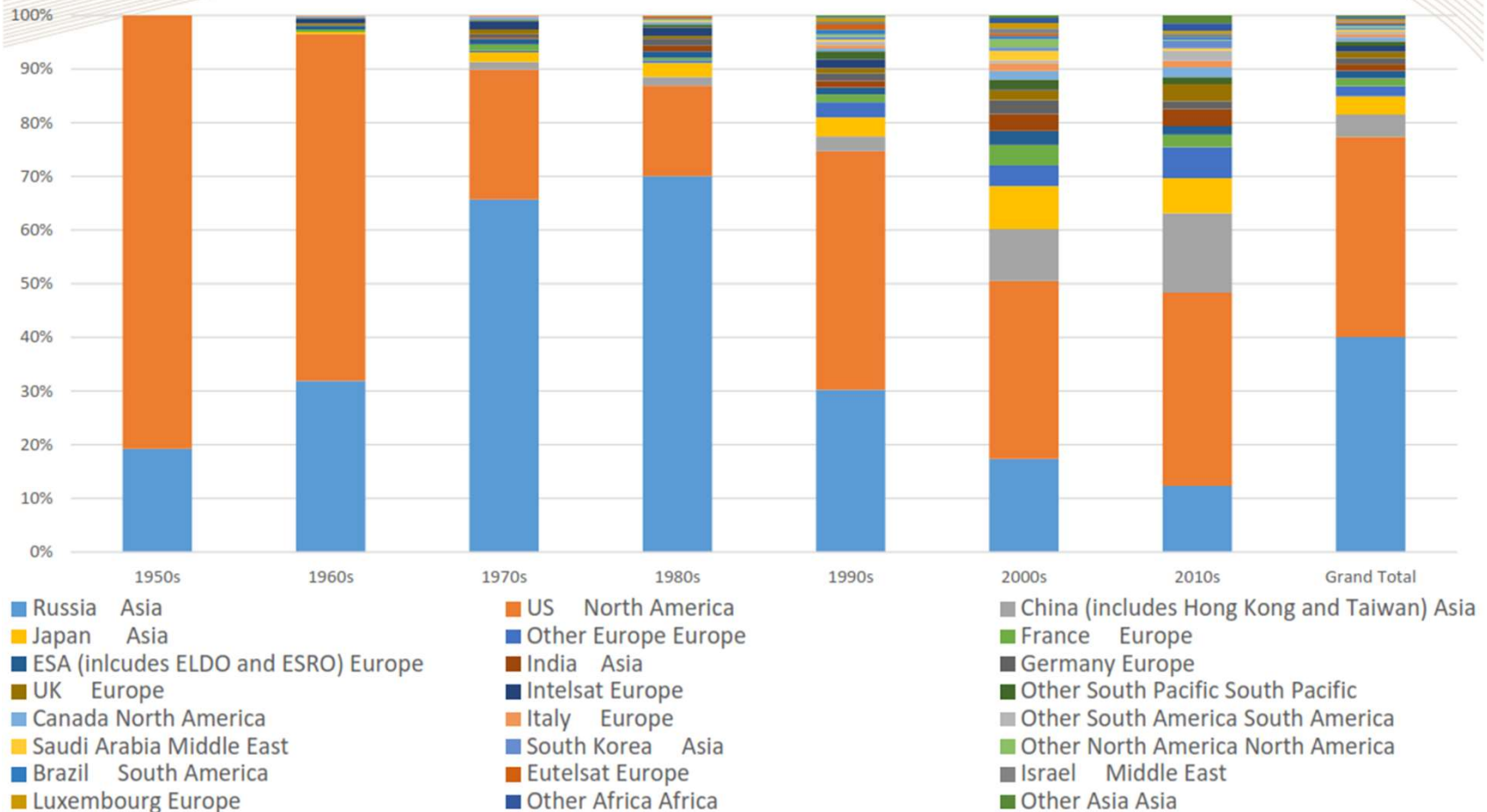
How do we manage the influx of new actors and growth in space activities to ensure long-term sustainability of space?



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More International

Satellites by Owner Country -1950s-today



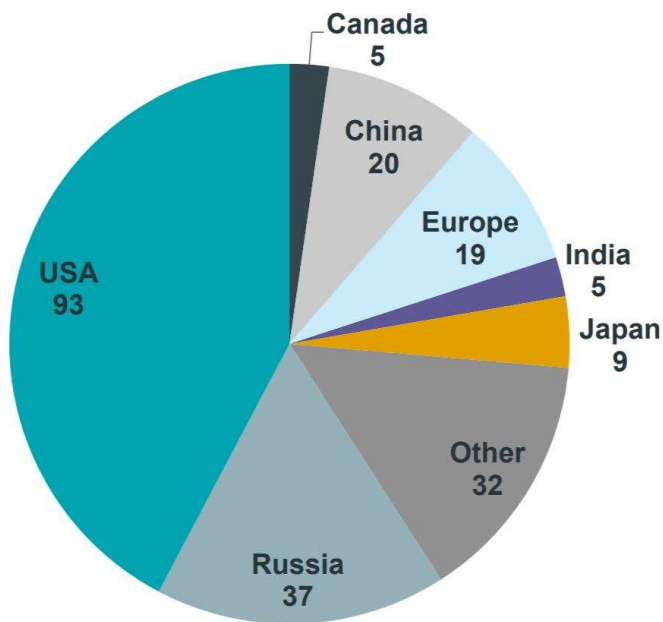
Source: Adapted from [IDA Global Trends in Civil and Commercial Space Study](#)



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New National Entrants

Government Smallsats by Country of Operator, 2012 – 2017



Source: Bryce Space and Technology "Small Satellites By the Numbers 2018"



Ghana launches its first satellite into space

7 July 2017



Bhutan Times
New Bhutan Times - Know Bhutan

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BHUTAN-1 Country's First Cubesat

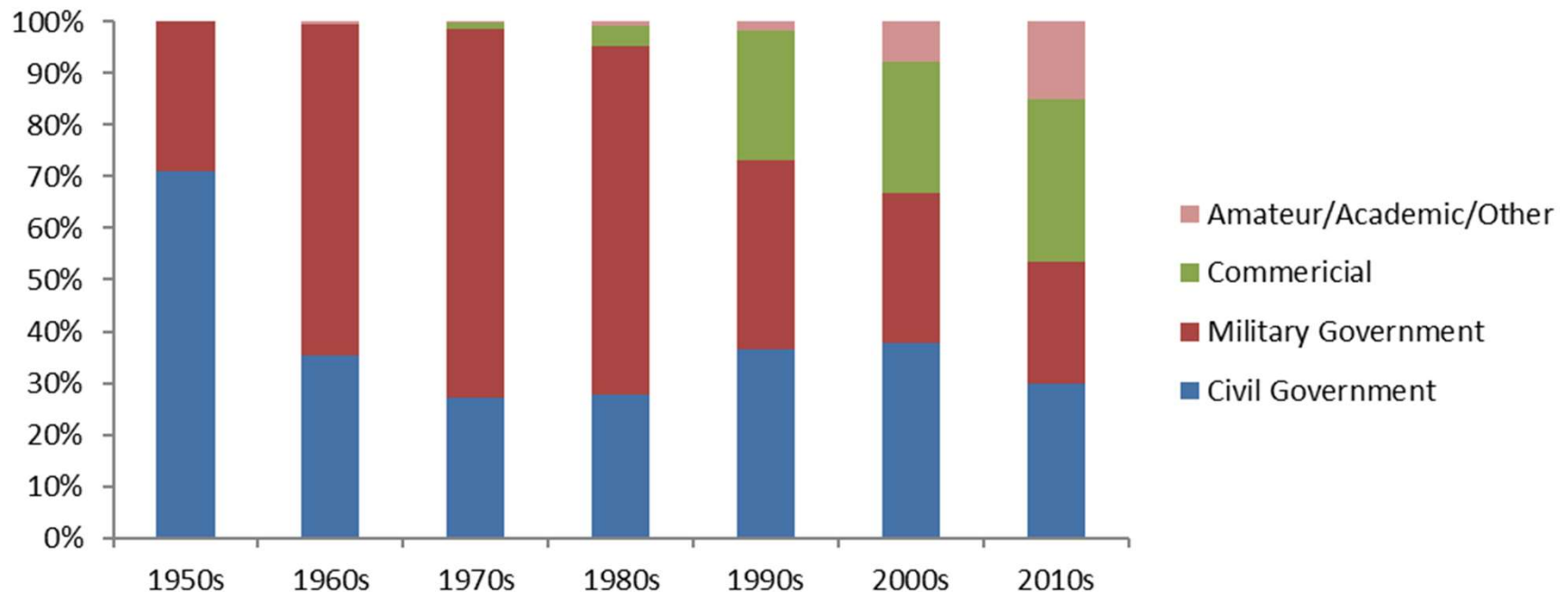
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Bhutan, along with Malaysia and the Philippines, is currently participating in the second joint global multi-nations BIRDS Project called BIRDS-2, initiated by Kyutech which is represented by four engineers from the telecom and space division of the information and communications ministry (MoIC).



More Diverse

Share of Satellites Launched per Decade, by Operator Type

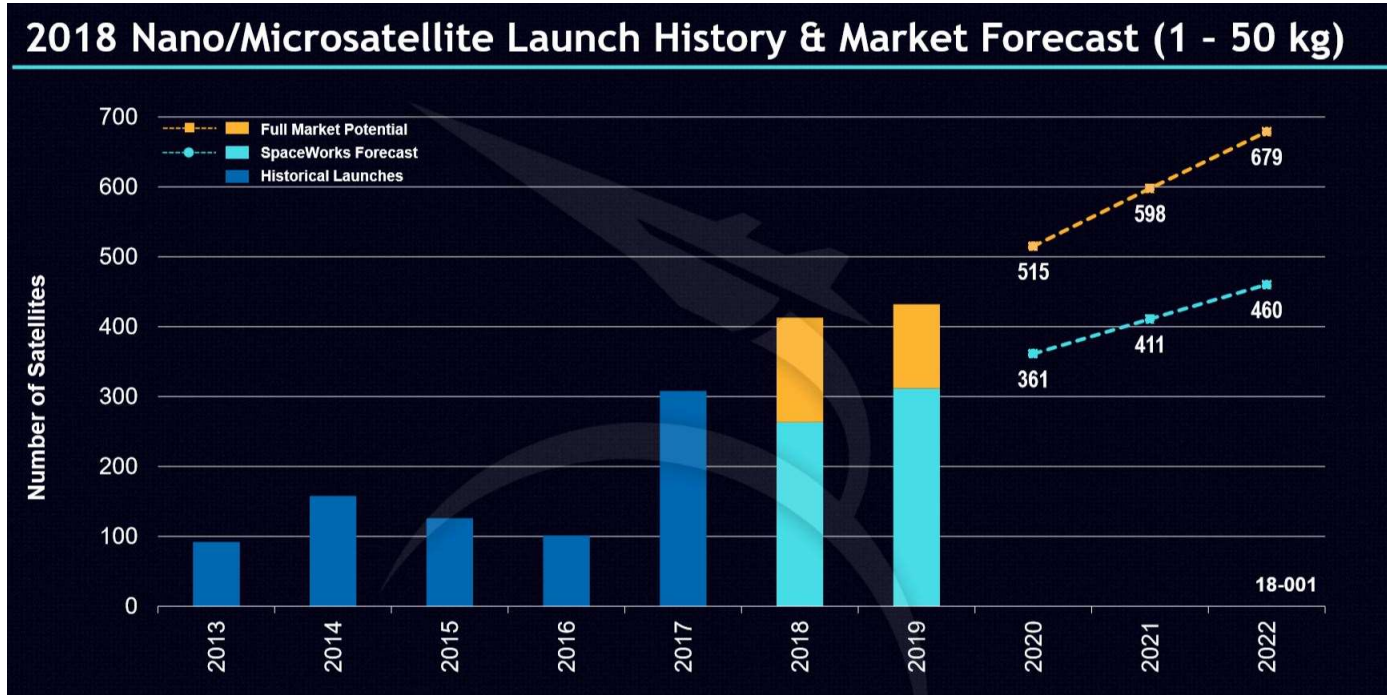


Source: McDowell, Jonathan C, 2017—Satellite Statistics http://www.planet4589.org/space/log/stats2/own_catg.txt



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Nano/Microsatellite Launch Predictions



Source: Spaceworks Enterprises, 2018 Nano/MicroSatellite Market Forecast

Launched in 2017: More than 300

Forecast: Up to 2600 micro/nanosatellites to launch in the next 5 years

Mega-constellations: 16,000+ planned satellites, many not included in above



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Earth Observation Services Growth

		High Res (<1m)	High revisit (<1dy)	Sensor Description	System Size	Sat Mass (kg)
Large Sats	Operational					
	Airbus D&S	•		Optical and radar	4	1,000
	DigitalGlobe	•	•	Optical	5	2,800
	MDA	•	•	Radar	1	2,300
	DMCii	•		Optical	6	450
	ImageSat	•		Optical	3	350
Small Satellites (<200 kg)	Planned					
	UrtheCast	•	•	Optical and radar	24	1,400
	Astro Digital	•	•	Optical	30	20
	Axelspace	•	•	Optical	50	95
	BlackBridge (Planet)	•	•	Optical	5	150
	BlackSky Global		•	Optical	60	50
	Capella Space		•	Radar	30	TBD
	XpressSAR	•		Radar	4	TBD
	GeoOptics		•	Radio occultation	24	115
	HawkEye360		•	RF mapping	21+	TBD
	Hera Systems		•	Optical	48	24
	ICEYE	•	•	Radar	50	<100
	PlanetiQ		•	Radio occultation	12	22
	Planetary Resources	•	•	Optical	10	TBD
	Planet		•	Optical	100+	3
	Satelloptic	•	•	Optical	25+	35
	Spire Global			Radio occultation	50	3
	Terra Bella (Planet)		•	Optical	24	120

- Massive expansion in active satellites:
 - OneWeb: 648+ smallsats
 - Planet: 100+ 3U cubesats
 - SSG: 200 nanosatellites
 - Spire: 50+ cubesats
- Transformation in launch?
 - 25+ smallsat-class launch vehicles currently proposed or under development

Source: Satellite Industry Association "State of the Satellite Industry Report"





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Small Satellites as a Disruptor

Opportunities

- Lower costs of access to space technology
- Lower technical and scientific barriers
- Broaden and diversify actors and users
- Enable new applications and services
- Provide increased societal benefit

Challenges

- Regulatory fit, efficiency, and scale
- Diverse, heterogeneous set of actors
- Few standards for operations
- Spectrum, SSA, and potential space debris implications

What can industry and academia be doing now to address these challenges?

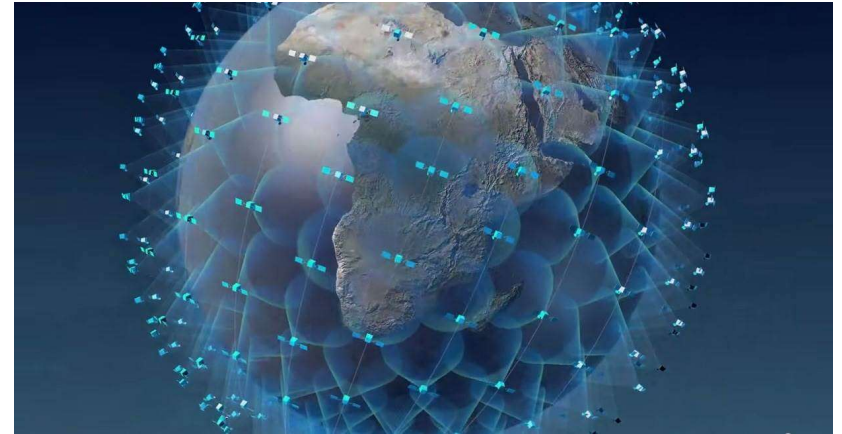


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Congested, Competitive and Invested

In an increasingly competitive orbital environment, how can industry and academia cooperate to develop norms of operations?

How can industry and academia work with government(s) to ensure safety of operations for all users of the space environment?



* Satellites not to scale

- Satellite tracking capabilities
- Satellite “transponders” or beacons
- Adequacy of space debris guidelines
- Spectrum management & coordination
- Information sharing and transparency
- Norms / best practices for operations



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Regulatory Fit & Efficiency

What is the proper governmental posture & policy context for small satellite driven applications?

How can industry and government collaborate to provide an appropriate & effective regulatory context?

- Pace of innovation vs. pace of government
- Government's role as a customer
- Regulatory authority and knowledge base
- Industry awareness of regulatory requirements
- Balance of national security & economic development objectives
- Propulsion/maneuverability

These issues are not unique to small satellites, but the small satellite community may have unique viewpoints on them

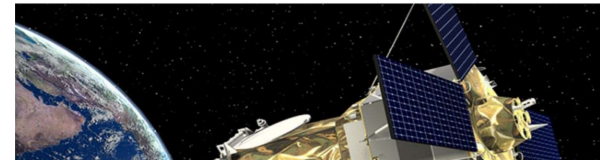
SPACE NEWS

NEWS OPINION VIDEO LAUNCH BUSINESS MISSIONS POLICY & POLITICS



NOAA speeds up remote sensing license reviews amid broader regulatory changes

by Jeff Foust — April 5, 2018





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Societal Benefit

SUSTAINABLE DEVELOPMENT GOALS



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Technology News / News-Analysis

National space agencies of Asia-Pacific countries look to develop satellites in collaboration

News-Analysis | IANS Nov 17, 2017 23:12 PM IST

In a first-of-its-kind initiative, the national space agencies of the Asia-Pacific region are looking at collaboratively developing small and cube satellites, a senior Indian space official said on Friday.

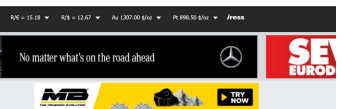


Heads of space agencies from 10 countries in the Asia-Pacific region along with various government bodies had come together for the 14th session of the Asia Pacific Regional Space Agency Conference, which was held here from 14-17 November.

At the forum, working groups with space repre-

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Space essential for meeting South Africa's economic and social development goals



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Observing the Earth, Fueling Global Development Solutions

By Anne Hale Miglarese - April 3, 2018

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Radiant.Earth's mission is to make [Earth observation \(EO\)](#) imagery and data available to discover, analyze and apply for unique insights to the issues the global development community encounters daily. The science of remote sensing and the Earth observation marketplace is evolving rapidly given the innovations of cloud computing, machine learning, and big data.

The NewTimes

RWANDA'S LEADING DAILY

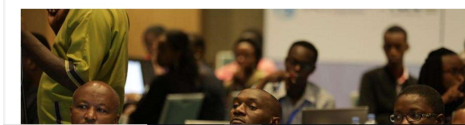
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NEWS

Rwanda looks to deploy satellite tech to monitor progress on SDGs

Rwanda is currently readying itself for satellite technology as one of the key tools to monitor implementation of the Sustainable Development Goals (SDGs) in the country.

By Athan Tashobya Published - March 13, 2018



How do small satellites fit into a variety of humanitarian and international development efforts?



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How to Address Changing Environment?

What Secure World Foundation is Doing



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SWF Handbook for New Actors in Space

- **Goal:** Create a publication that provides an overview fundamental principles, laws, norms, and best practices for safe, predictable, and responsible activities in space
- **Two specific audiences:**
 - Countries developing space programs and/or having to oversee and regulate their first satellites
 - Universities and start-up companies that are developing/operating satellites



Chapter 1 – International framework

- Freedom and Responsibility
- Registration of Space Objects
- International Frequency Management
- Remote Sensing
- International Standards
- International Export Control
- International Liability
- Dispute Settlement
- Environmental Issues
- Advanced Issues
- International Organizations

Part A: Information provided in conformity with the Registration Convention or General Assembly Resolution 1721 B (XVI)		
New registration of space object	Yes <input type="checkbox"/>	Check Box
Additional information for previously registered space object	Submitted under the Convention: ST/SG/SER.E/ <input type="checkbox"/> Submitted under resolution 1721B: A/AC.105/INF. <input type="checkbox"/>	UN document number in which previous registration data was distributed to Member States
Launching State/States/international intergovernmental organization		
State of registry or international intergovernmental organization	<input type="text"/>	Under the Registration Convention, only one State of registry can exist for a space object.
Other launching States	<input type="text"/>	
Designator		
Name	<input type="text"/>	
COSPAR international designator	<input type="text"/>	
National designator/registration number as used by State of registry	<input type="text"/>	
Date and territory or location of launch		
Date of launch (hours, minutes, seconds optional)	<input type="text"/> <input type="text"/> <input type="text"/> hrs <input type="text"/> min <input type="text"/> <input type="text"/> <input type="text"/> dd/mm/yyyy sec	Coordinated Universal Time (UTC)
Territory or location of launch	<input type="text"/>	
Basic orbital parameters		
Nodal period	<input type="text"/>	minutes
Inclination	<input type="text"/>	degrees
Apogee	<input type="text"/>	kilometres
Perigee	<input type="text"/>	kilometres

*UNOOSA International
Registry Form*

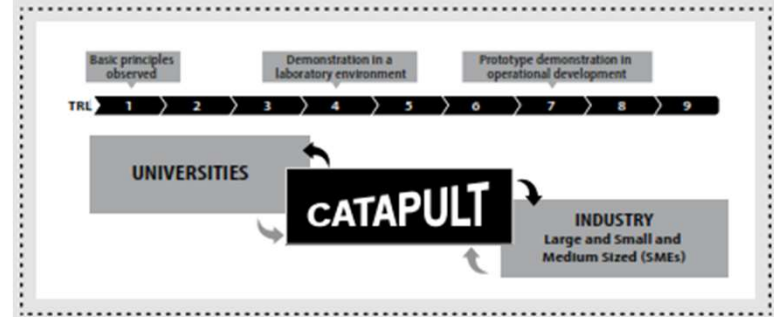
Chapter 2 – National policy and administration

- Public Policy
 - Rationales, objectives, principles
 - Government roles and responsibilities
- Public Administration and National Oversight
 - National regulators and licensing
 - National frequency administration
 - Export controls
- Case Study: Remote Sensing Policy and Administration

Case Study:

The United Kingdom Satellite Applications Catapult

The United Kingdom Satellite Applications Catapult was established by the government of the United Kingdom (UK) in May 2013 with the goal of creating economic growth in the UK through supporting the development, commercialization, and use of satellite applications. According to its Delivery Plan 2015–2020, the Catapult (Figure 8) aims to promote satellite application and technology development and to help domestic industry “bring new products and services more rapidly to market.” The Satellite Applications Catapult is one of 11 “Catapults” operating in the UK, each focusing on different technologies and application areas. The Catapult operates as a private, not-for-profit research organization. It is governed by a board, which includes representation from the United Kingdom Space Agency (UKSA) and from Innovate UK—a government agency focused on fostering technology and economic development.



UK Satellite Applications Catapult

Chapter 3 – Responsible space operations

- Pre-launch
 - Licensing
 - Launch vehicle selection and integration
 - Insurance
- Launch
 - Safety considerations
- On-orbit
 - Orbit determination, propagation, and tracking
 - Conjunction assessment and collision avoidance
 - Anomaly response
- End-of-life

Examples of CA Screening Volumes					
Orbit Regime	Orbit Regime Criteria/Definition	Predict/ Propagate/ Time	Radial Miss (km)	In-Track Miss (km)	Cross-Track Miss (km)
GEO	1300min < Period < 1800 min Eccentricity < 0.25 & Inclination < 35°	10 days	12	364	30
HEO 1	Perigee < 2000 km & Eccentricity > 0.25	10 days	40	77	107
MEO	600 min < Period < 800 min Eccentricity < 0.25	10 days	2.2	17	21
LEO 4	1200 km < Perigee ≤ 2000 km Eccentricity < 0.25	7 days	0.5	2	2
LEO 3	750 km < Perigee ≤ 1200 km Eccentricity < 0.25	7 days	0.5	12	10
LEO 2	500 km < Perigee ≤ 750 km Eccentricity < 0.25	7 days	0.5	28	29
LEO 1	Perigee ≤ 500 km Eccentricity < 0.25	7 days	2	44	51

Examples of close approach screening volumes



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Handbook Next Steps

- The Handbook was officially released in February 2017
- Electronic copies are available through the SWF website, free of charge:
www.swfound.org/handbook
- Printed copies are also be available today
- Feedback is welcome!
- SWF plans to curate an electronic library of resources to accompany the Handbook and is looking for interested partners to help with sponsorship or contributions
 - Companies
 - Governments
 - NGOs
 - Universities



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Previous Events and Materials

Events

- Hosted “[Cubesat Launch and Deployment Best Practices Side Event](#)” and “[Dialogue on Practices for Post Mission Disposal](#)” at 2017 SmallSat Conference in Logan, Utah
- Held workshop on “[Space Sustainability and Small Satellites](#)” during the 12th Annual Ilan Ramon Conference in Herzliya, Israel in January 2017.
- Participated in [Small Satellites Tech, Business & Regulatory Industry Workshop](#) in Noordwijk, Netherlands in April 2017
- Presented on “[Small Satellite Technology and Space Capability](#)” at the United Nations/United Arab Emirates High Level Forum in November 2016
- Held side event on [SSA challenges and small satellites](#) at the Advanced Maui Optical and Space Surveillance Technologies Conference in Maui, Hawaii in September 2016
- Held side event on [Small Satellite Operator Best Practices for SSA and Conjunction Assessment](#) at 2016 SmallSat Conference in Logan, Utah

Publications

- [Insight - Small Satellites for the Global South](#) – March 2017
- [Insight- Small Satellites and Space Situational Awareness](#) – September 2016
- [Legal and Regulatory Considerations of Small Satellite Projects](#) – April 2014



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Upcoming Events

Currently Planned:

- **Global Space Applications Conference 2018** in May in Montevideo, Uruguay
- **2018 UNIDIR Space Security Conference** in May in Geneva, Switzerland
- **Space Situational Awareness: Strategic Challenges for India** in June in Bengaluru, India
- **SmallSat Conference** in August in Logan, Utah
- **Student Generation Advisory Council Space Generation Congress** in October in Bremen, Germany

Lots more in development! Topics include space weather, citizen science, on-orbit servicing, spectrum.



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Questions?

Thanks.

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