



*Promoting Cooperative Solutions for Space Sustainability*

# **Congested and Contested: Current Trends in Space Security**

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# Trends in space security

- Space is becoming more ***globalized***
  - 12 countries have demonstrated indigenous space launch capability (Iran, North Korea, and South Korea are the newest)
  - Private sector now makes up significant portion of space activity
  - Increasing amount of physical and electromagnetic congestion in highly-used orbits and spectrum
- Space security is becoming more ***multidimensional***
  - The space environment (human-generated and natural) poses a significant threat to all space actors
  - Mistakes, mishaps, and misperceptions can be misinterpreted as intentional aggression
  - Increasing reliance on space for national security leads to increased vulnerability



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# CONGESTED SPACE

# Human-generated space objects

## Active Satellites

Total number of operating satellites: 1,381			
United States: 568	Russia: 133	China: 177	Other: 503
LEO: 759	MEO: 92	Elliptical: 37	GEO: 493

*Current through end of 2015.*

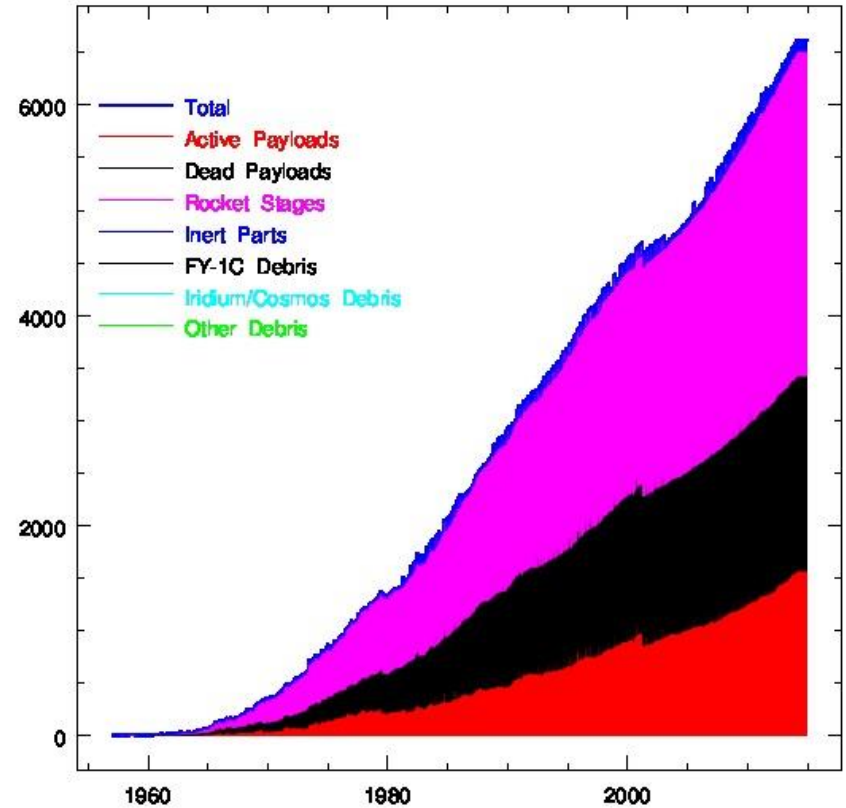
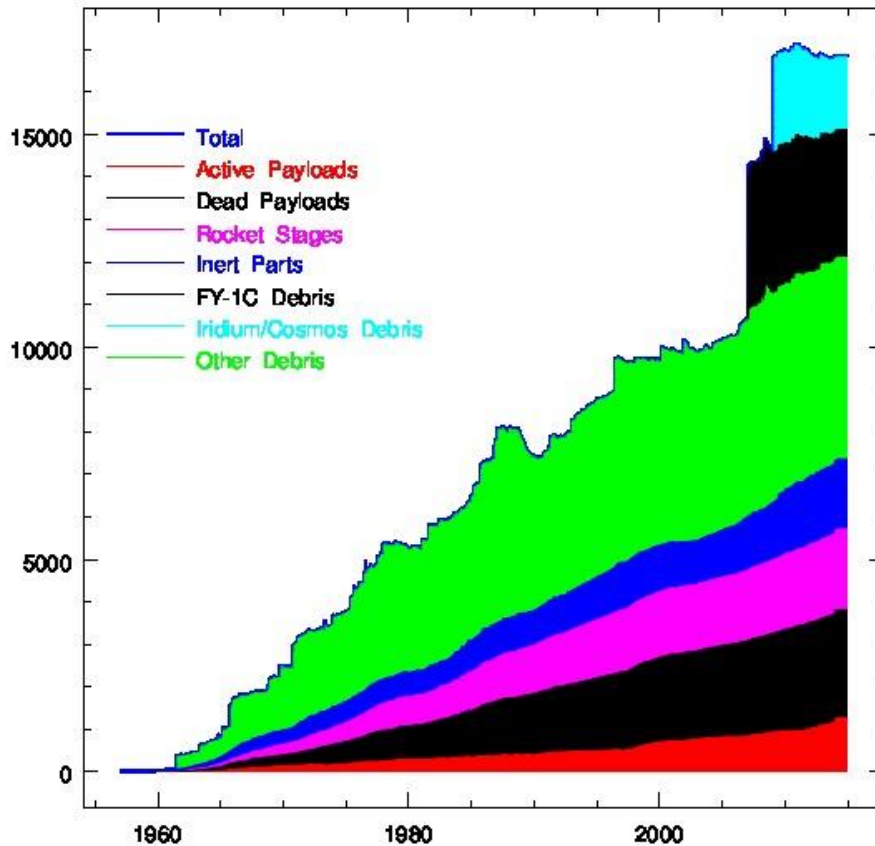
*Data from the [Union of Concerned Scientists](#)*

## Space Debris

Larger than 10 cm	~17,000	Sources of new debris
Between 1 and 10 cm	~500,000	Can cause major damage
Smaller than 1 cm	Many millions	Can cause minor damage

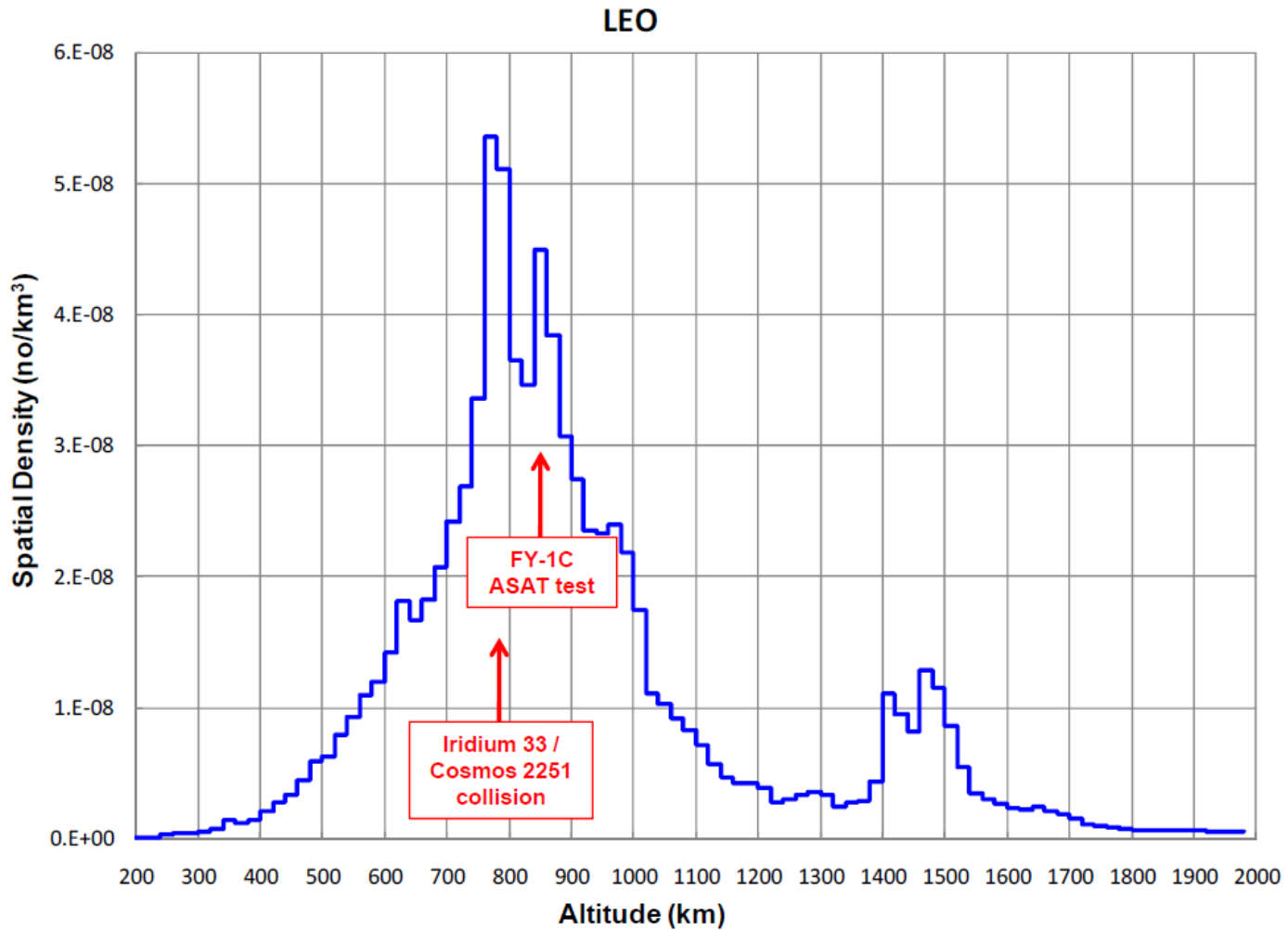
*Data compiled from U.S. Strategic Command, NASA, and ESA.*

# Long-term growth in space objects



Graphs from Jonathan's Space Page <http://planet4589.org/>

# Highest congestion is in LEO



*J-C Liou, NASA Orbital Debris Program Office*

# Who owns what?

An interesting way of looking at who owns objects in space is to consider the percentage of ownership by number of objects (left) and by mass of objects (right).

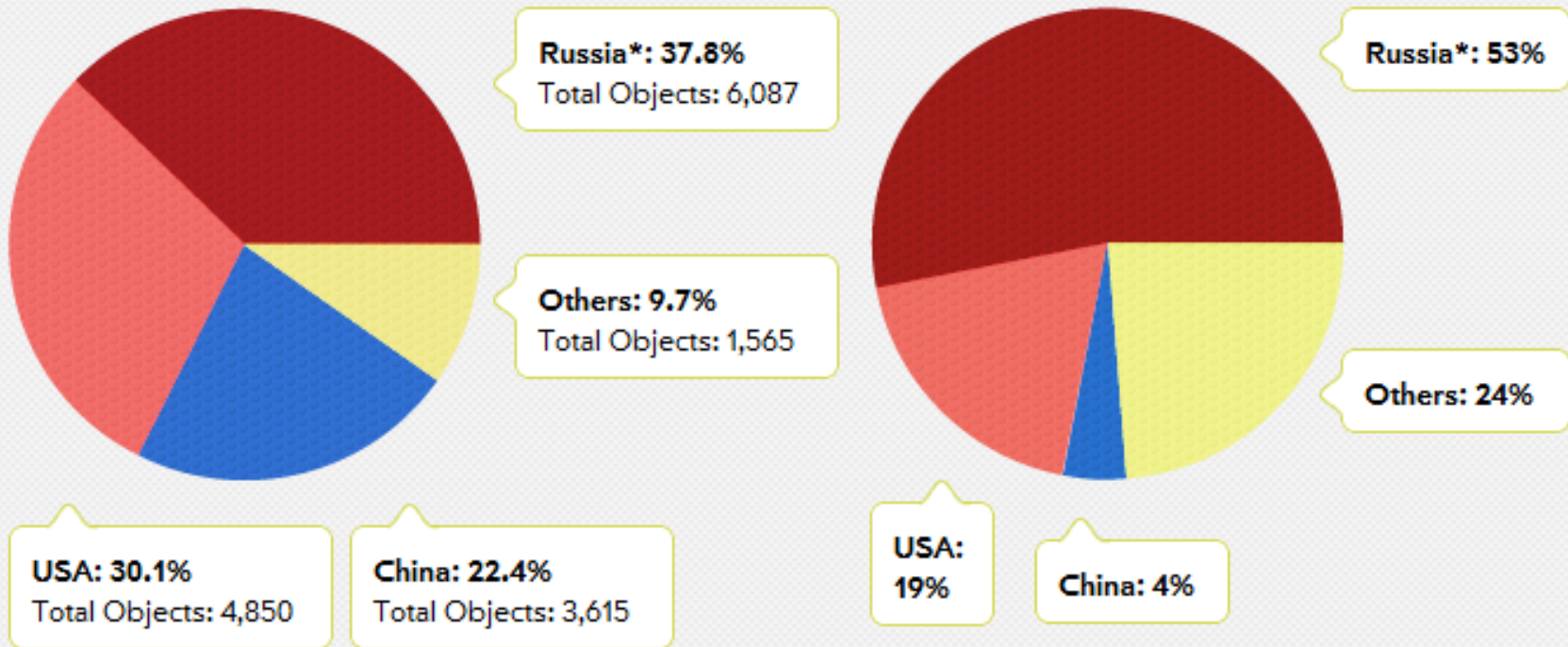
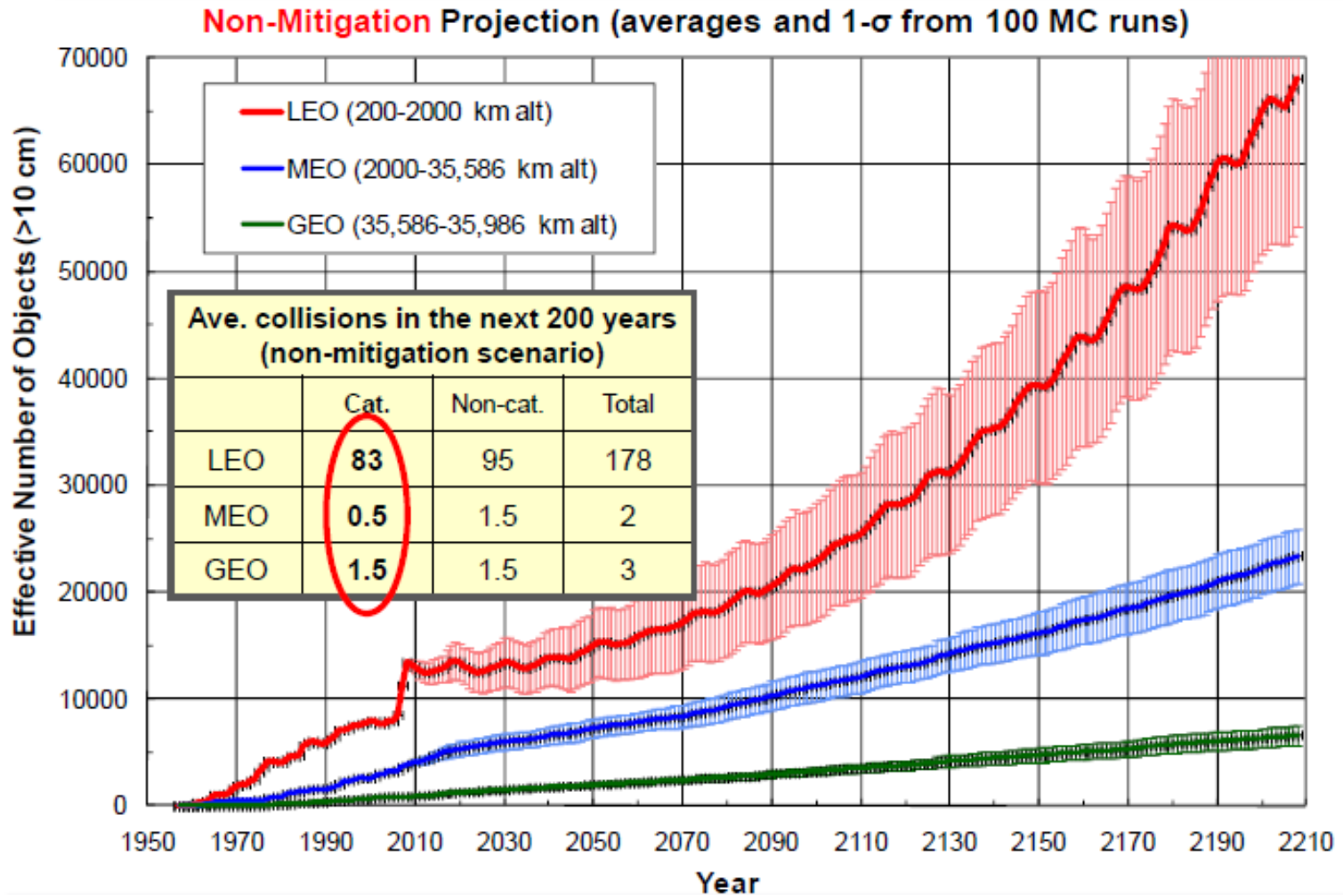


Chart from Scientific American (2012)

# The next 200 years, if things stay the same



*J-C Liou, NASA Orbital Debris Program Office (2009)*

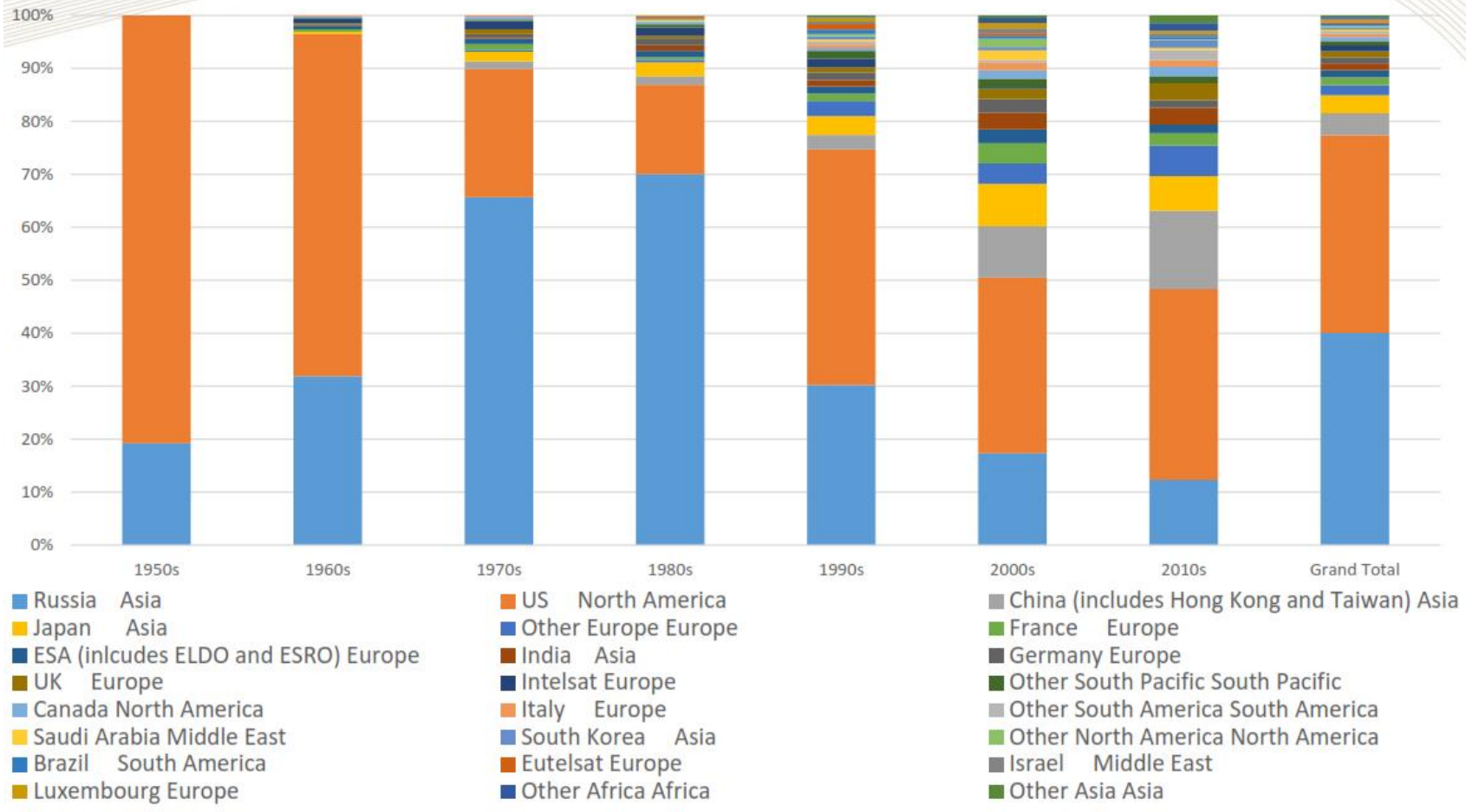




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# Space is becoming more international

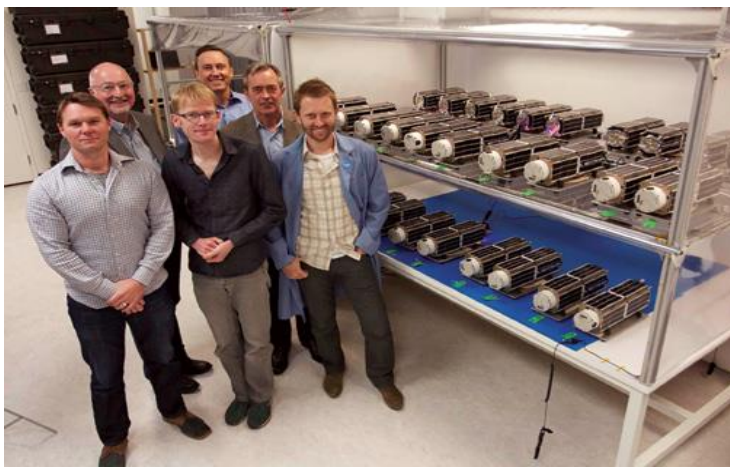
## Satellites by Owner Country -1950s-today



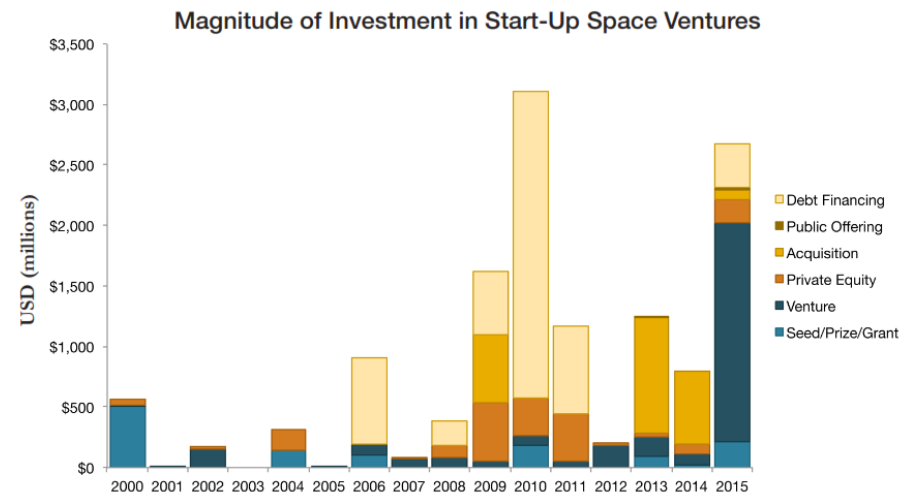
Adapted from [IDA Global Trends in Civil and Commercial Space Study](#)

# Surge in commercial remote sensing

Company	Sector	Projected # of satellites	Mass (kg)	Altitude (km)	First Launch
SkyBox Imaging	Imagery	12-24	120	800	2013
PlanetLabs	Imagery	100	3	550	2013
Spire Global	Weather/ Maritime Domain Awareness	50	3	800	2014
OmniEarth	Remote Sensing	15-18	110	800	2018
NorStar	Imagery	40	?	800	?

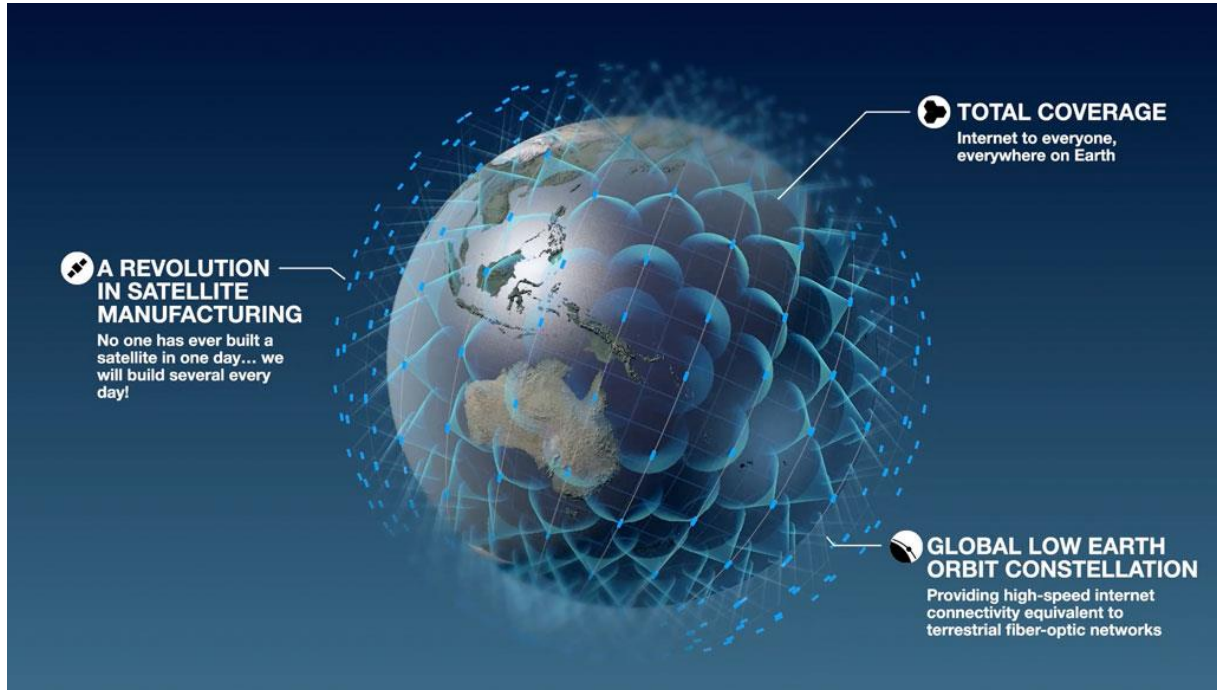


OneWeb founders pose with a flock of Doves.  
Image credit: [SatMagazine](#)



Source: [Tauri Group](#) (2015)

# Increased competition for spectrum



*OneWeb constellation  
and service concept*

## Signs of a Satellite Internet Gold Rush in Burst of ITU Filings

by Peter B. de Selding — January 23, 2015

PARIS — The international agency that regulates satellite orbital slots and broadcast frequencies has registered at least a half-dozen filings for massive constellations of satellites in the past eight weeks, a development that suggests a gold-rush mentality may be taking hold.



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# CONTESTED SPACE

# Heightened U.S. concerns

- For much of the last 50 years, the U.S. national security space community didn't worry (much) about hostile threats
  - Main use of space was for strategic purposes (intelligence, nuclear warfare, and treaty verification)
  - Soviet Union had operational ASAT programs from 1960s-1990s, mainly targeting LEO satellites
- U.S. military now reliant on space for projecting military power
  - Wars in Afghanistan and Iraq were first real “space” wars
  - Space capabilities have shifted from strategic to operational/tactical
- Growing concerns that future conflicts will involve attacks on space capabilities

- China is on a deliberate path to develop the full-spectrum of space capabilities as the US and Russia
  - Space for prestige
  - Space for industrial/technological development
  - Space for human and environmental security
  - Space for military purposes
- China also appears to be developing counterspace capabilities to counter US space capabilities in the event of a conflict
  - **Chinese perspective:** need to counter U.S. space capabilities to defend against U.S. aggression or coercion
  - **U.S. perspective:** Chinese counterspace capabilities will allow them to attack and expand their influence

# China's recent ASAT testing activities

Date of Test	Target Object	Interceptor Object	Interceptor Type	Amount of Trackable Debris Created	Notes
7/5/2005	None known	SC-19	direct ascent	0	Likely rocket test
2/6/2006	None known	SC-19	direct ascent	0	Likely flyby of an unknown orbital target
1/11/2007	FengYun 1C	SC-19	direct ascent	3,280	Successful intercept and destruction of an orbital target
1/11/2010	CSS-X-11 (ballistic)	SC-19	direct ascent	0	Successful intercept and destruction of a suborbital target
1/27/2013	Unknown (ballistic)	SC-19	direct ascent	0	Successful intercept and destruction of a suborbital target
5/13/2013	None known	?	direct ascent	0	Likely rocket test of a new system capable of reaching GEO
7/23/2014	None known	SC-19	direct ascent	0	Non-destructive test
10/30/2015	None known	Possible upgraded SC-19	direct ascent	0	Non-destructive test
<b>Total Amount of Trackable Debris</b>				<b>3,280</b>	

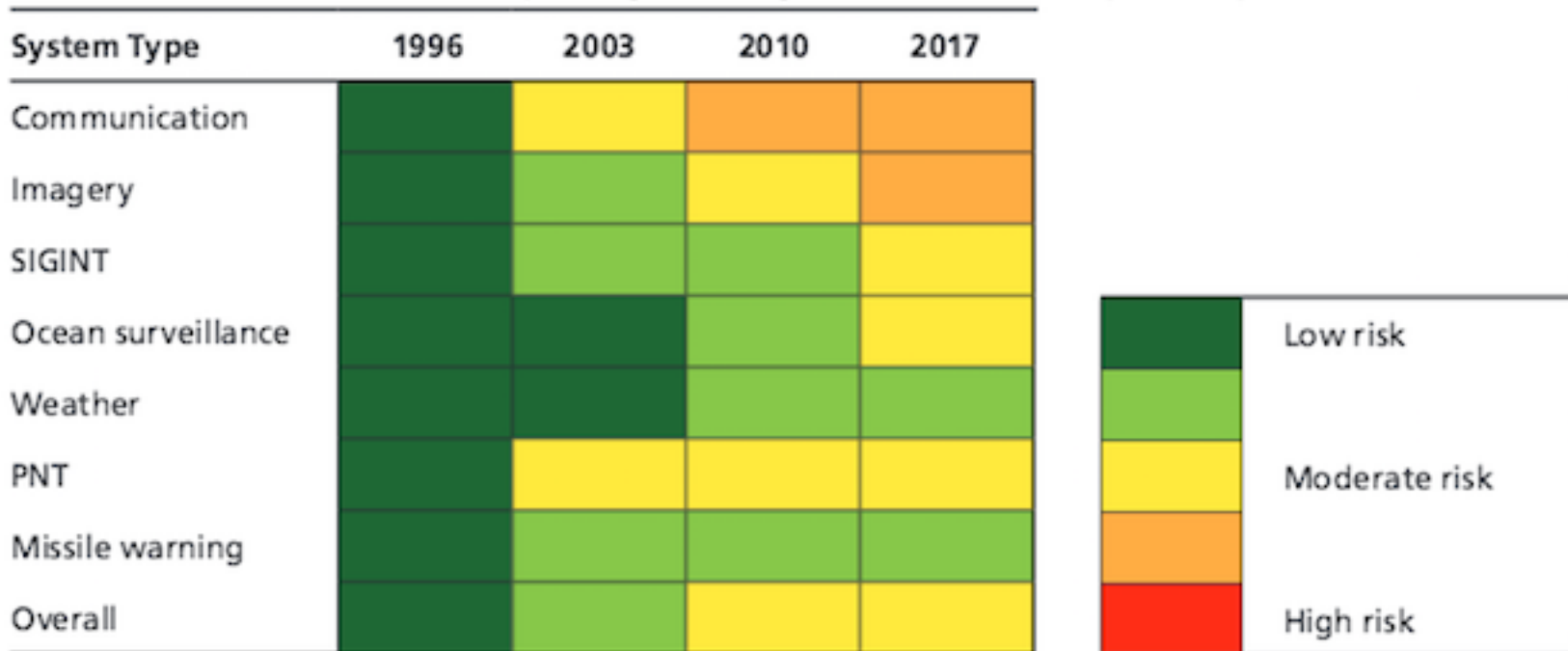


*TEL on launch pad in May 2013.  
Image © DigitalGlobe.*



*Korla Missile Test Complex Jan 2013  
Image © DigitalGlobe.*

## Estimated Risk Posed to U.S. Space Systems by Chinese Counterspace Capabilities



*The U.S.-China military scorecard: Forces, geography, and the evolving balance of power ([RAND 2015](#))*

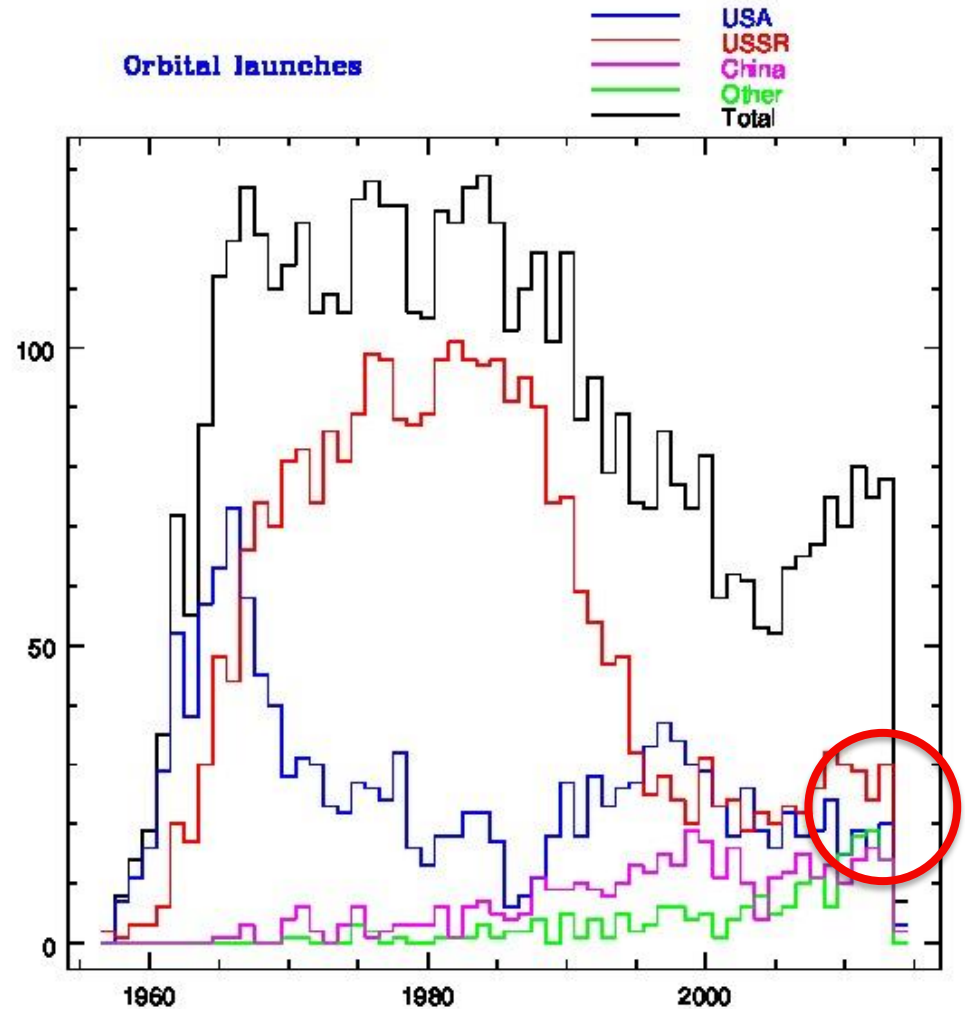


“China Lofts New Satellite, Breaks US Rocket Launch Record”

- *Space.com*, Dec 26, 2011

“China Now Tops U.S. in Space Launches”

- *Wired.com*, Apr 16, 2012



# A resurgent Russia?

- Evidence suggests Russia may have restarted some of its ASAT programs
  - Russian generals quoted on having “retained” capability, must “respond to U.S. and China tests”
  - Media reports of new test flights of Russian fighter-launched ASAT
  - Media reports of 1<sup>st</sup> “successful” test of Nudol missile defense system
- Rumors that Russian electronic warfare, cyber, and jamming capabilities have been on display in Ukraine and Syria
- But Russia is still far from the power that they were, and faces huge challenges



*Possible image of Nudol TEL.  
Image credit: [Live Journal](#)*

# Rendezvous and proximity ops (RPO)

- Chinese RPO demonstrations
  - 2010: SJ-12 with SJ-06F, possible bump
  - July 2013: SY-7 with SJ-7
  - May 2014: SY-7 with SJ-7
- Russian RPO demonstrations
  - Nov 2014: Cosmos 2499 with Briz-KM upper stage
  - Jan 2015: Cosmos 2499 with Briz-KM upper stage
  - April 2015: Cosmos 2504 with Briz-KM upper stage, possible bump
- Russian “Luch” satellite parked near American commercial communications satellites in geostationary orbit

# What's a weapon and what's a tech demo?

- A mid-course missile defense system is effectively a LEO direct ascent ASAT, with different guidance software
  - American SM-3 and Aegis used to destroy USA 193
  - Chinese SC-19 tested against ballistic targets
  - Russian Gorgon ABM system
- Chinese and Russian RPO activities essentially duplicates last decade of U.S. RPO testing
  - DARPA OrbitalExpress (servicing/refueling)
  - NASA DART (which bumped into MUBLCOM)
  - AFRL XSS-11 (rendezvous with its rocket body, likely other sats)
  - AFRL ANGELS (rendezvous with its rocket body in GEO graveyard)



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# U.S. POLICY RESPONSES

# Improving space situational awareness (SSA)

- Developing and deploying new sensors, focus on space-based
  - S-Band Space Fence being built on Kwajalein
  - Geostationary Space Situational Awareness Program (GSSAP) monitoring high value satellites in GSO
  - Space-Based Space Situational Awareness Satellite (SBSS) follow-on
- Signed 63 data sharing agreements with foreign countries and commercial satellite operators
- Emerging private sector capabilities
  - AGI's Commercial Space Operations Center (ComSpOC) plans to be “on par” with U.S. military catalog by end of 2016
  - Multiple other private sector entities getting into the game and innovating

# Pondering space traffic management (STM)

- Review federal agency roles/responsibilities for implementing space debris mitigation guidelines
- Shift some responsibility for SSA to a civil agency?
- Who should have authority for on-orbit operations?
  - Power to mandate collision avoidance maneuvers?
- Active removal of space debris?
  - Which agency does it?
  - Who pays?

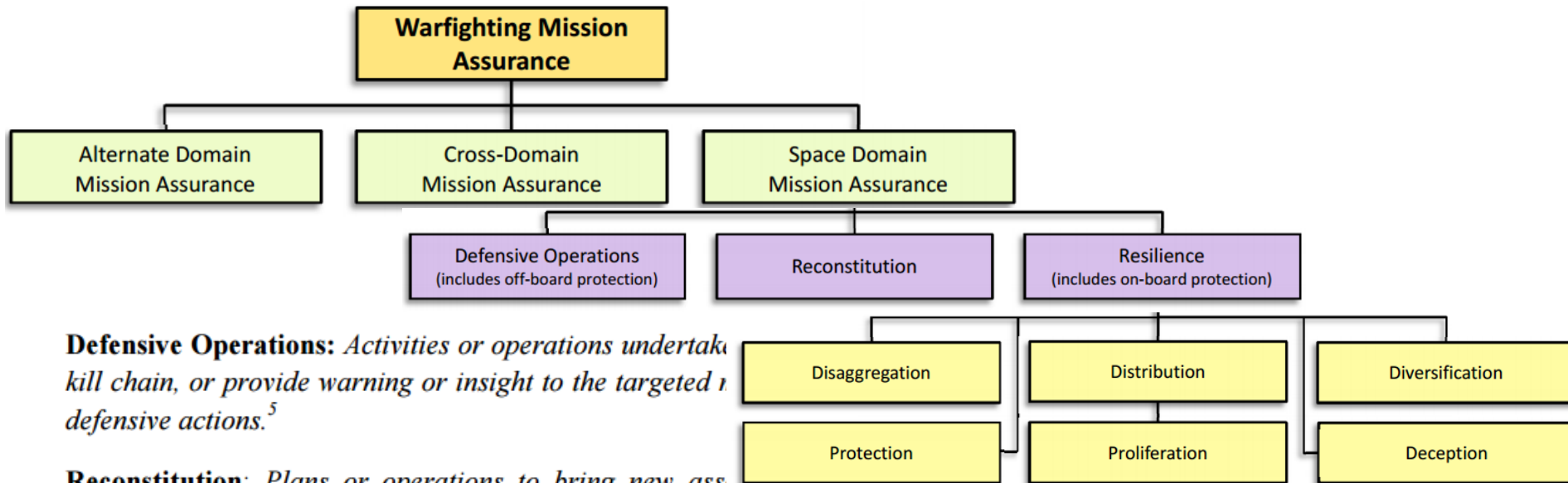


# International engagement

- Stronger cooperation with allies and partners
  - Signed Combined Space Operations (CSpO) agreement with Australia, Canada, United Kingdom, and New Zealand
  - Considering future expansion to France, Germany, and Japan
- International discussions
  - Guidelines for long-term sustainability of space
  - Norms of behavior for space activities (governments and private sector)
  - Transparency and confidence building measures (TCBMS) to reduce risk of mistakes and misperceptions



# Focus on space mission assurance



**Defensive Operations:** *Activities or operations undertaken to disrupt the kill chain, or provide warning or insight to the targeted and to enable defensive actions.*<sup>5</sup>

**Reconstitution:** *Plans or operations to bring new assets (e.g., replacement satellites or activating new ground stations) in order to replenish lost or diminished functions to an acceptable level for a particular mission, operation, or contingency after an attack or catastrophic event.*<sup>5</sup>

**Resilience:** *The ability of an architecture to support the functions necessary for mission success with higher probability, shorter periods of reduced capability, and across a wider range of scenarios, conditions, and threats, in spite of hostile action or adverse conditions [...].*<sup>6</sup>

Source: [Office of the Secretary of Defense](#)

# Shift towards a “warfighting” culture

- Stronger integration between military and IC on space
  - Joint Space Doctrine and Tactics Forum (JSDTF)
  - Improve collaboration and coordination on space operations
  - Develop tactics, techniques, and procedures for responding to attacks on space capabilities
- Renewed focus on operating in a contested environment
  - Creation of the Joint Interagency and Combined Space Operations Center (JICSpOC) at Schriever AFB, CO
  - “Experiment” with scenarios

“I hope to never fight a war in space. It’s bad for the world. Kinetic [anti-satellite weaponry] is horrible for the world. But if war does extend into space, we have to have offensive and defensive capabilities to respond with, and Congress has asked us to explore what those capabilities would be.

- General John Hyten



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**Thank you.  
Questions?**

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