MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Introdução à Economia no Setor Espacial

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Seminário apresentado em 12/07/2018

Curso de Inverno 2018 - Introdução às Tecnologias Espaciais

Conteúdo

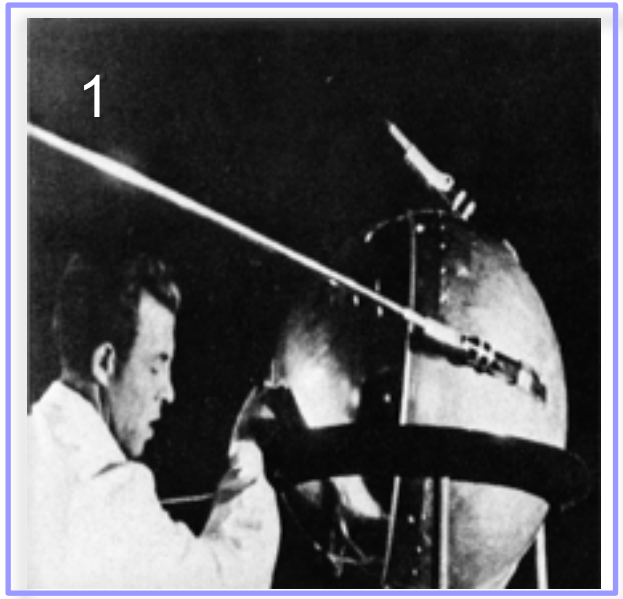
- Velha Economia Espacial Vs Nova Economia Espacial
- Economia Espacial: Definições e principais atividades
- Entrepreneurs
- Sustentabilidade Espacial
- Visão da Economia Espacial até 2030

Velha Economia Espacial

Vs.

Nova Economia Espacial

Economia Espacial durante a Corrida Espacial

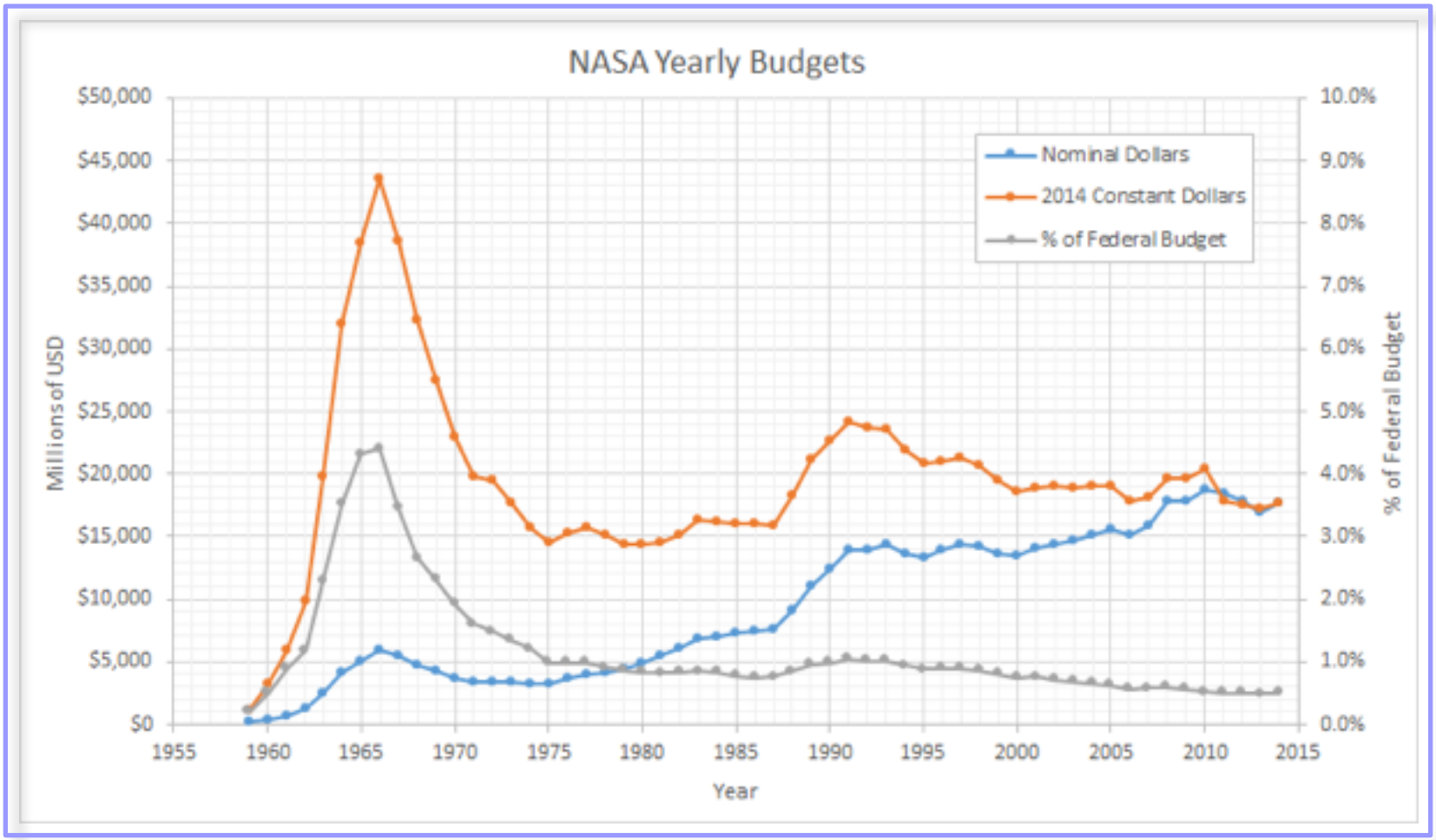


1) Sputnik: O Primeiro Satélite Artificial (1957)

2) Y. Gagarin: O Primeiro Homem no Espaço (1961)

3) N. Armstrong: O Primeiro Homem na Lua (1969)

Orçamento da NASA



https://upload.wikimedia.org/wikipedia/en/1/1a/NASA_budget_linegraph_BH.PNG

NASA recebe US$ 20,7 bilhões em conta de dotações orçamentárias em 2018

http://spacenews.com/nasa-receives-20-7-billion-in-omnibus-appropriations-bill/

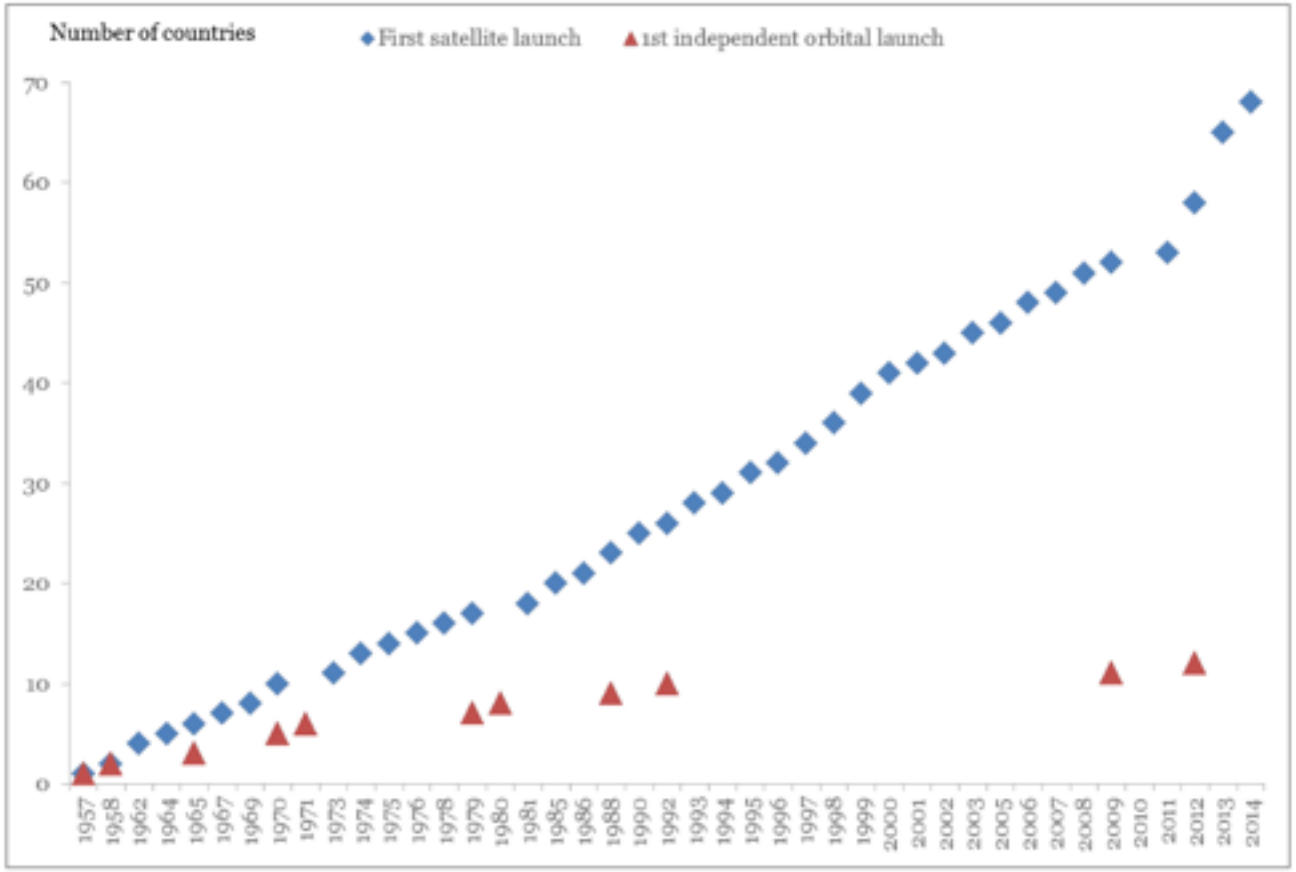
Tabela Orçamentária do Ano Fiscal de 2018 (todos os valores em milhões de dólares)

Account	FY18 Request	House CJS	Senate CJS	Omnibus
SCIENCE	$5,711.8	$5,858.5	$5,571.8	$6,221.5
– Earth Science	$1,754.1	$1,704.0	$1,921.0	$1,921.0
– Planetary Science	$1,929.5	$2,120.9	$1,611.9	$2,227.9
– Astrophysics	$816.7	$822.0	$816.7	$850.4
– JWST	$533.7	$533.7	$533.7	$533.7
– Heliophysics	$677.8	$677.9	$688.5	$688.5
SPACE TECHNOLOGY	$678.6	$686.5	$700.0	$760.0
AERONAUTICS	$624.0	$660.0	$650.0	$685.0
EXPLORATION	$3,934.1	$4,550.0	$4,395.0	$4,790.0
– SLS	$1,937.8	$2,150.0	$2,150.0	$2,150.0
– Orion	$1,186.0	$1,350.0	$1,350.0	$1,350.0
– Ground Systems	$460.4	$600.0	$545.0	$895.0
– Exploration R&D	$350.0	$450.0	$350.0	$395.0
SPACE OPERATIONS	$4,740.8	$4,676.6	$4,751.5	$4,751.5
EDUCATION	$37.3	$90.0	$100.0	$100.0
SAFETY, SECURITY, AND MISSION SERVICES	$2,830.2	$2,826.2	$2,826.9	$2,826.9
CONSTRUCTION	$496.1	$486.1	$496.1	$562.2
INSPECTOR GENERAL	$39.3	$37.9	$38.0	$39.0
TOTAL	$19,092.2	$19,871.8	$19,529.3	$20,736.1

http://spacenews.com/nasa-receives-20-7-billion-in-omnibus-appropriations-bill/

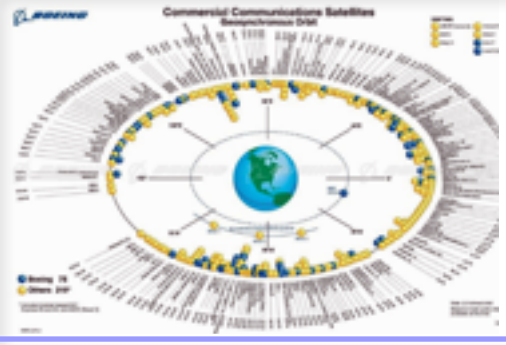
Almost 70 countries with satellites in orbit…

Number of countries with satellites (launched independently or via a third party)

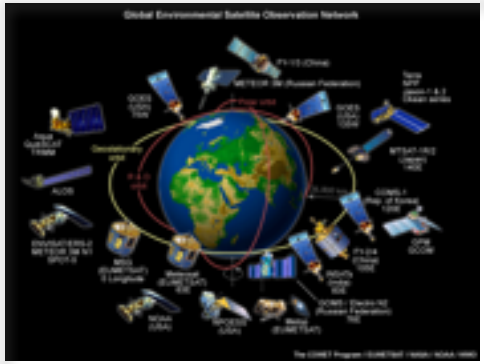


Source: OECD, 2015.

Importância Econômica e Estratégica



Comunicar em qualquer lugar do mundo e divulgar informações e dados em grandes áreas, independentemente do estado da rede de estações terrenas.



Observar qualquer lugar na Terra com precisão e em amplo espectro de freqüências, de maneira não intrusiva

Localizar com níveis crescentes de precisão um objeto fixo ou móvel em qualquer lugar na superfície do globo.

OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Velha Economia Espacial: Alguns Participantes

NASA

LOCKHEED

MARTIN MARIETTA

LOCKHEED MARTIN

BOEING

esa

European Space Agency

AEROSPATIALE

MATRA

AEROSPATIALE MATRA

Nova Economia Espacial: Alguns Participantes Famosos

NASA

ULA United Launch Alliance

SPACEX

BLUE ORIGIN

BIGELOW AEROSPACE

zero G the weightless experience

PLANETARY RESOURCES

Virgin GALACTIC

esa European Space Agency

ThalesAlenia Space A Thales / Finmeccanica Company

AIRBUS DEFENCE & SPACE

Velha Economia Espacial vs Nova Economia Espacial

Velha Economia Espacial:
- grandes programas de governo,
- poucos grandes contratados,
- pouca competição e
- nenhum crescimento.

Nova Economia Espacial:
- uma mistura de programas de governo e comercial,
- uma diversidade de contratados,
- grande competição e
- crescimento exponencial

http://spacenews.com/new-space-economy/

Economia Espacial:

Definições

e

Principais Atividades

Definição da Economia Espacial - OCDE 2011

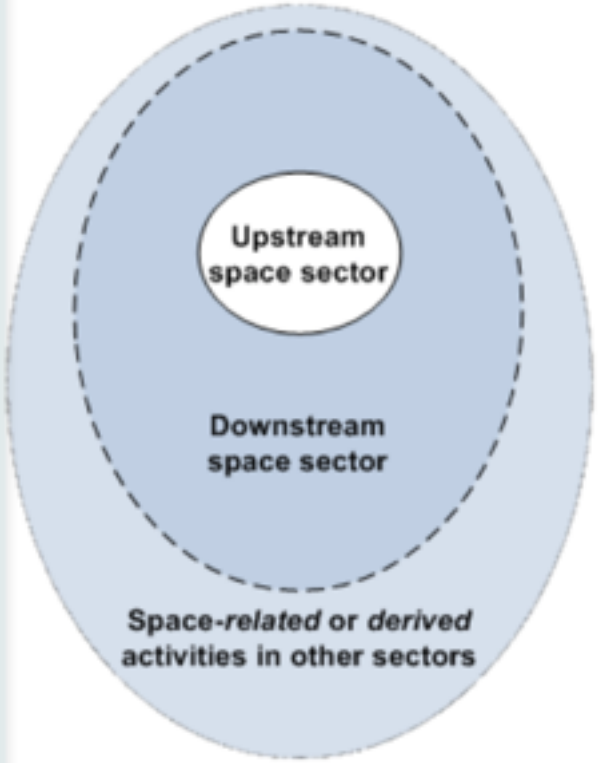
A economia espacial é a gama completa de atividades e o uso de recursos que criam e fornecem valor e benefícios para os seres humanos no decurso da exploração, conhecimento, gestão e utilização do espaço.

Por isso, inclui todos os atores públicos e privados envolvidos no desenvolvimento, e usando produtos e serviços relacionados ao espaço, que vão desde pesquisa e desenvolvimento, fabricação e utilização de infra-estruturas espaciais (veículos de lançamento, satélites, estações terrenas,), aplicações derivadas do espaço (equipamento de navegação, telefones por satélite, serviços meteorológicos, etc.) e o conhecimento científico gerado por tais atividades.

Segue-se que a economia espacial vai muito além do próprio setor espacial, já que compreende também a crescente e contínua mudança dos impactos (quantitativos e qualitativos) dos produtos derivados do espaço, serviços e conhecimentos sobre a economia e a sociedade.

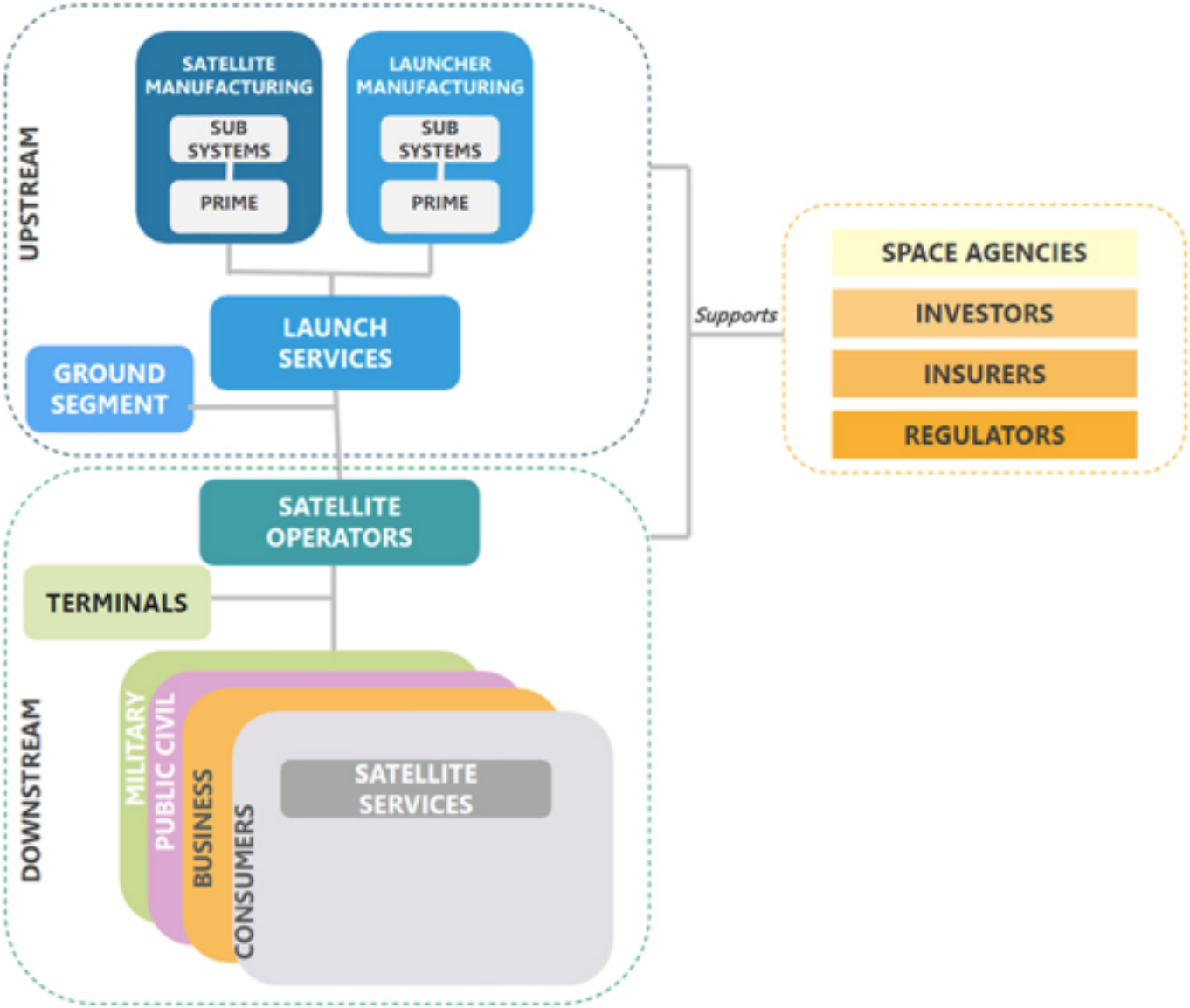
http://www.keepeek.com/Digital-Asset-Management/oecd/economics/oecd-handbook-on-measuring-the-space-economy/definitions-and-industrial-classifications_9789264169166-3-en#page6

Definição dos perímetros do setor espacial e suas atividades derivadas

Main perimeters	Activities	Products and services
	Upstream space sector = scientific research, R&D, manufacturing and production	Upstream space sector = space research/technology/product/ service specific to the space sector (e.g. astronomy research, satellite, sub-system, space component manufacturing)
	Downstream space sector = space-*enabled* activities which WOULD not exist/function without satellite signal or data	Downstream space sector = space-enabled product/service (e.g. satellite television broadcast, selected GIS, GPS-enabled devices and dedicated ancillary services (e.g. insurance)
	Space-*related* or *derived* activities in other sectors = activities in various economic sectors that may derive from or have relied on space technology transfers to develop	Space-*related* or *derived* activities in other sectors = activities/products/ services that are derived from space technology, but not dependent on it to function (e.g. ad hoc spin-offs in the automobile or medical industry)

OECD (2016), *Space and Innovation*, OECD Publishing, Paris. *http://dx.doi.org/10.1787/9789264264014-en*

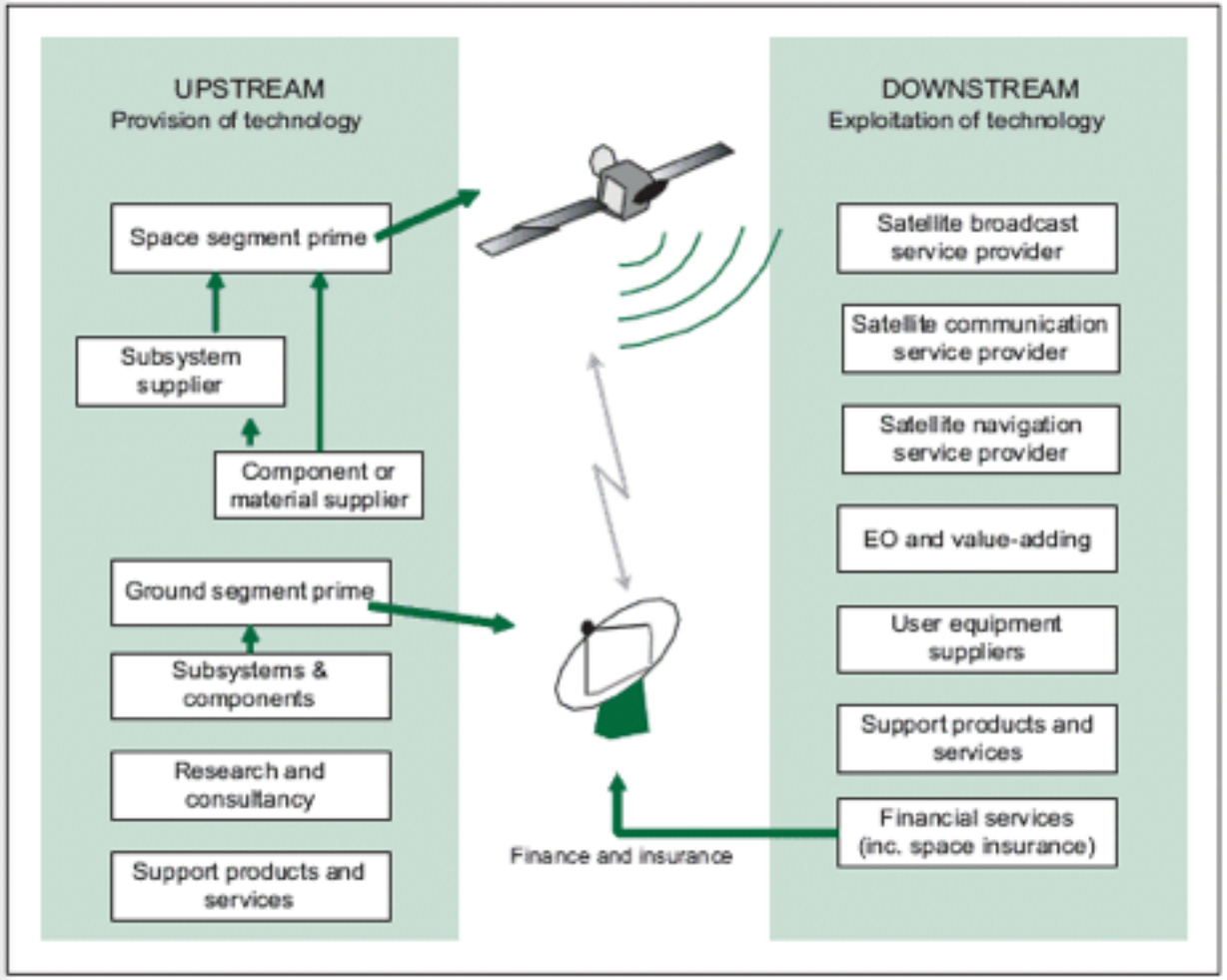
Upstream e Downstream



http://www.asc-csa.gc.ca/eng/publications/2015-assessment-canadian-space-sector.asp#fig01

Cadeia de Valores: componentes Upstream and Downstream

- **Upstream** é composto pelas entidades que constroem a infraestrutura espacial (satélites, lançadores, segmento de terra) e fornece um sinal para os usuários
- **Downstream** fornece os produtos e serviços

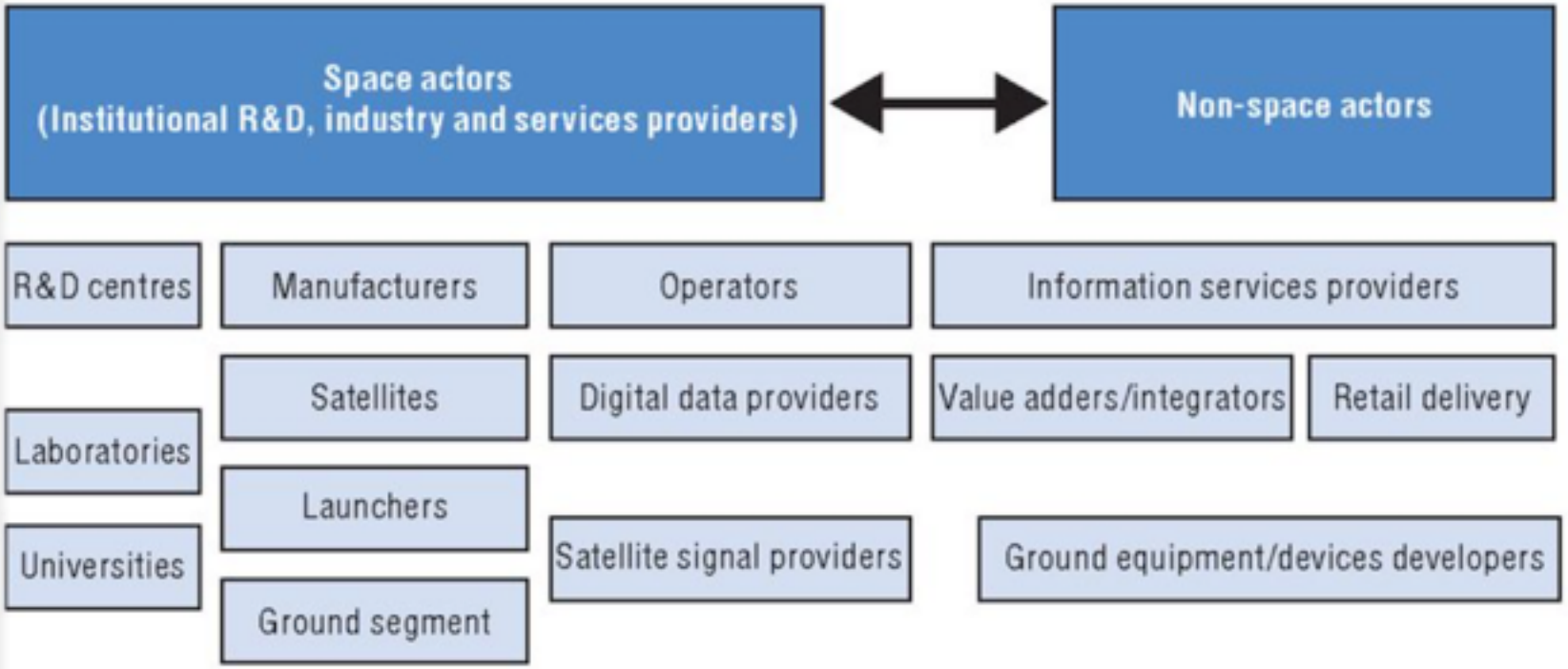


Exemplo:
O Setor Espacial no Reino Unido

https://publications.parliament.uk/pa/cm200607/cmselect/cmsctech/66/6608.htm

Atores da Economia Espacial

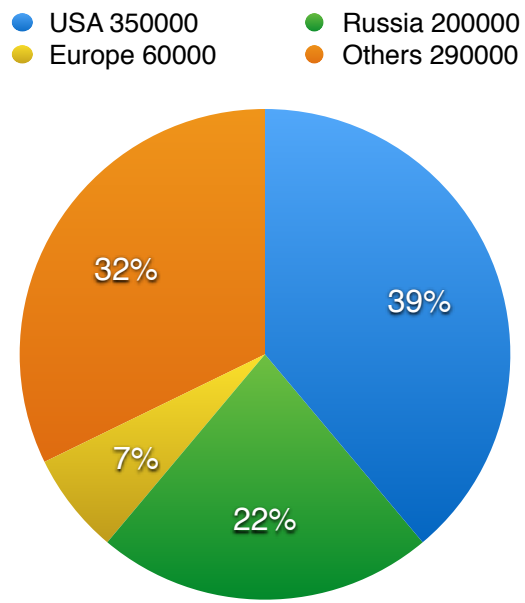
Figure 2.1. **The space economy's simplified value chain**



Source: Adapted from OECD (2011), *The Space Economy at a Glance 2011*, OECD Publishing, http://dx.doi.org/10.1787/9789264111790-en, p. 15.

http://www.keepeek.com/Digital-Asset-Management/oecd/economics/oecd-handbook-on-measuring-the-space-economy/definitions-and-industrial-classifications_9789264169166-3-en#page6

Força de Trabalho Global: 900.000 Empregos (2013)



Incluídos: as administrações públicas com responsabilidades na gestão de atividades espaciais e de financiamento público de programas de pesquisa e desenvolvimento (agências espaciais,departamentos de organizações espaciais em questões civis e de defesa), a indústria de fabricação do setor espacial(construção de foguetes, satélites, sistemas terrestres),fornecedores para esta indústria e o amplo setor de serviços espaciais (principalmente telecomunicações satélites comerciais)

Não incluídos: universidades, militares trabalhando em programas classificados

OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Cadeia de Suprimentos de Fabricação Espacial

Primes: Projeto e montagem de sistemas completos de espaçonaves (telecomunicações, satélites de observação da Terra, lançadores, cápsulas para missão tripulada)

Airbus Space and Defence (FRA, DEU), Thales Alenia Space (FRA, ITA),

Orbitale Hochtechnologie Bremen (OHB System) (DEU), MacDonald, Dettwiler and Associates (MDA) (CAN),

Lockheed Martin (USA), Boeing (USA), Space Systems/Loral (USA),

Orbital Sciences Corporation (USA); Northrop Grumman Space Technology (USA),

Mitsubishi Heavy Industries (JPN), Alenia Spazio (ITA),

Surrey Satellite Technology Ltd (GBR), China Aerospace Science and Technology Corporation (CASC) (CHN),

Krunichev State Research and Production Space Center (RUS), Israel Aircraft Industry (ISR)...

OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Cadeia de Suprimentos de Fabricação Espacial

Tier 1: atores intervêm na concepção, montagem e fabricação principais subsistemas (por exemplo, estruturas de satélites, subsistemas de propulsão, carga útil)

Snecma (FRA),

OKB Fakel (RUS),

L-3 ETI (USA),

Aerojet Rocketdyne (USA),

Com Dev (CAN),

UTC Aerospace Systems (USA),

Teledyne Brown Engineering (USA),

Ruag (CHE)

Most of Prime actors…

OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Cadeia de Suprimentos de Fabricação Espacial

Tier 2: atores são fabricantes de equipamentos a serem montados em grandes subsistemas

Sodern (FRA),

APCO Technologies (CHE),

Bradford Engineering B.V (NDL),

Selex ES (ITA),

Airbus' Space Engineering (ITA),

Aeroflex (USA),

Raytheon (USA),

Kongsberg Gruppen (NOR)...

OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Cadeia de Suprimentos de Fabricação Espacial

Tier 3 & 4: atores incluem produtores de componentes e subconjuntos, que tendem a se especializar na produção de aparelhos eletrônicos, elétricos e componentes eletromecânicos (EEE) e materiais (por exemplo, cabos e chaves elétricas)

Composite Optics (USA),

M/A-COM (USA),

Thales Electron Devices (FRA)...

OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Operadoras de Satélites de Telecomunicação: mais de 50 companhias

Eutelsat (FRA),

Intelsat (USA/NDL),

Inmarsat (UK),

Telenor (NOR)...

OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Operadoras de Satélites de Observação da Terra: companhias menores

BlackBridge's Rapid Eye (DEU),

Airbus's Spot Image (FRA),

DMC International Imaging Ltd (UK),

DigitalGlobe (USA),

ImageSat (ISR)...

OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Composição da Indústria Espacial

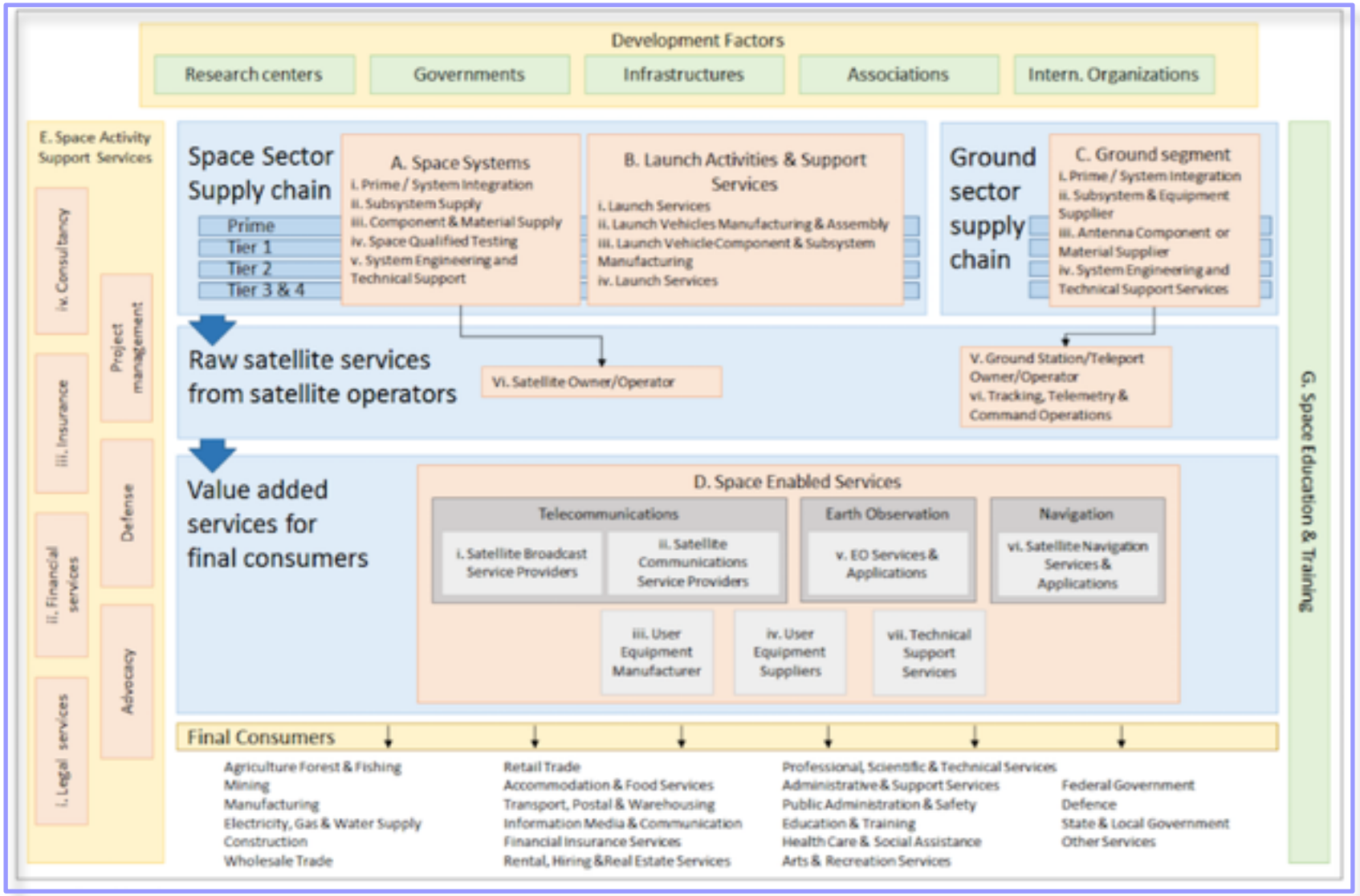


Table 1.1. Space budgets in PPP and per capita for selected countries

	Space budget in USD millions (PPP), 2013	Budget per capita
USA	39 332.2	123.2
CHN	10 774.6	7.9
RUS	8 691.6	61.0
IND	4 267.7	3.3
JPN	3 421.8	26.9
FRA	2 430.8	38.0
DEU	1 626.6	20.1
ITA	1 223.3	20.7
KOR	411.5	8.2
CAN	395.9	11.5
GBR	338.9	5.3
ESP	302.9	6.7
BRA	259.2	1.3
BEL	244.8	21.9
IDN	142.0	0.6
CHE	133.0	16.6
SWE	122.0	12.7
NDL	110.5	6.6
TUR	104.3	1.4
NOR	89.6	18.5
ISR	89.3	11.1
POL	80.7	2.1
ZAF	76.4	1.5
AUT	73.0	8.6
FIN	53.9	9.9
DNK	38.2	6.9
PRT	32.2	3.0
GRC	30.3	2.7
CZE	25.4	2.5
IRL	25.3	5.6
AUS	24.9	1.1
LUX	17.0	34.5
HUN	8.9	0.9
MEX	8.5	0.1
EST	5.4	4.0
SVK	4.8	0.9
SVN	2.9	1.4

Source: OECD calculations based on national data and OECD MEI data.

Ref: The Space Economy at a Glance 2014- OECD

Atividade Espacial Global em 2015

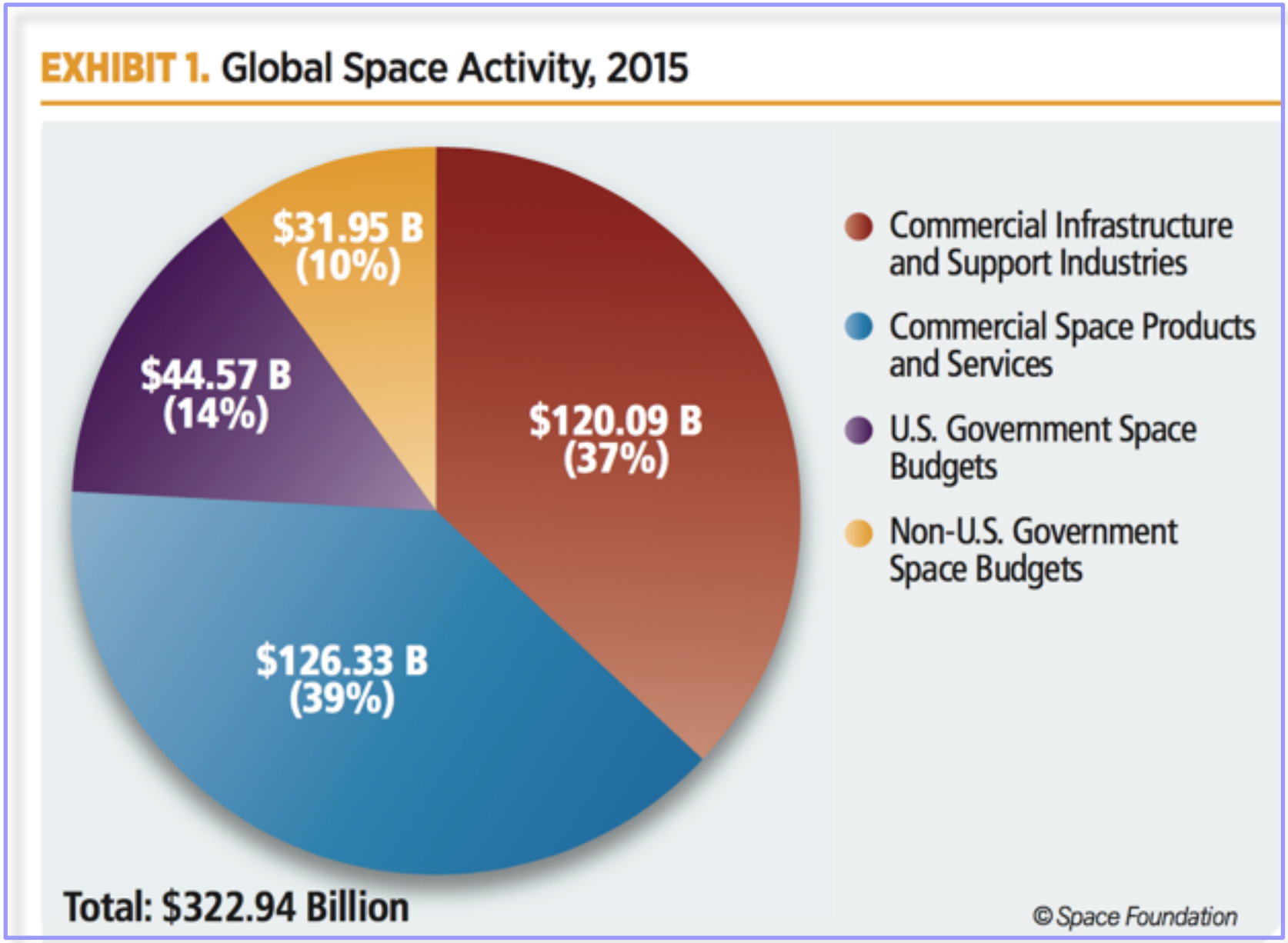
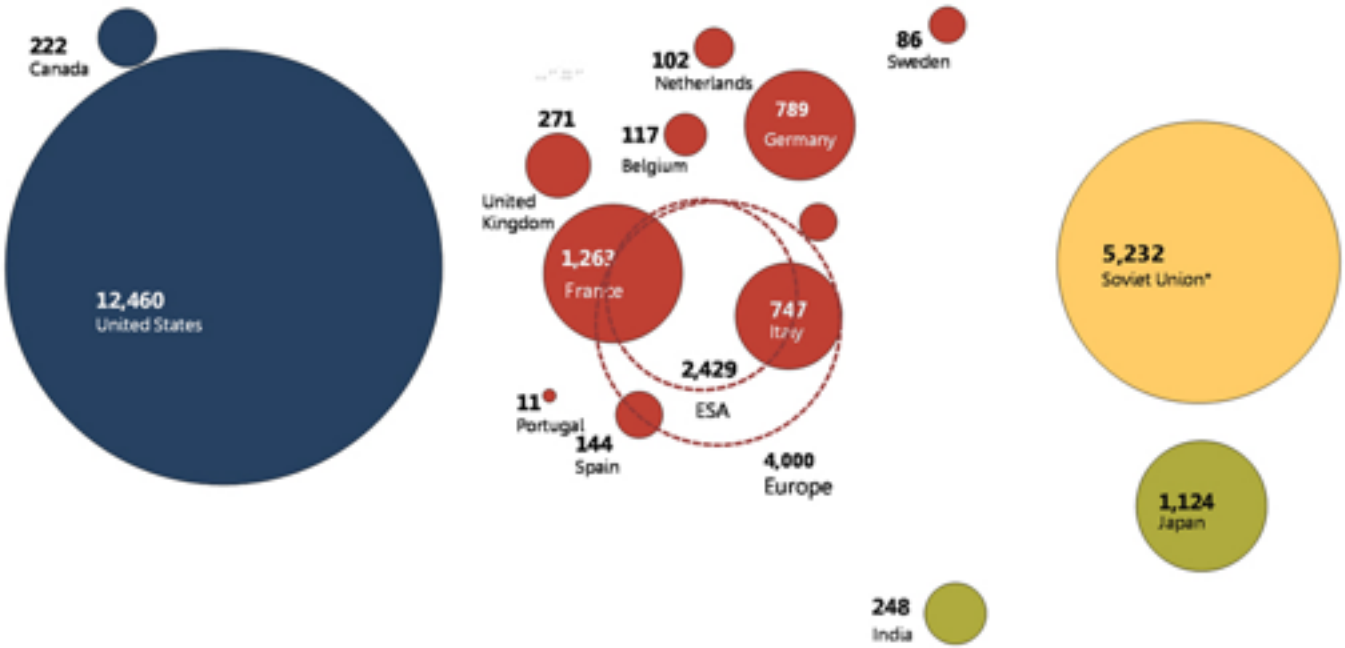


Figure 2: Three decades government civil space expenditures in the world

(Countries spending over $10 million only)

(Current US$ in million)

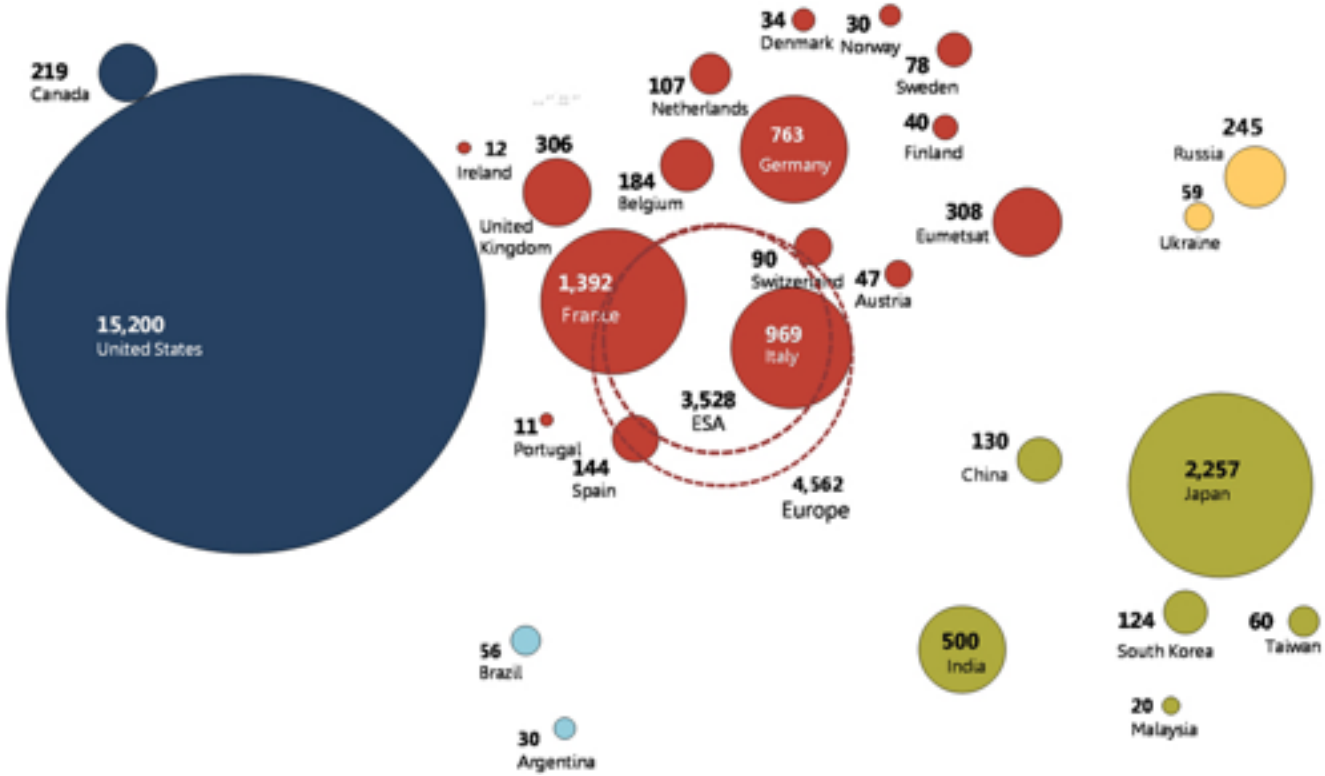
1990: 15 countries - Total ~US$ 23 Billion



http://www.asc-csa.gc.ca/eng/publications/2015-assessment-canadian-space-sector.asp

Figure 2: Three decades government civil space expenditures in the world
(Countries spending over $10 million only)
(Current US$ in million)

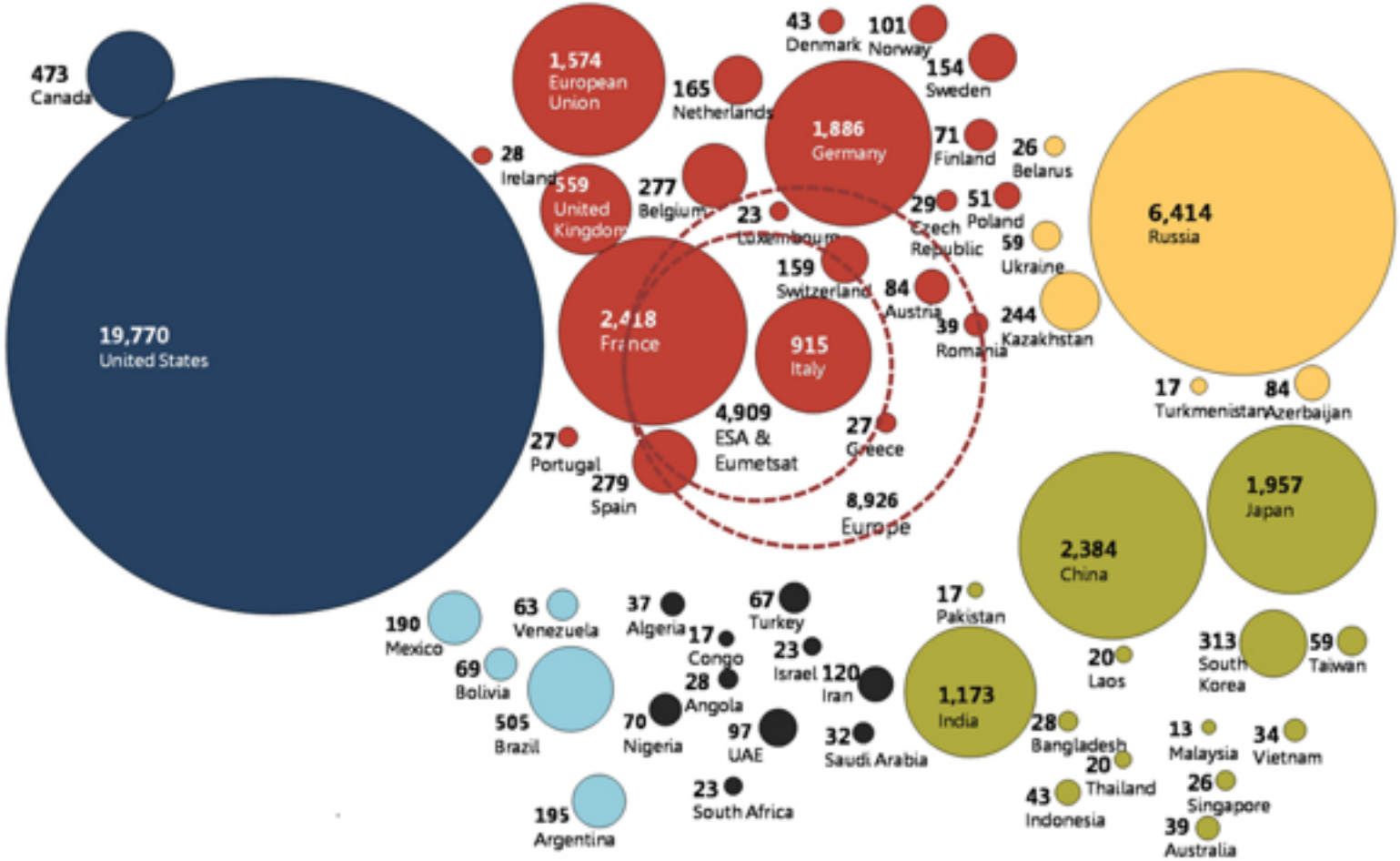
2003: 37 countries



http://www.asc-csa.gc.ca/eng/publications/2015-assessment-canadian-space-sector.asp

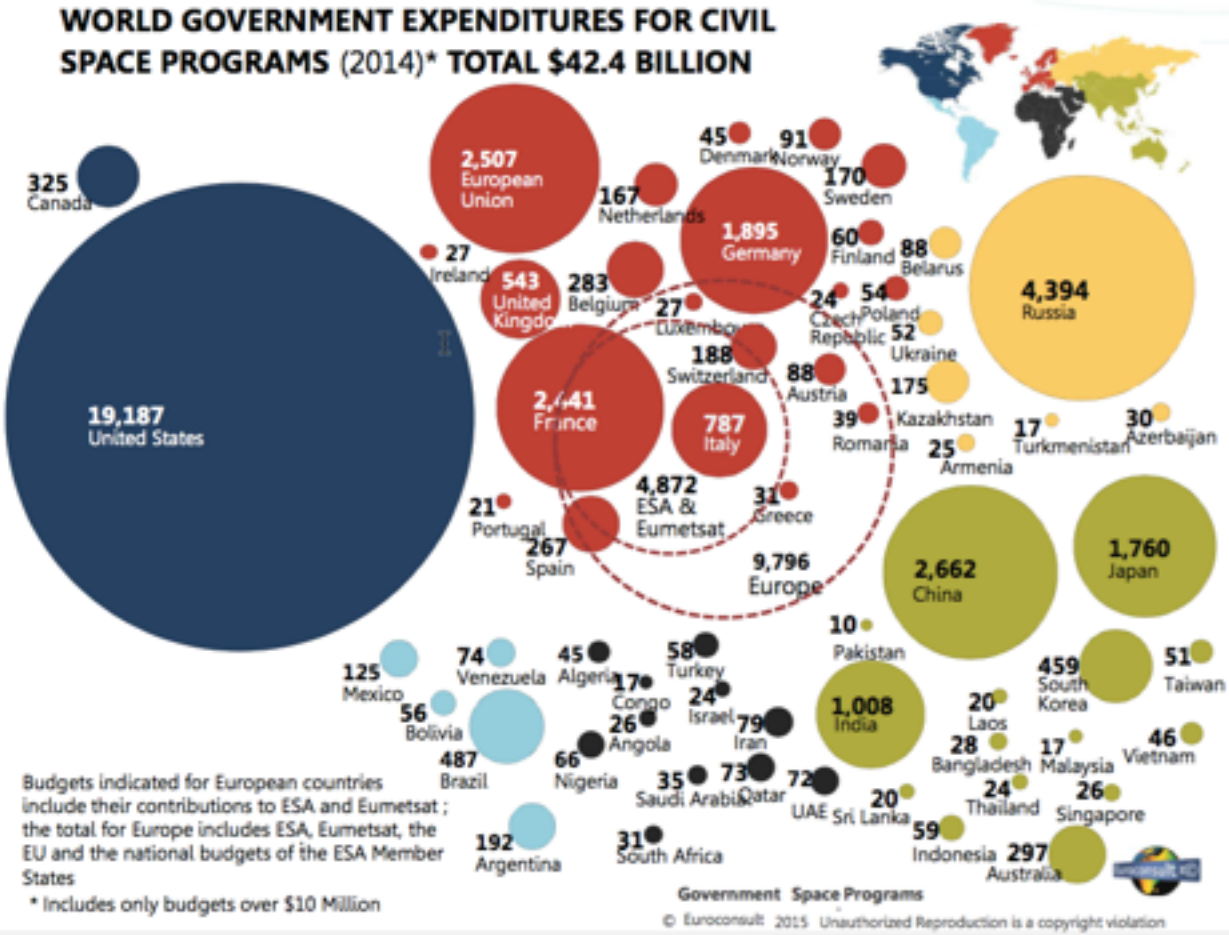
Figure 2: Three decades government civil space expenditures in the world
(Countries spending over $10 million only)
(Current US$ in million)

2013: 58 countries



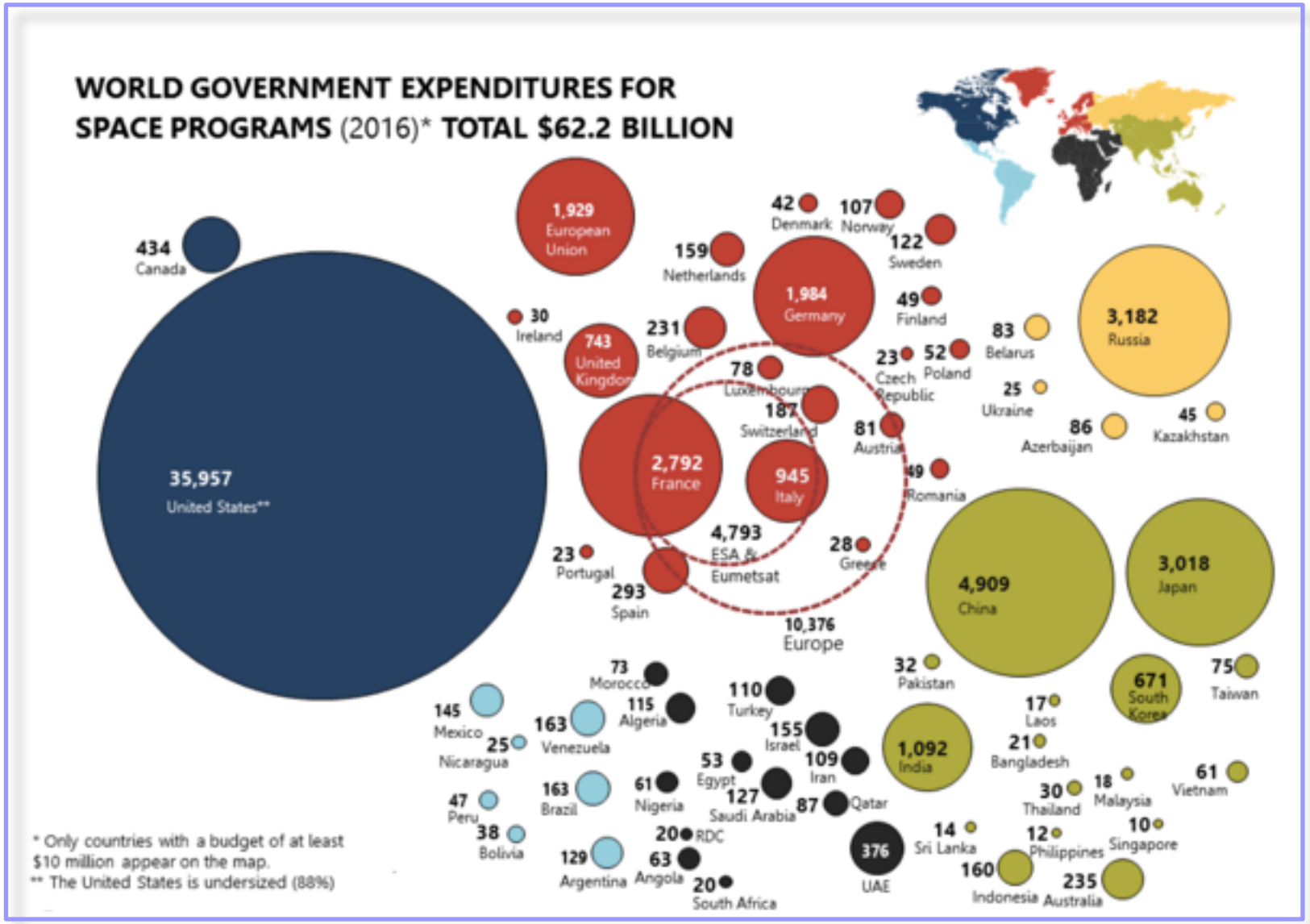
http://www.asc-csa.gc.ca/eng/publications/2015-assessment-canadian-space-sector.asp

TODAY....



SPACE EXPLORATION IN THE SPACE ECONOMY
| ©Euroconsult 2016

http://www.unoosa.org/documents/pdf/copuos/stsc/2016/symp-01E.pdf



http://euroconsult-ec.com/30_May_2017

CHANGING LANDSCAPE FOR GOVERNMENTS

	1995	2005	2015	2025
# COUNTRIES WITH SPACE PROGRAM	15	30	60	80
TOP 3 AS OF WORLD	USA/URSS/ESA 95%	USA/ESA/JAPAN 80%	USA/RUSSIA/CHINA 70%	USA/RUSSIA/CHINA 70%
# GOV SATS LAUNCHED	35	50	86	76
# OF SAT IN OPERATION FROM EMERGING PROGS	20	39	87	155

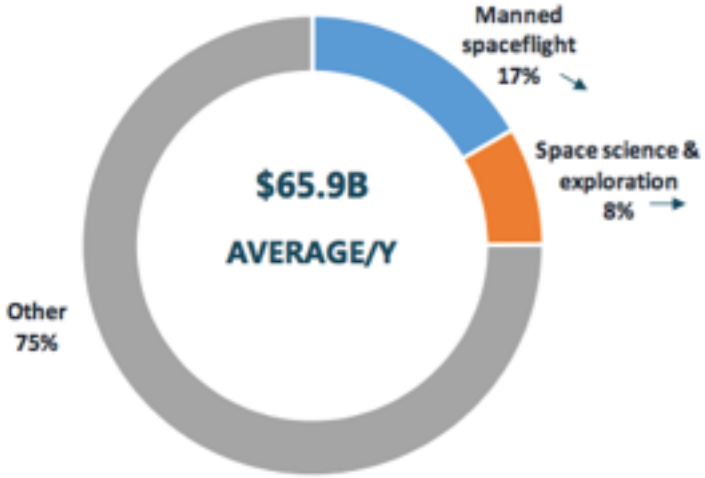
SPACE EXPLORATION IN THE SPACE ECONOMY
| ©Euroconsult 2016

SYMPOSIUM TO STRENGTHEN THE PARTNERSHIP WITH INDUSTRY THE ROLE OF INDUSTRY IN SPACE EXPLORATION; United Nations, Vienna, Feb. 15 2016;by Steve Bochinger, COO

SPACE EXPLORATION & MANNED SPACEFLIGHT IN GOVERNMENT PROGRAMS

WORLD GOV SPENDING FOR SPACE

2006-2015



COUNTRIES INVESTING IN APPLICATIONS

	2004	2013	2023
EO	28	55	62
Satcom	20	48	61
Science & exploration	18	25	28
Launchers	11	15	16
Security	4	8	11
Satnav	6	9	9
Manned Spaceflight	7	8	8

SPACE EXPLORATION IN THE SPACE ECONOMY
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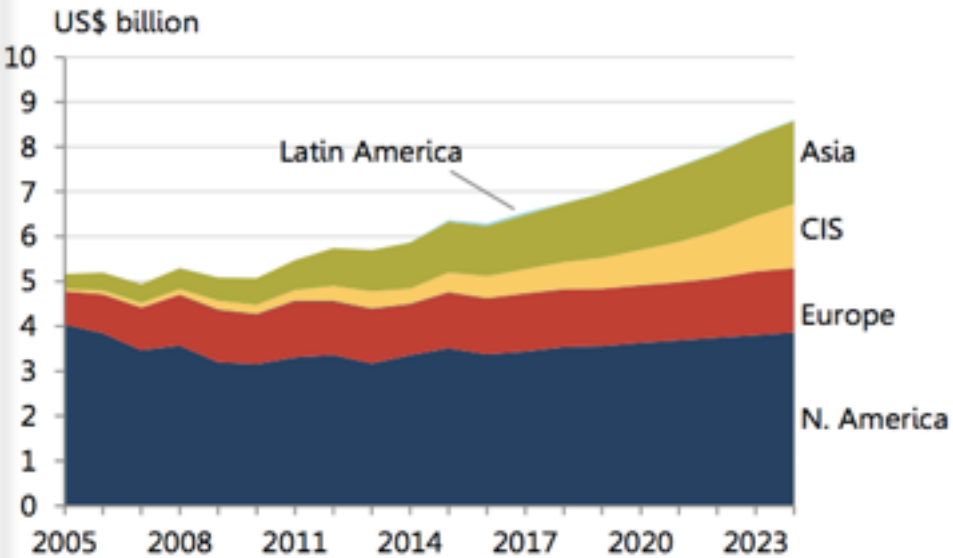
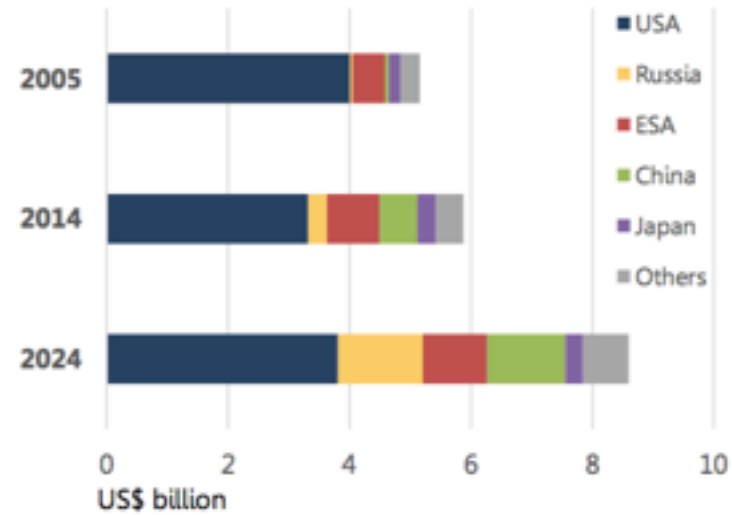
http://www.unoosa.org/documents/pdf/copuos/stsc/2016/symp-01E.pdf

GROWING INTEREST FOR SPACE EXPLORATION

SPACE SCIENCE AND EXPLORATION SPENDING BY REGION



CONCENTRATION OF SPENDING



SPACE EXPLORATION IN THE SPACE ECONOMY
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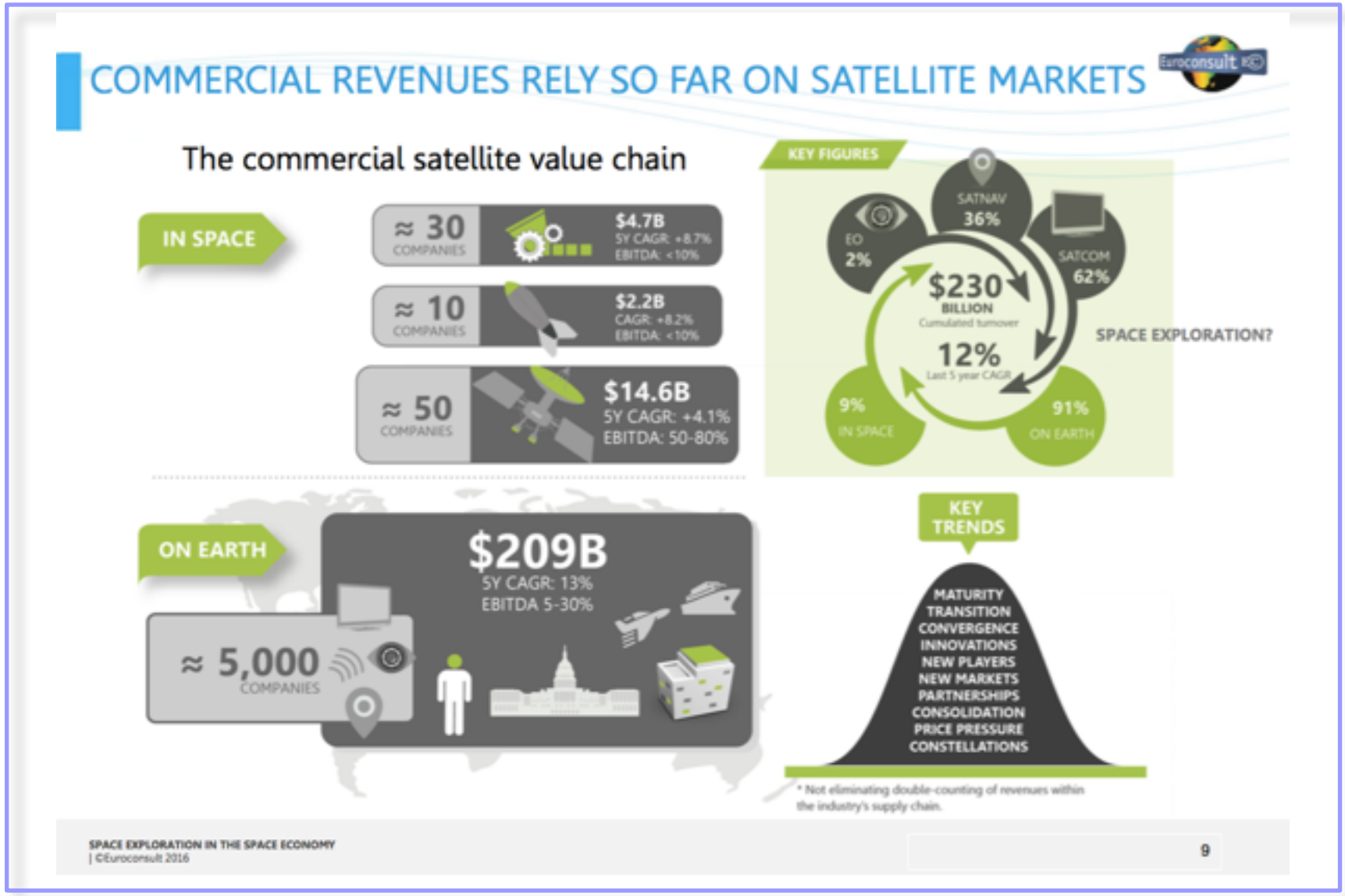
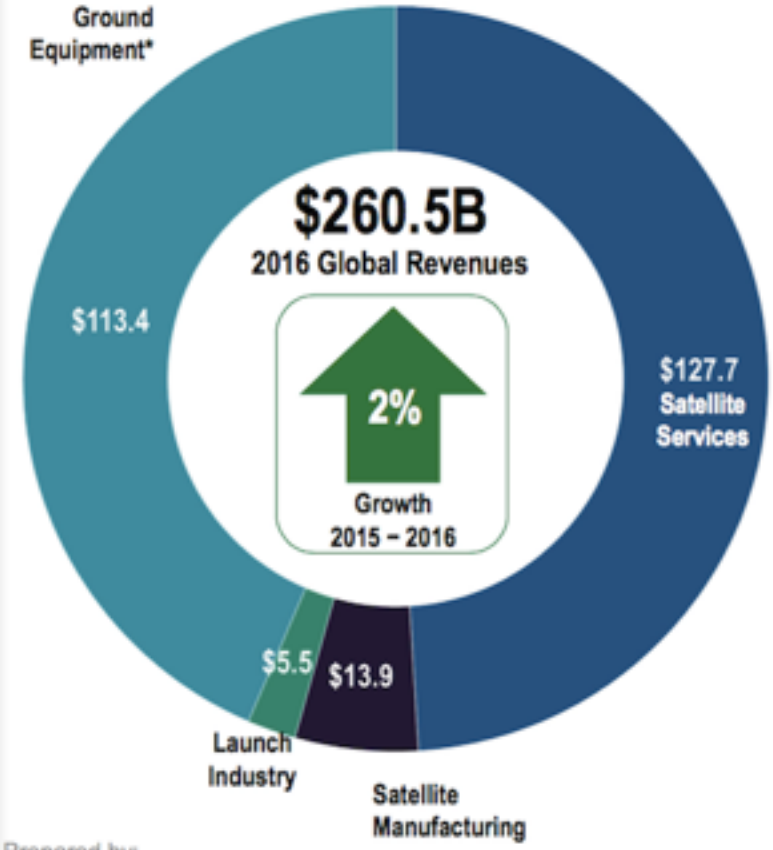
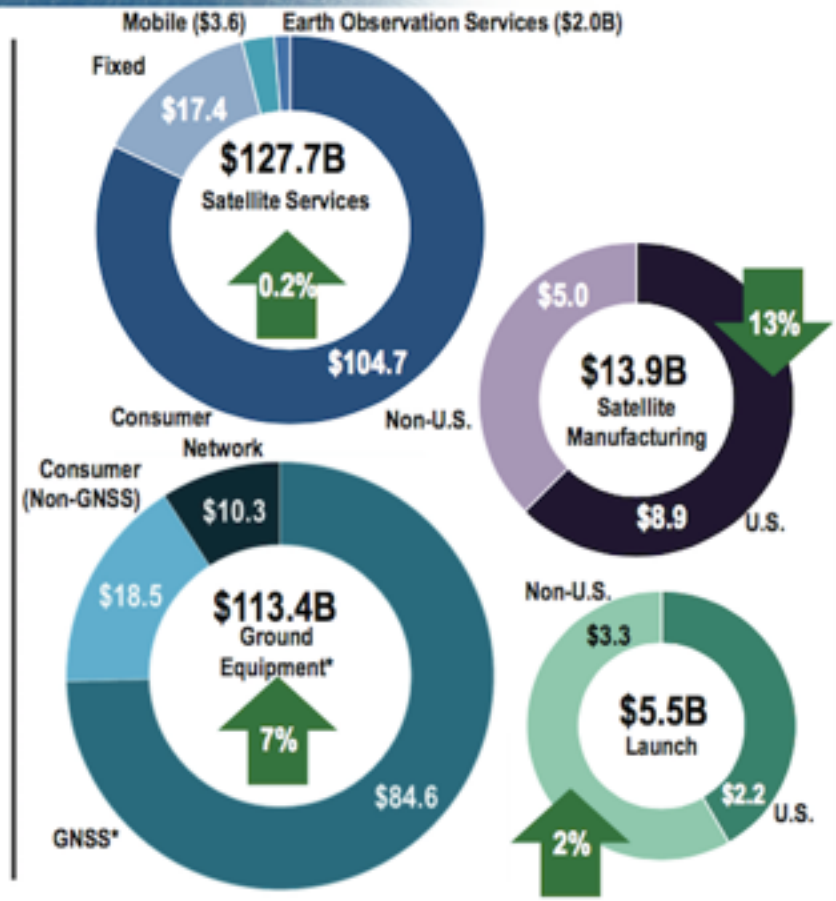
Receitas do setor espacial comercial



http://www.unoosa.org/documents/pdf/copuos/stsc/2016/symp-01E.pdf

2016 Satellite Industry Indicators Summary





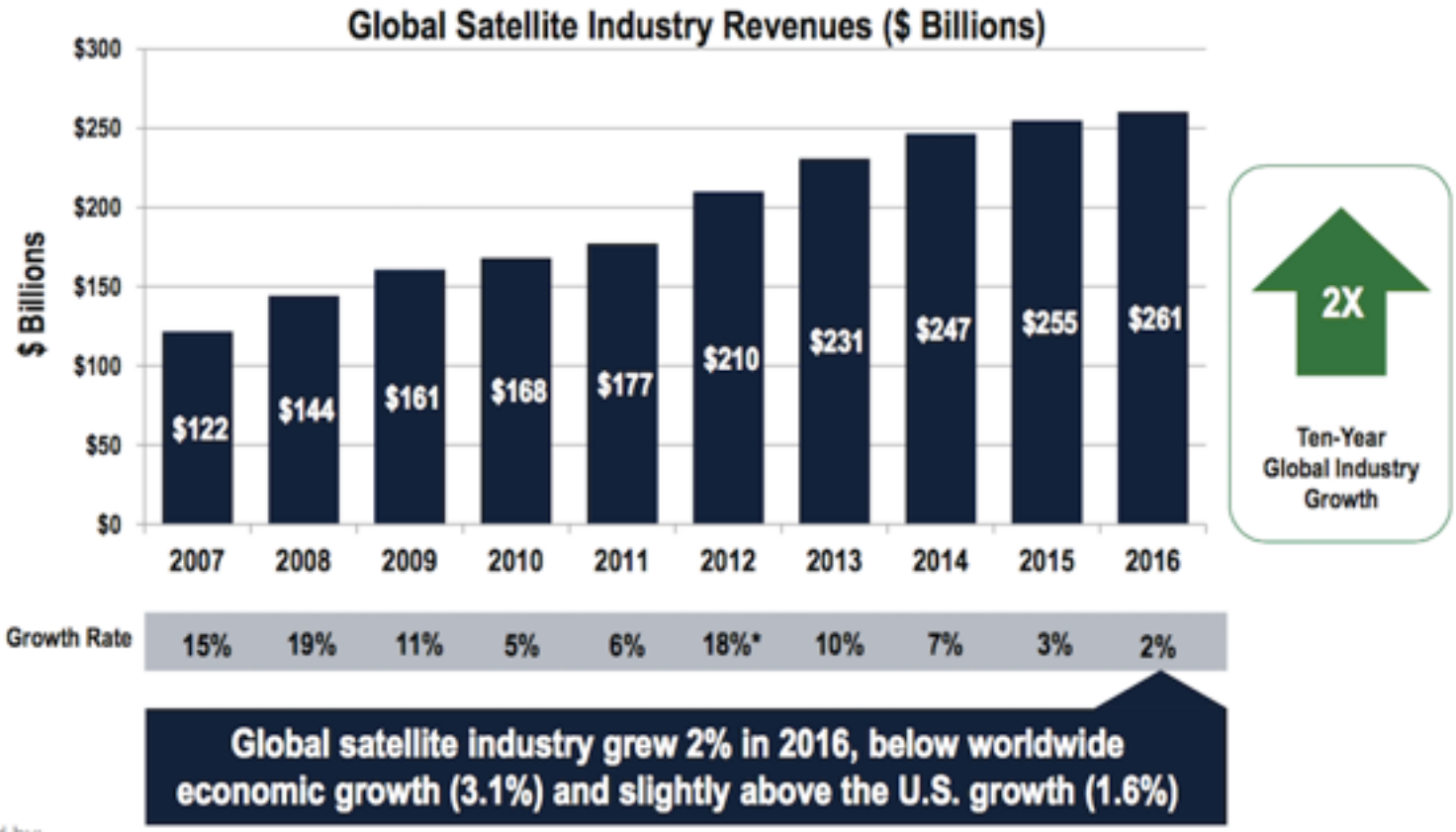
Prepared by:

BRYCE
Formerly Tauri Group Space and Technology

*Ground equipment revenues include the entire GNSS segment: stand-alone navigation devices and GNSS chipsets supporting location-based services in mobile devices; traffic information systems; aircraft avionics, maritime, surveying, and rail .

4

Global Satellite Industry Revenues



Prepared by:

BRYCE
Formerly Tauri Group Space and Technology

*Beginning with 2012, ground equipment revenues include the entire GNSS segment: stand-alone navigation devices and GNSS chipsets supporting location-based services in mobile devices; traffic information systems; aircraft avionics, maritime, surveying, and rail.

5

Inovação no Setor Espacial

Três impulsos abrangentes estão impulsionando a inovação no setor espacial:

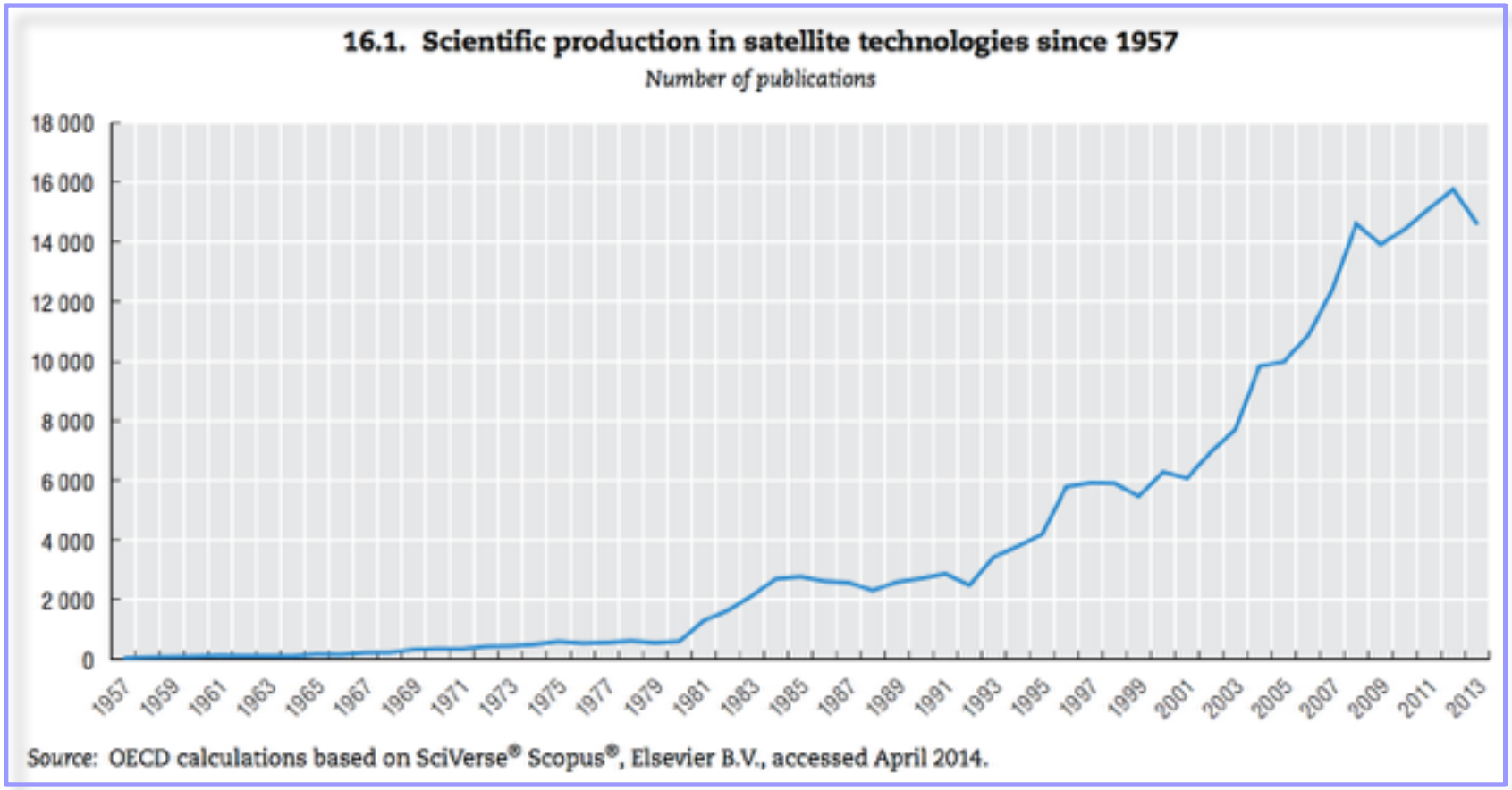
a persistência dos objetivos de segurança nacional e ciência com cada vez mais países investindo em programas espaciais,

a expansão das aplicações espaciais no setor downstream, e

a busca da exploração espacial humana

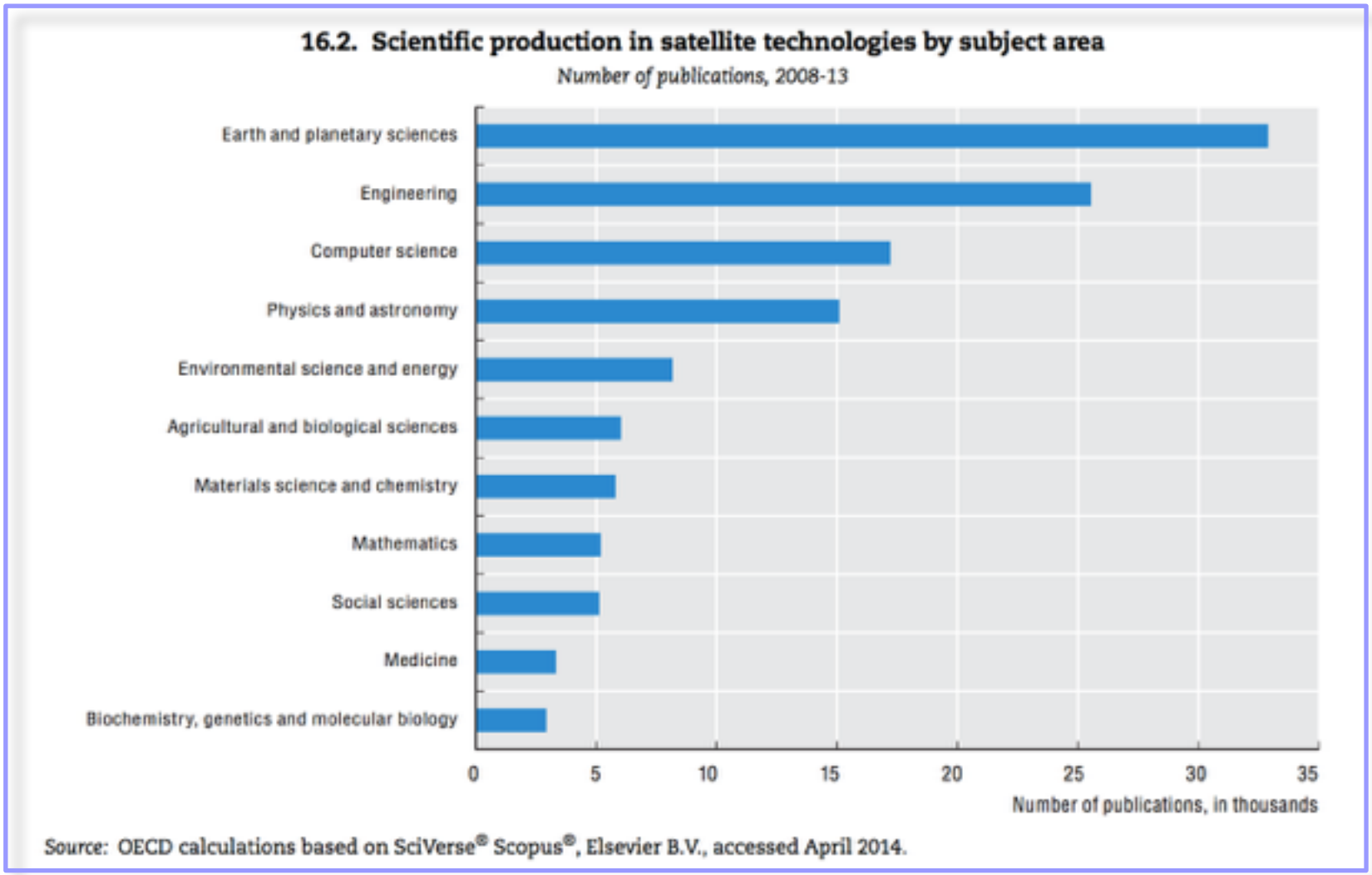
OECD (2016), *Space and Innovation*, OECD Publishing, Paris. *http://dx.doi.org/10.1787/9789264264014-en*

Produção Científica no Setor Espacial (P&D/Inovação)



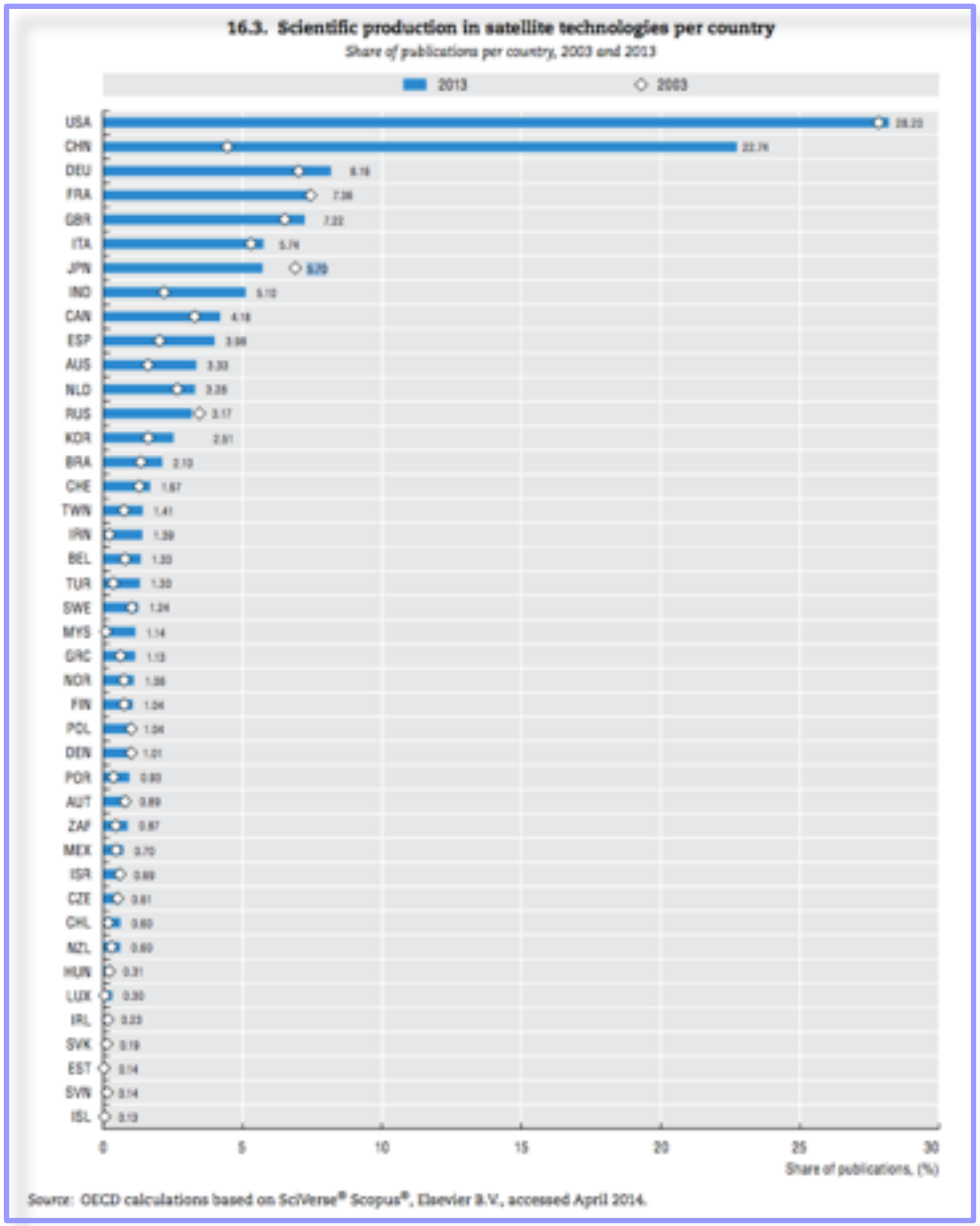
OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Produção Científica no Setor Espacial (P&D/Inovação)



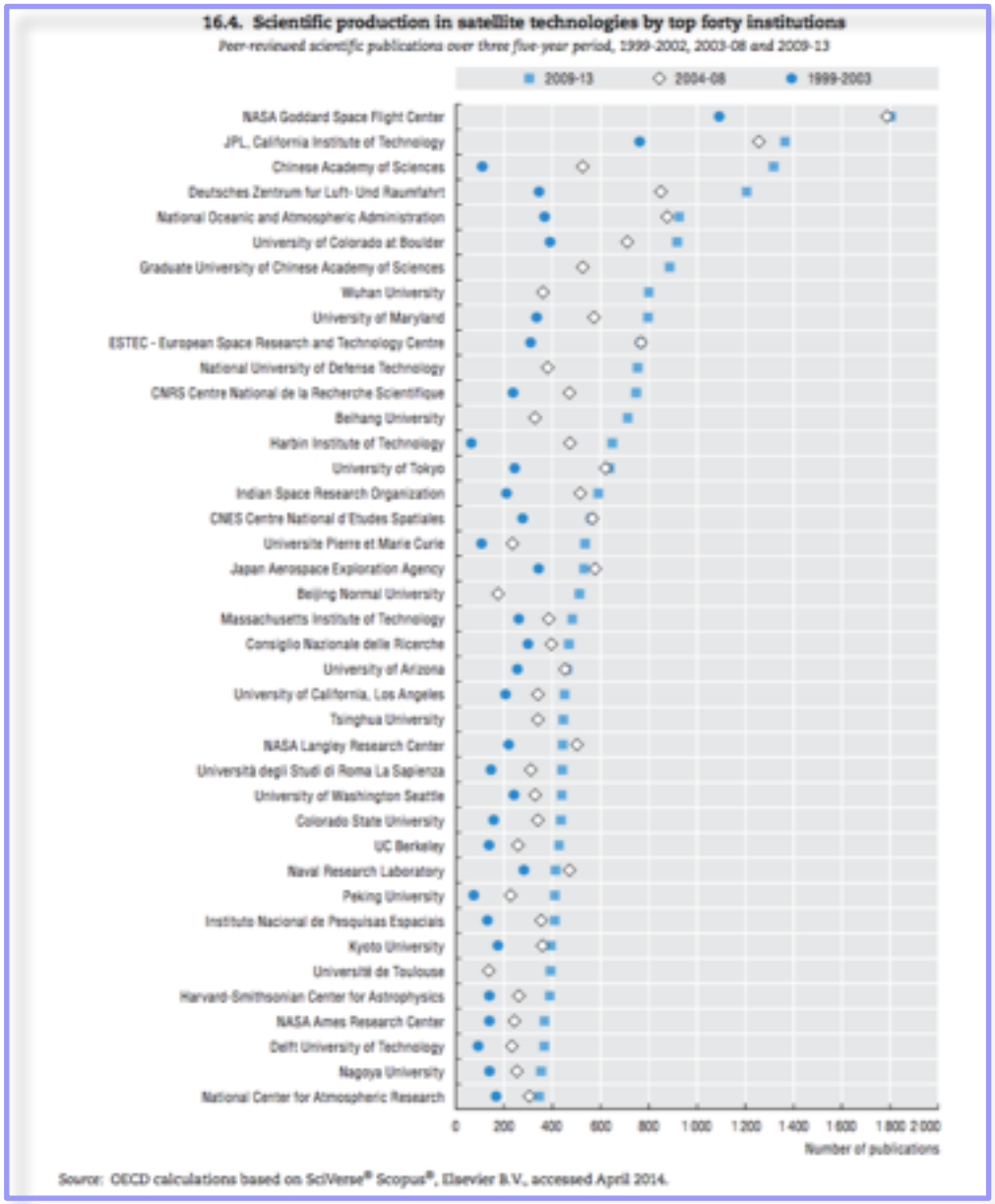
OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

Produção Científica no Setor Espacial (P&D/Inovação)



OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

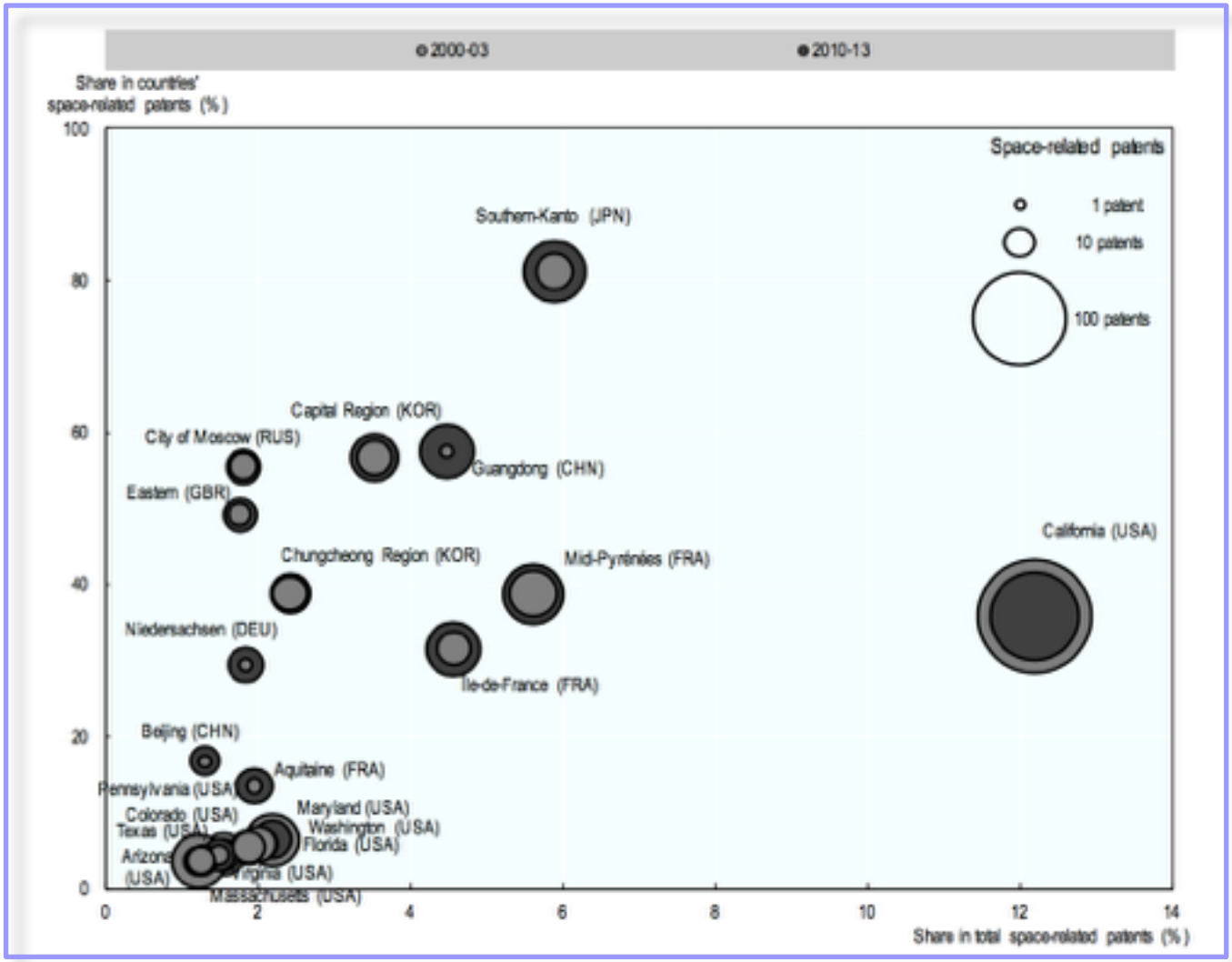
Produção Científica no Setor Espacial (P&D/Inovação)



OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing. *http://dx.doi.org/10.1787/9789264217294-en*

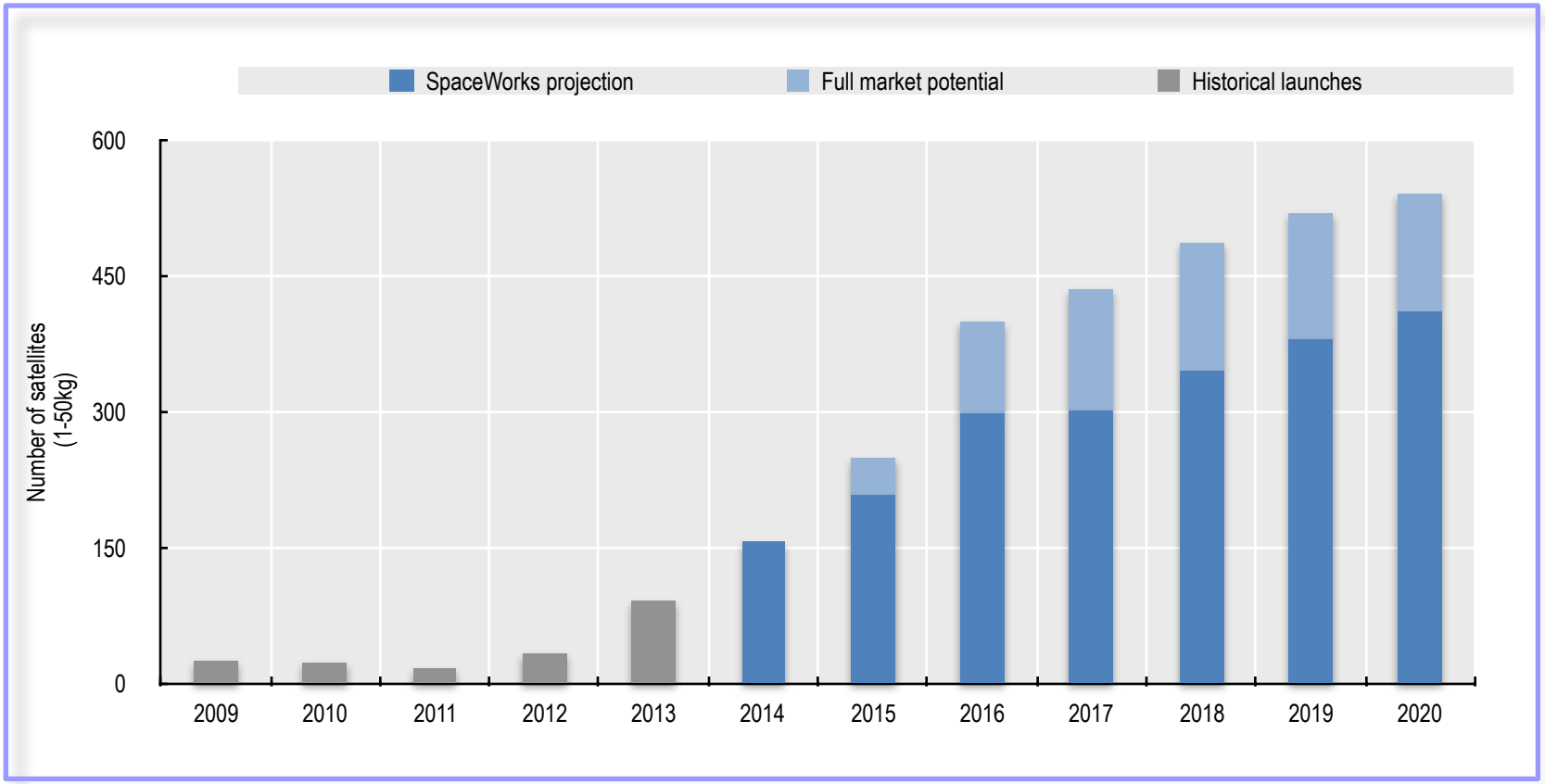
Top 20 regions in space-related patents

Patent applications filed under the Patent Co-operation Treaty by inventor's residence and priority date



OECD (2016), *Space and Innovation*, OECD Publishing, Paris. *http://dx.doi.org/10.1787/9789264264014-en*

Histórico de lançamento e projeção para nano- e microsatélites



- A nano- or microsatellite can be built for EUR 200 000 to EUR 300 000.

- Small satellites can be launched as secondary payloads for less than EUR 100 000.

- It is expected that between 2014 and 2020 more than 2 000 nano- and microsatellites will require launching worldwide

OECD Science, Technology and Innovation Outlook 2016 - © OECD 2016

Nano/Microsatellite Definitions and Terminology

- 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 a volume of exactly one liter
  - Each "U" has a mass close to 1 kg and not to exceed 1.33 kg (e.g. a 3U CubeSat has mass between 3 and 4 kg)

- 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.

Aalborg University's AAUSAT4 CubeSat

Satellite Class	Mass Range
Femtosatellite	10 – 100 g
Picosatellite	< 1 kg
Nanosatellite	1 – 10 kg
Scope of this study	1 – 50 kg
Microsatellite	10 – 100 kg
Small Satellite	100 – 500 kg

SpaceWorks

Copyright 2014, SpaceWorks Enterprises, Inc. (SEI)

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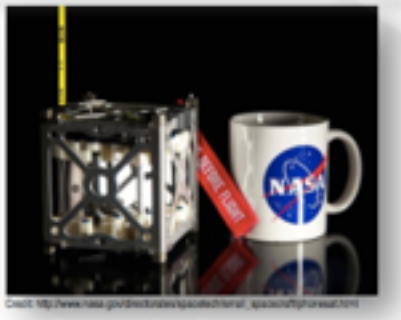
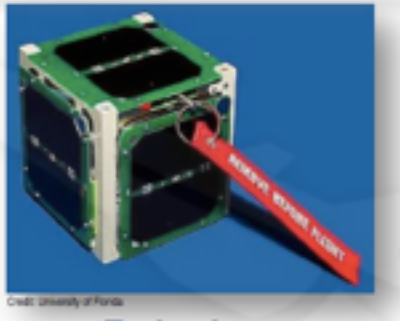
SpaceWorks (2014), *www.sei.aero/eng/papers/uploads/archive/SpaceWorks_Nano_Microsatellite_Market_Assessment_January_2014.pdf*. *http://dx.doi.org/10.1787/88893343328*

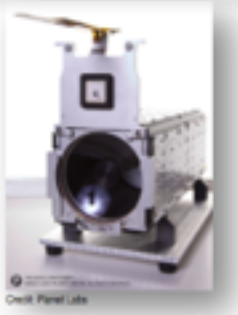
Nano/Microsatellite Applications and Associated Examples



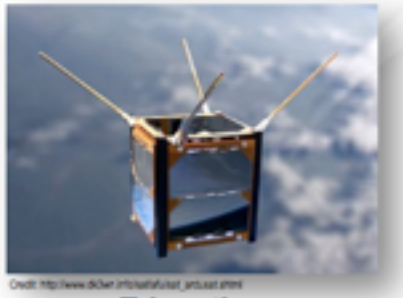
Scientific Research
Phonesat 1.0
Mass: 1 kg
Launched: 4/2013



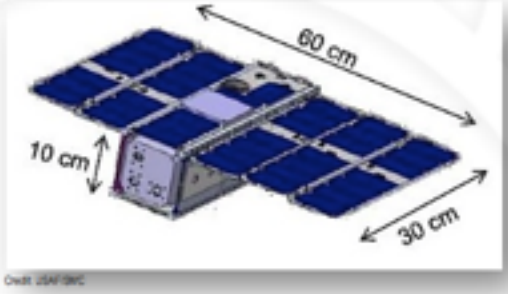
Technology
SwampSat
Mass: 1.2 kg
Launched: 11/2013



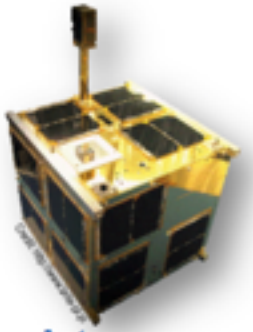
Earth Observation
Dove 2
Mass: 5.5 kg
Launched: 4/2013



Education
ArduSat
Mass: 1 kg
Launched: 8/2013



Military Application
SENSE-1
Mass: 5 kg
Launched: 11/2013



Astronomy
BRITE-PL
Mass: 7 kg
Launched: 11/2013

SpaceWorks

Copyright 2014, SpaceWorks Enterprises, Inc. (SEI)

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SpaceWorks (2014), *www.sei.aero/eng/papers/uploads/archive/SpaceWorks_Nano_Microsatellite_Market_Assessment_January_2014.pdf*. *http://dx.doi.org/10.1787/88893343328*

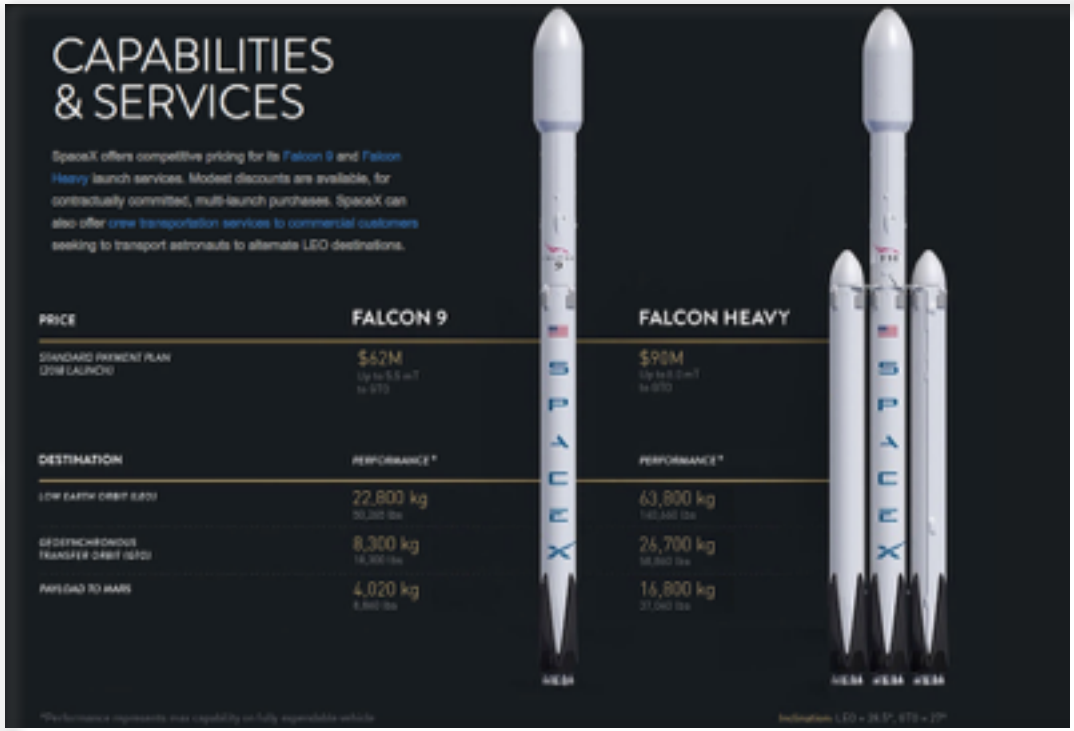
Entrepreneurs:

- **SpaceX**
- **Blue Origin**
- **Virgin Galactic**
- **Zero G**
- **Bigelow Aerospace**
- **Planetary Resources**
- **Breakthrough Starshot**

SpaceX: a única empresa privada a retornar um spacecraft da LEO

Elon Musk

Dragon spacecraft



A SpaceX acredita que um foguete totalmente e rapidamente reutilizável é o avanço crucial necessário para substancialmente reduzir o custo do acesso ao espaço

O provedor de serviços de lançamento de mais rápido crescimento do mundo e tem mais de 70 missões futuras em seu manifesto, representando mais de US $ 10 bilhões em contratos

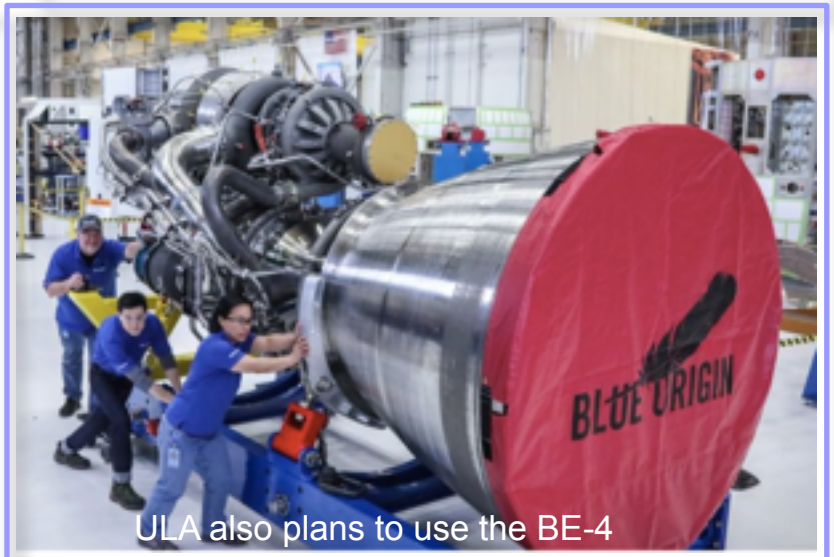
http://www.spacex.com/news/2013/03/31/reusability-key-making-human-life-multi-planetary

Blue Origin: Voo Sub-orbital e Motores de Foguete

Bezos investiment exceeds $500 million (since 2000)

New Shepard Capsule Interior

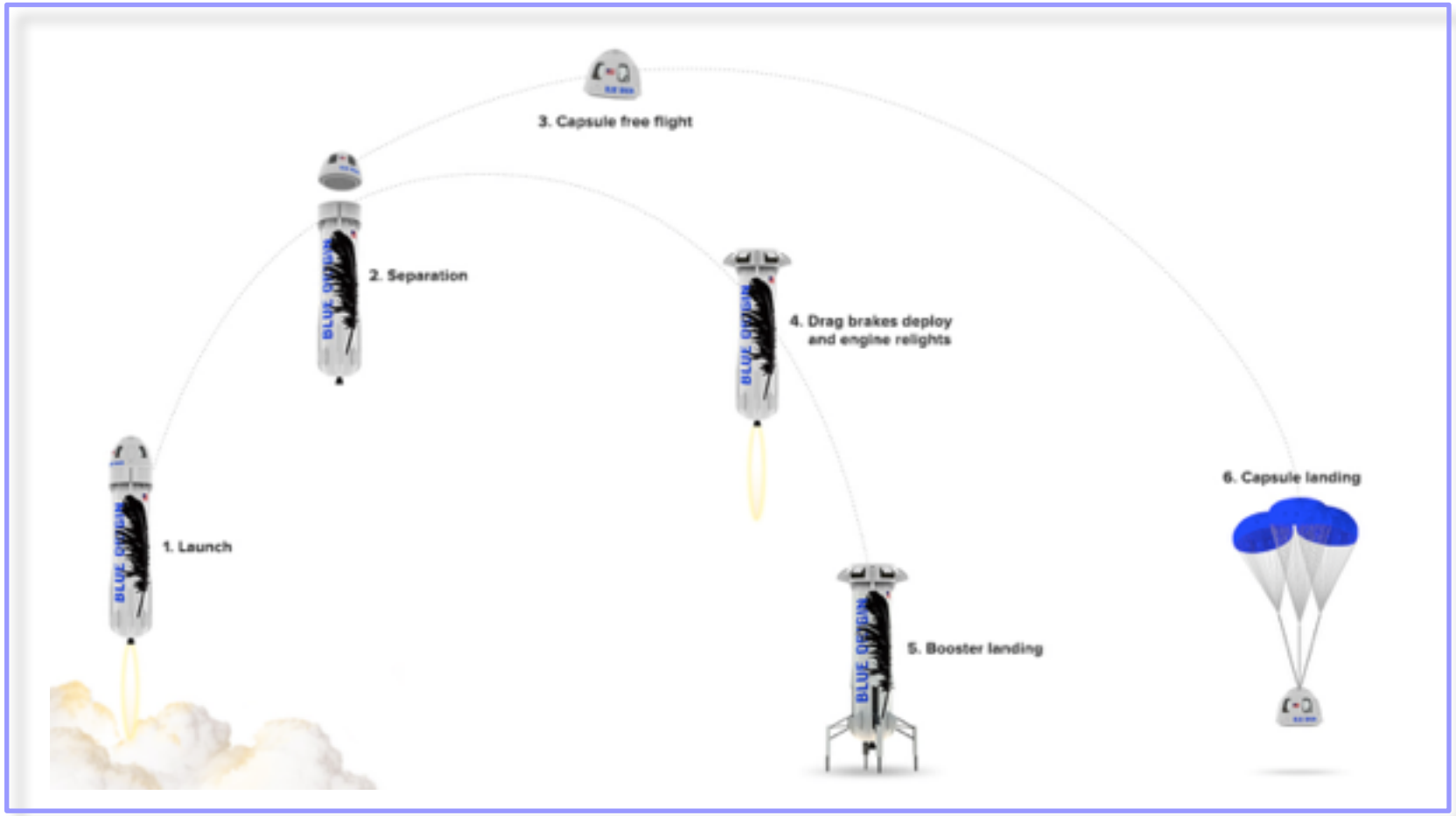
New Shepard Rocket uses BE-3 Engine



ULA also plans to use the BE-4

https://www.blueorigin.com/be4
https://www.theverge.com/2017/3/6/14827530/jeff-bezos-blue-origin-rocket-engine-be-4-new-glenn
https://www.theverge.com/2017/3/29/15105684/blue-origin-new-shepherd-crew-interior-photos-tourist-space
http://spacenews.com/41299bezos-investment-in-blue-origin-exceeds-500-million/

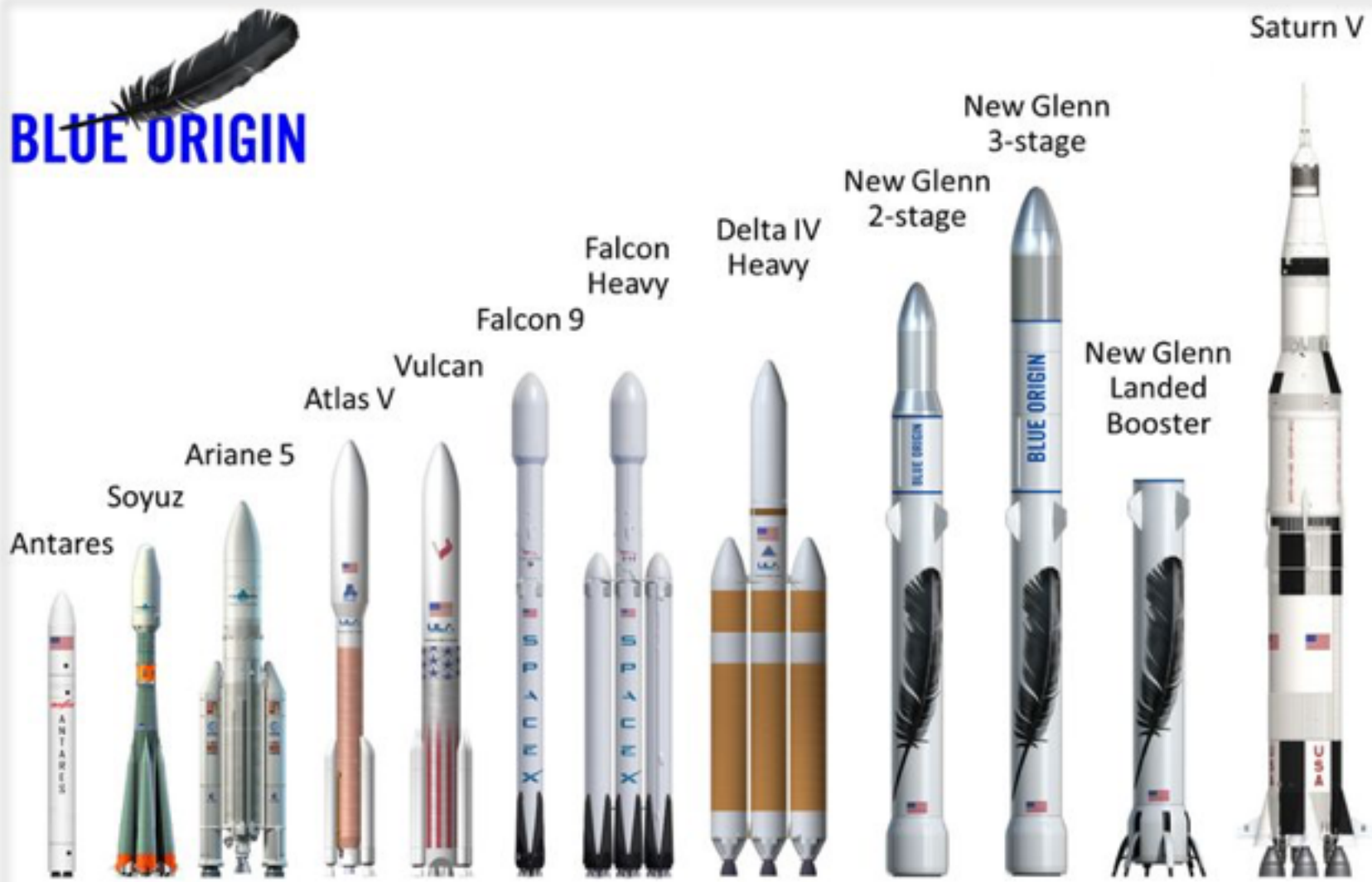
Blue Origin: Voo Sub-orbital e Motores de Foguete



The rocket has been successfully launched and landed five times already, but no people have ridden in the capsule yet.
Blue Origin is planning to take its first paying customers to space by 2018, according to Jeff Bezos.

https://www.theverge.com/2017/3/29/15105684/blue-origin-new-shepherd-crew-interior-photos-tourist-space

Blue Origin: Voo Sub-orbital e Motores de Foguete



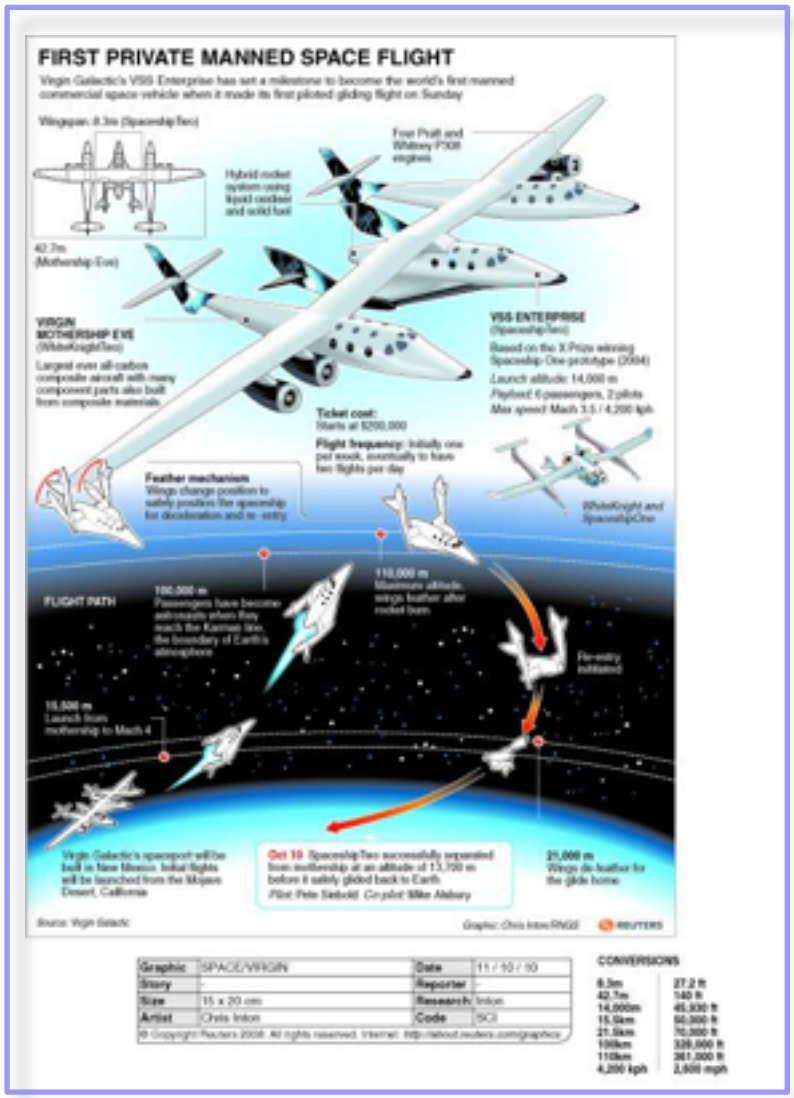
Blue Origin's future New Glenn rocket, compared to other industry vehicles. **Photo: Blue Origin**

https://www.theverge.com/2017/3/6/14827530/jeff-bezos-blue-origin-rocket-engine-be-4-new-glenn

Virgin Galactic: o objetivo é enviar turistas incrivelmente ricos para o espaço

Sir Richard Branson

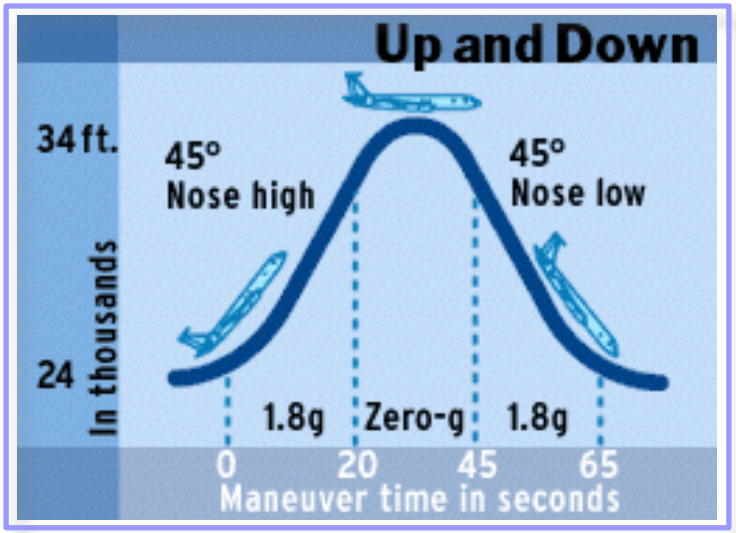
WhiteKnightTwo and SpaceShipTwo



http://www.ibtimes.com/virgin-galactic-spaceshiptwo-crash-how-first-space-tourism-vehicle-works-1717168
http://www.telegraph.co.uk/technology/0/virgin-galactic-much-will-cost-travel-space/

Zero G: empresa privada de entretenimento e turismo espacial

Peter Diamandis



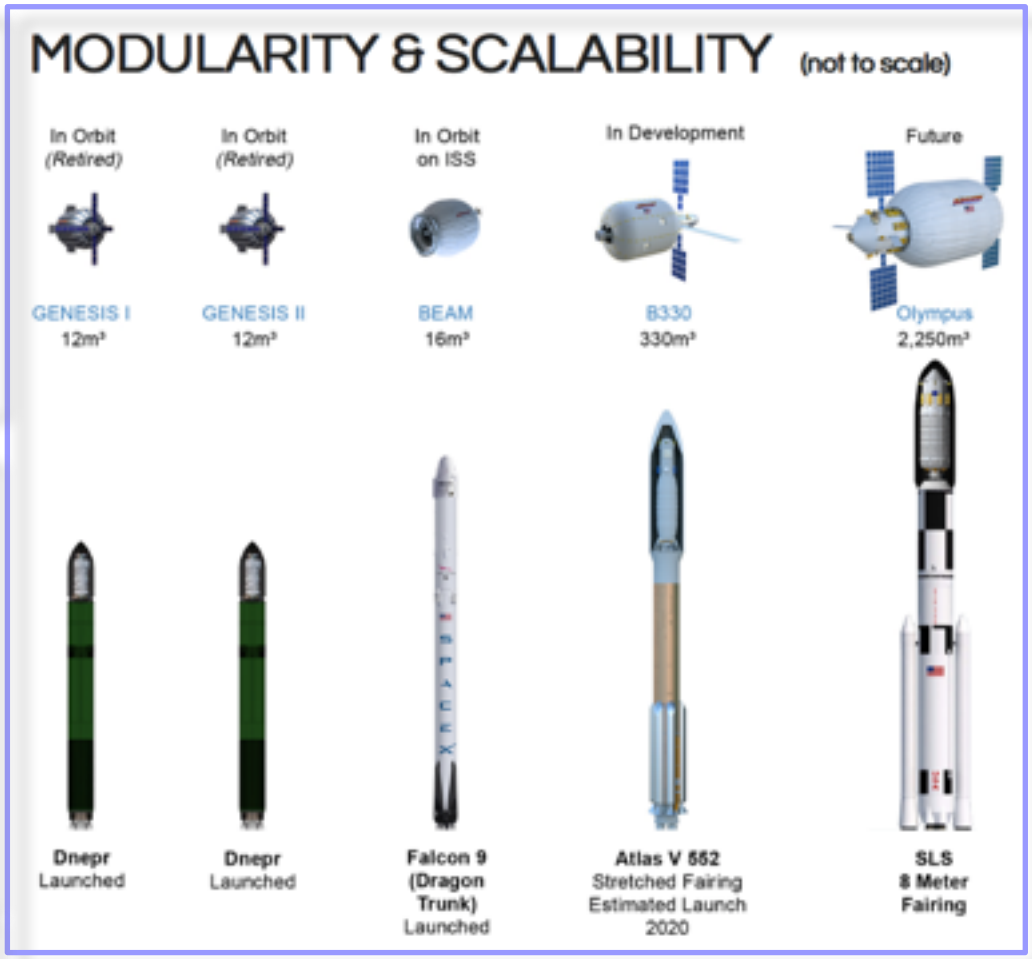
Education flights

Stephen Hawking

https://www.gozerog.com/index.cfm?fuseaction=Photos_and_Videos.welcome&albumid=5140F6E9-1372-5743-E921F2FC6BFB2500&typeid=D717C203-1372-5743-E98841098DE889C9&media=2&page=1#items
https://www.gozerog.com/index.cfm?fuseaction=Photos_and_Videos.welcome&albumid=F05E15E4-1372-5743-E99746EEB8396943&typeid=D717C203-1372-5743-E98841098DE889C9&media=11&page=1#items
http://incredible-adventures.com/zero-gravity-usa.html

Bigelow Aerospace: facilidades orbitais e estações espaciais comerciais

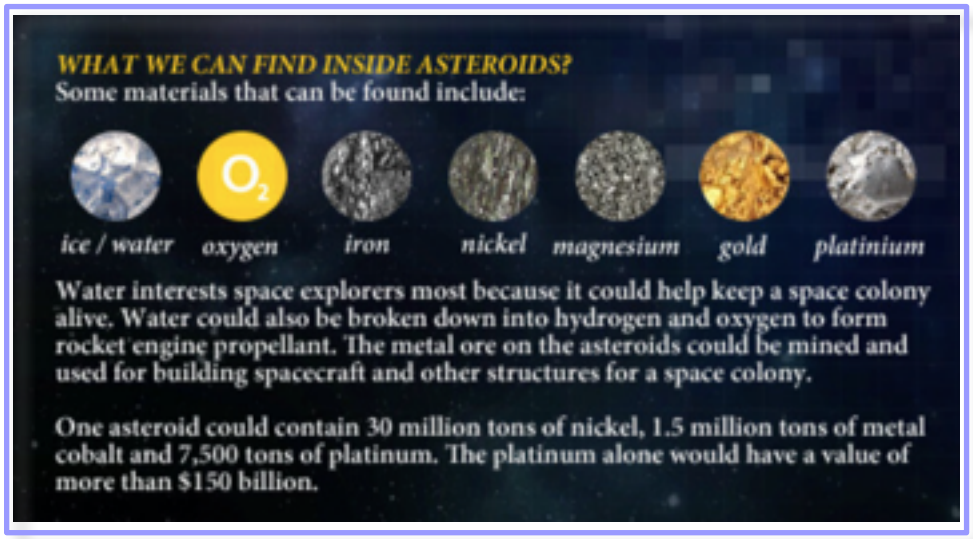
B330 designed to attach to the ISS in 2020

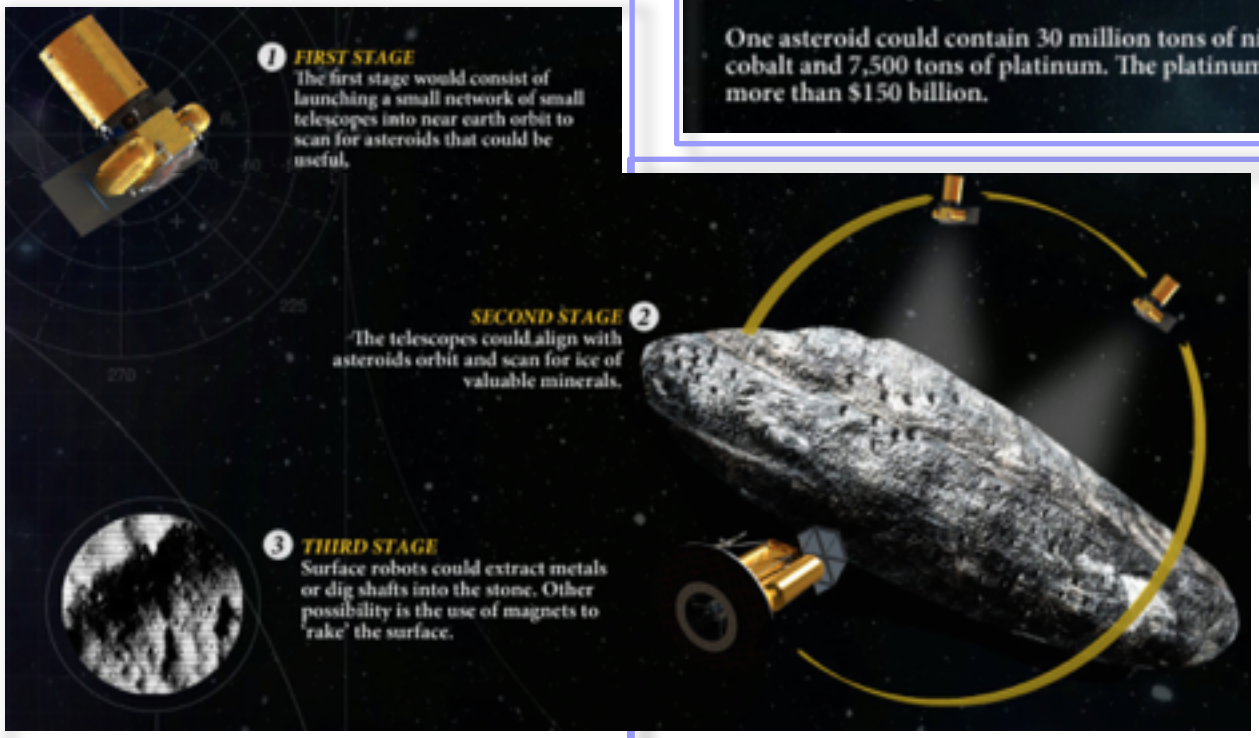


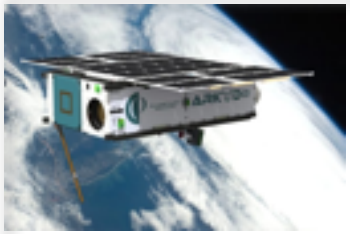
By 2013, Bigelow had invested US$250 million in the company

http://bigelowaerospace.com/media/albums/B330/
http://bigelowaerospace.com/ourtech/
https://www.nbcnews.com/science/space/bigelow-aerospace-shows-its-expandable-space-station-future-n322521

Planetary Resources: Mineração de asteróides





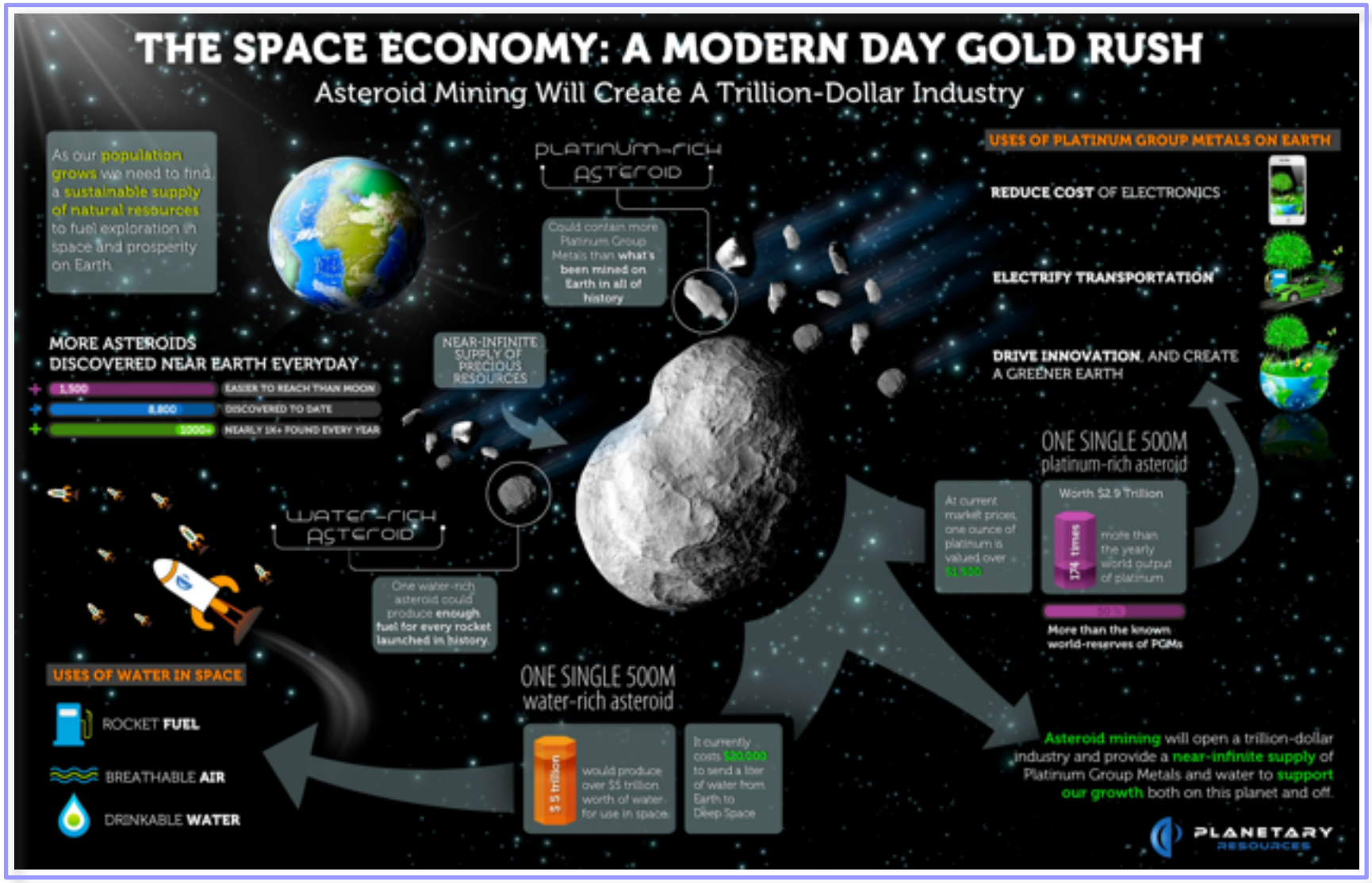


The Arkyd 6 spacecraft is scheduled to launch later this year.
(Photo courtesy of Planetary Resources)
Size: 4 by 8 by 12 inches

https://imgur.com/a/6Hzl8

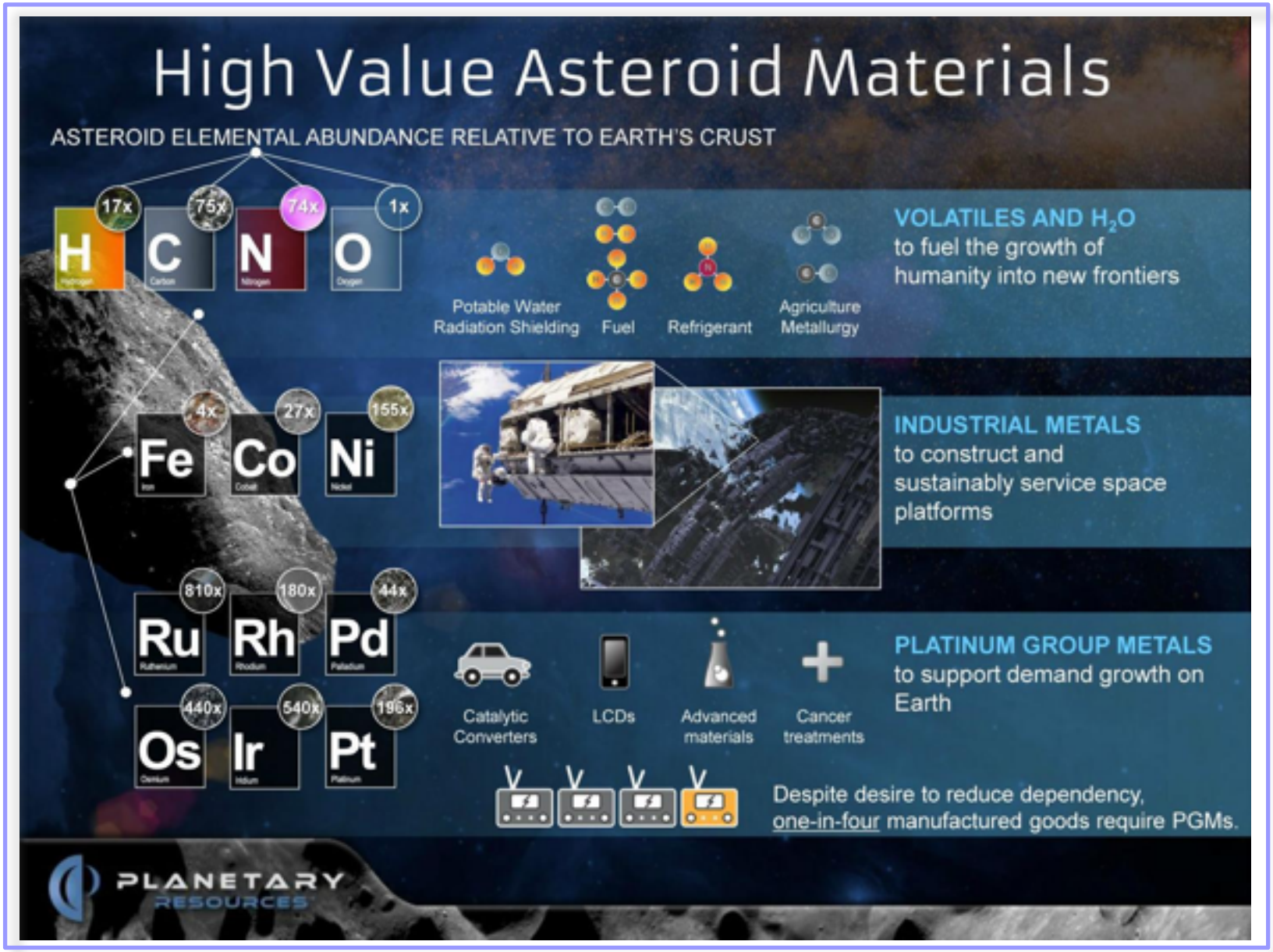
https://www.geekwire.com/2017/2020-bust-planetary-resources-getting-bullish-asteroid-mining/

Planetary Resources: Mineração de asteróides



https://imgur.com/a/6Hzl8

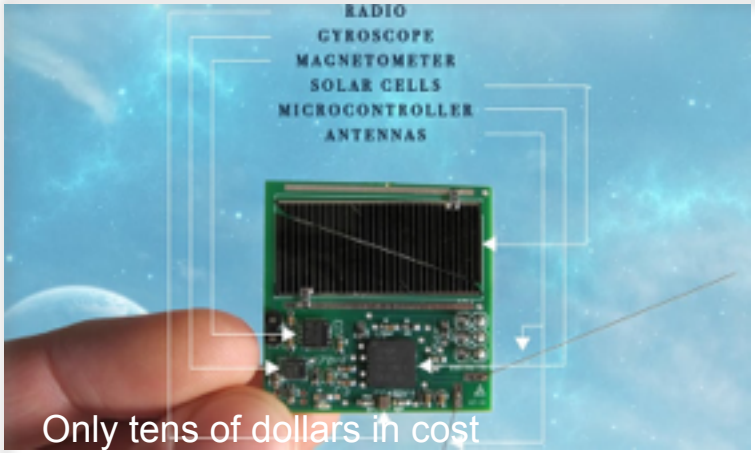
Planetary Resources: Mineração de asteróides



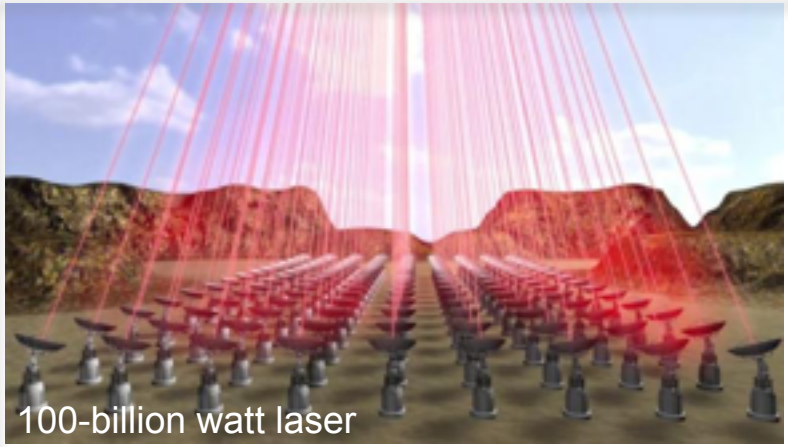
https://imgur.com/a/6Hzl8

Breakthrough Starshot: US$100 milhões (5 anos)

Y. Milner (M. Zuckerberg) S. Hawking



Only tens of dollars in cost



100-billion watt laser

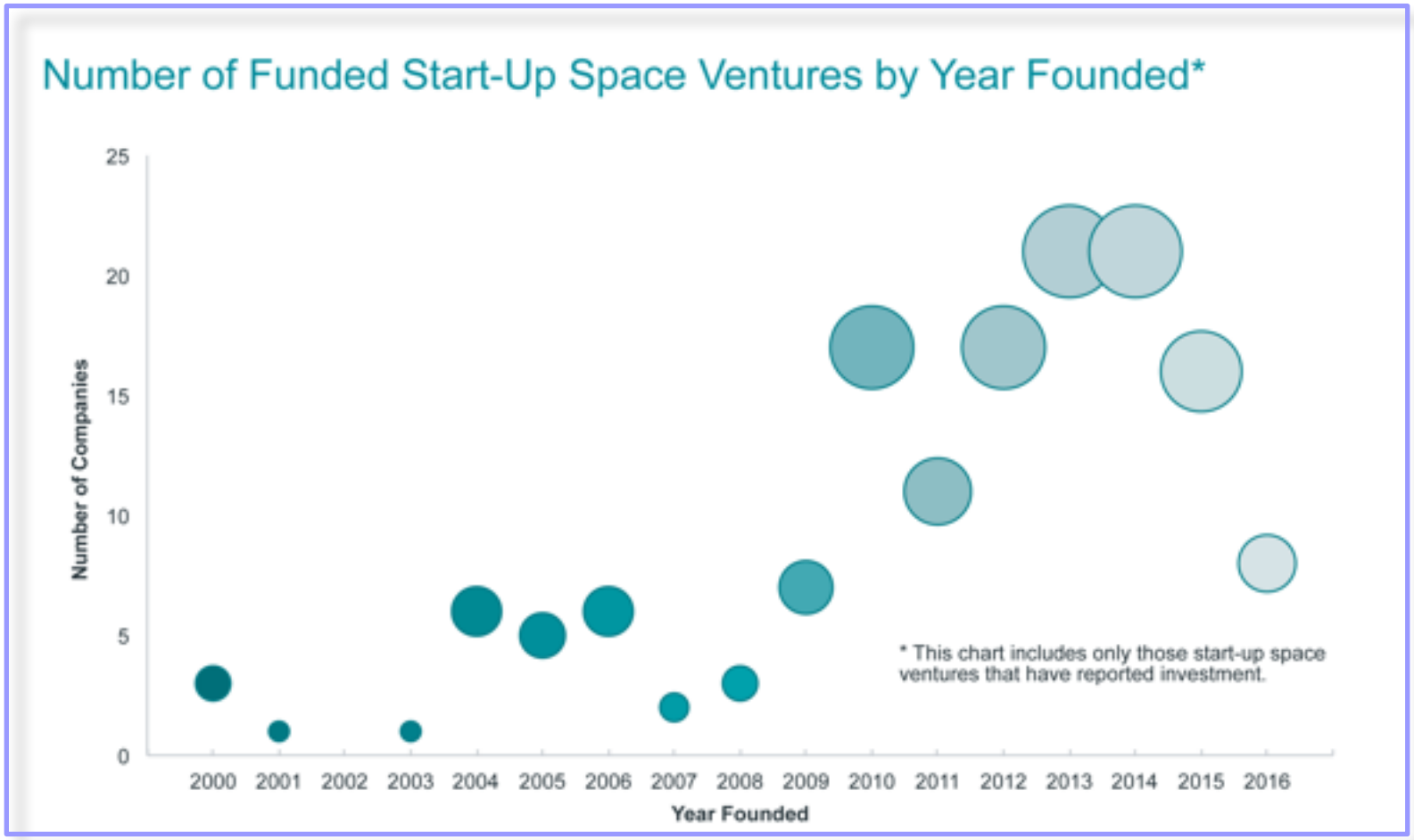
Alpha Centaury in 20 years from the launch

The ‘sprites’ – 3.5cm x 3.5cm miniature satellites weighing four grams each – are successfully in orbit and communicating with systems back on Earth

http://www.theaustralian.com.au/news/world/the-times/breakthrough-starshot-mans-new-mission-to-the-stars/news-story/824aa6eeba743e7496a01d10a016c2ae

https://www.theguardian.com/science/2017/jul/28/breakthrough-starshot-successfully-launch-worlds-smallest-spacecraft

Economia Espacial: Startups

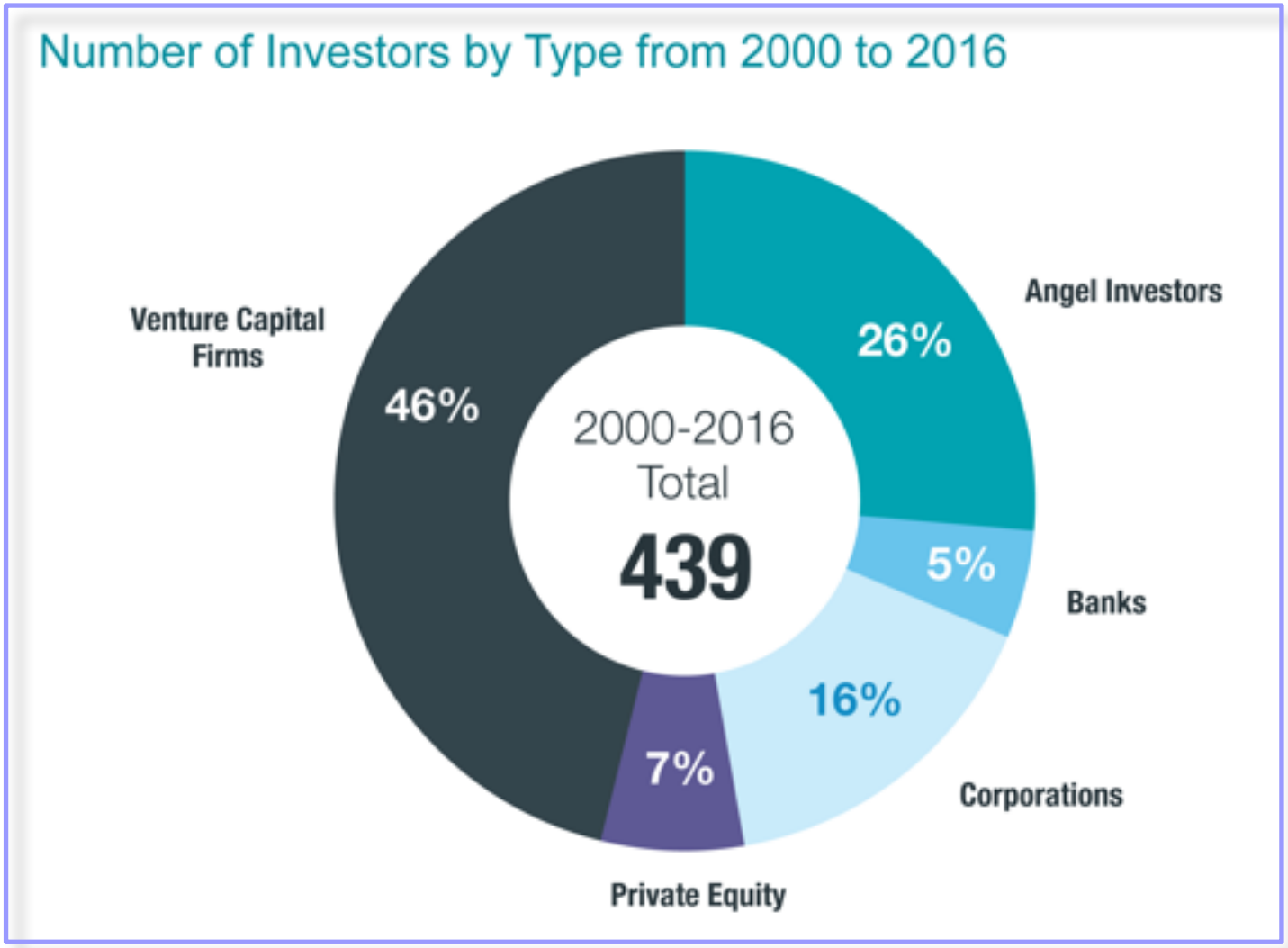


Mais de 140 empresas espaciais foram financiadas por diversos tipos de investidores desde 2000.

As start-ups já atraíram mais de US $ 16,6 bilhões em investimentos, desde 2000.

Start-up Space Update on investment in comercial space ventures 2017 BRYCE Space and Technology

Economia Espacial: Investidores



Em número de investidores, os VCs são o maior grupo de investidores para start-ups espaciais.

Start-up Space - Update on investment in comercial space ventures 2017 BRYCE Space and Technology

Previsão para o primeiro trilionário do mundo

O empresário espacial Peter Diamandis previu em 2015 que o primeiro trilionário do mundo - que os analistas esperam que surja na próxima duas décadas - virá do setor e da comunidade do NewSpace que agora incluem

Jeff Bezos, Elon Musk, Sir Richard Branson, Paul Allen,

Mark Zuckerberg, Yuri Milner, Larry Page, Eric Schmidt,

Robert Bigelow, Naveen Jain, James Cameron, Charles Simonyi,

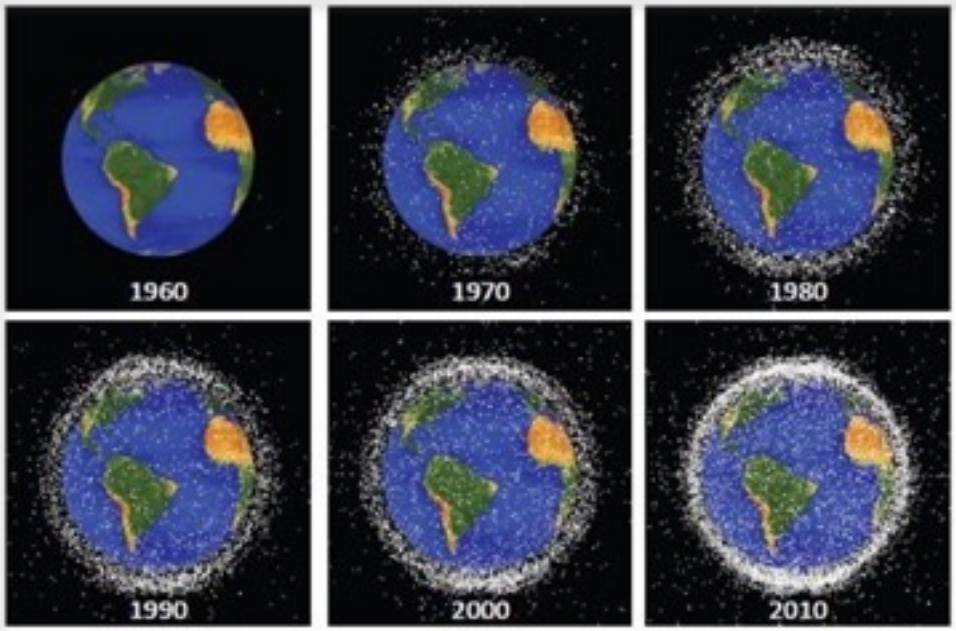
Ross Perot Jr., Masayoshi Son,

e um número crescente de outras personalidades globais poderosas e influentes com legítimo potencial trilhionário

https://en.wikipedia.org/wiki/NewSpace

Sustentabilidade do Espaço

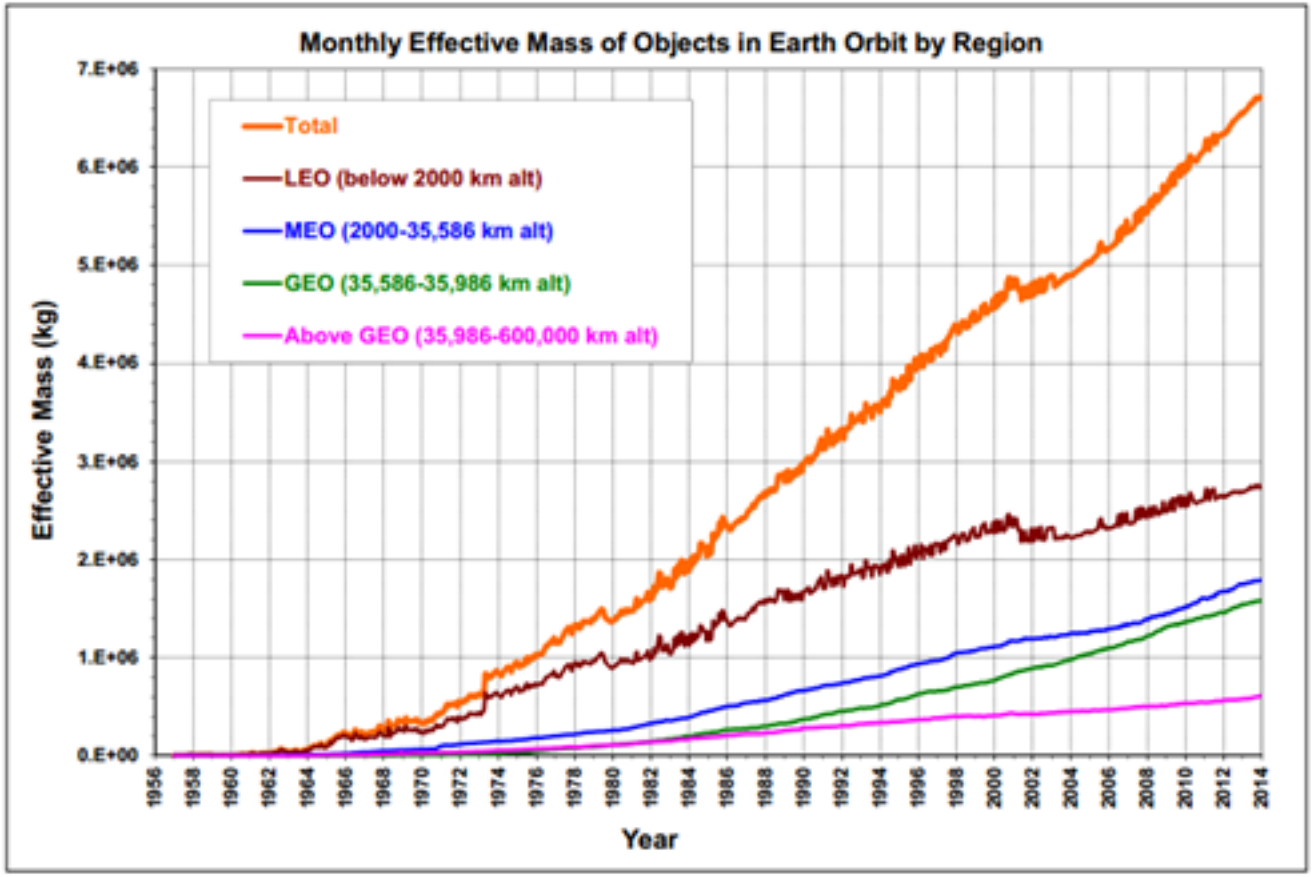
Sustentabilidade do Espaço



Satellites and debris in low Earth orbit, 1960-2010. Courtesy NASA.

A sustentabilidade espacial é garantir que toda a humanidade possa continuar usar o espaço exterior para fins pacíficos e benefícios socioeconômicos. Isso exigirá cooperação internacional, discussão, e acordos concebidos para garantir que o espaço exterior seja seguro, protegido e pacífico.

Sustentabilidade do Espaço



Monthly Effective Mass of Objects in Earth Orbit by Region: This chart displays the mass of all objects in Earth orbit officially cataloged by the U.S. Space Surveillance Network. Divided into orbital altitude regions, "effective mass" accounts for the fraction of its orbit that an object may spend in the different regions.

https://swfound.org/space-sustainability-101/the-persistent-problem-of-orbital-debris/

Sustentabilidade do Espaço

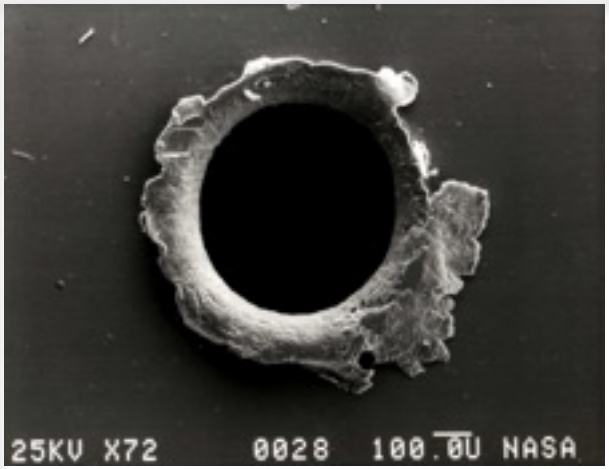
Por que isso é importante?

Um número crescente de atores está usando o espaço para aumentar a variedade de benefícios socioeconômicos e de segurança nacional.
Muitas dessas atividades espaciais usam as mesmas regiões da órbita da Terra, levando a aglomeração e possíveis interferências físicas e eletromagnéticas.
Ações inseguras ou irresponsáveis de um ator podem ter conseqüências para todos.
Se não usarmos espaço de forma sustentável, o custo do uso do espaço aumentará, o que poderia tornar muito caro continuar a usar espaço para:

Segurança nacional e internacional
Observação da terra
Telecomunicações
Navegação por satélite
Exploração científica
Desenvolvimento Econômico

https://swfound.org/our-focus/space-sustainability/

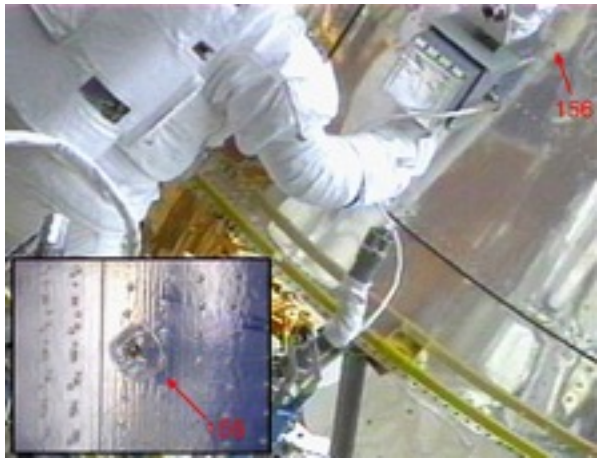
Sustentabilidade do Espaço



View of an orbital debris hole made in the panel of the Solar Max experiment.

On 21 January 2001, a Delta 2 third stage, known as a PAM-D (Payload Assist Module - Delta), reentered the atmosphere over the Middle East. The titanium motor casing of the PAM-D, weighing about 70 kg, landed in Saudi Arabia about 240 km from the capital of Riyadh.

Space Shuttle window being inspected for orbital debris impacts.



Orbital debris damage seen during Hubble Space Telescope repairs.

https://www.orbitaldebris.jsc.nasa.gov/photo-gallery.html

Sustentabilidade do Espaço

Mais de 60 países operam atualmente pelo menos um satélite e estima-se que 16.000 novos satélites estejam previstos para serem lançados na próxima década.

Exemplos de iniciativas que estão tentando resolver esses problemas:

Os EUA fornecem avisos de aproximações próximas entre satélites e outros objetos espaciais para todos os operadores de satélites do mundo, gratuitamente.

A Fundação Secure World, uma organização sem fins lucrativos com sede nos EUA, dedicada à sustentabilidade do espaço a longo prazo, publicou um Manual para os Novos Atores no espaço, que fornece uma visão geral dos princípios fundamentais, leis, políticas, normas e práticas operacionais pacíficas, seguras e responsáveis atividades no espaço.

A ONU, através de seu Comitê sobre os Usos Pacíficos do Espaço Exterior (COPUOS), também está desenvolvendo um conjunto de diretrizes de melhores práticas para a sustentabilidade de longo prazo de atividades espaciais. Um conjunto inicial de 12 diretrizes foi aprovado em junho de 2016 por todos os 84 estados membros do COPUOS, e diretrizes adicionais são esperadas pelo final de 2018.

https://www.weforum.org/agenda/2017/09/why-the-new-space-race-should-focus-on-sustainability/

Promising space systems

and

applications

by 2030

Promising space systems and applications by 2030

On the basis of three scenarios developed in 2002-04, a list of possible promising space applications that could become fully operational by 2030, was established:

Main contenders:

- entertainment (digital radio, TV, data and multimedia broadcasting to fixed and mobile assets, high bandwidth to the home/convergence of different media)
- meteorology and climate change (meteorological and sea condition forecasting for commercial sea shippers, pollution maps with evolution in time, monitoring of the application of treaties, standards and policies)
- distance learning and telemedicine (broadcasting to remote areas and across national borders, medical remote surveillance)
- e-commerce (enabling changing work patterns due to mobile workforce/home working and economic consequences, HDTV teleconferencing)
- location-based consumer services (driver assistance and navigation aids, insurance based on real-time usage data, vehicle fleet management, asset tracking [especially high-value] and road repair management)
- traffic management (location and positioning of aircraft and ships, optimisation of airport traffic management, optimisation of traffic management – road pricing – driver behaviour logging)

OECD (2016), *Space and Innovation*, OECD Publishing, Paris. *http://dx.doi.org/10.1787/9789264264014-en*

Promising space systems and applications by 2030

- precision farming and natural resources management (precision agriculture for maximal efficiency in equipment and application of fertilizer, deforestation and forestry management)
- urban planning (plans, maps and numerical terrain models, precise positioning of engineering structures and buildings, automatic control of job site vehicles, management and optimisation of job site vehicle routes)
- disaster prevention and management (telecom capability in absence of ground infrastructure, remote assessment of damage and pollution for insurance claims).

Outsiders:

- adventure space tourism (suborbital then orbital)
- in-orbit servicing
- power relay satellites.

Source: Adapted from OECD (2004), *Space 2030: Exploring the Future of Space Applications*, http://dx.doi.org/10.1787/9789264020344-en.

OECD (2016), *Space and Innovation*, OECD Publishing, Paris. *http://dx.doi.org/10.1787/9789264264014-en*

Conclusões

- Velha Economia Espacial Vs Nova Economia Espacial
- Economia Espacial: Definições e principais atividades
- Entrepreneurs
- Sustentabilidade Espacial
- Visão da Economia Espacial até 2030

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