– New Space Economy

UCM / EuroSpaceHub

Prof. W. Peeters (ISU)

November/2023

Outline

NEWSPACE

- Definition
- Paradigm Shift

NEWSPACE COMPANIES

- Role in Value Chain
- Equity Investors

NEWSPACE FINANCING

START-UP CREATION IN THE NEWSPACE ENVIRONMENT

Learning Outcomes

At the end of this lecture, you should be able to:

- **LO1: Describe the differences between NewSpace and traditional space**
- **LO2: Understand the rational of NewSpace companies**
- **LO3: Understand the concept of Equity vs. Debt Financing**
- **LO4: Describe The financing flow of NewSpace companies**
- **LO5: Describe the flow to start up a company**
- **LO6: Understand the role of incubators**
- **LO7: Understand the basics of a Business Plan Slide-deck**
- **LO8: Understand the sequence of funding rounds with equity investors**

New Space in general

New Space Economy : Definition

“New Space”

“NewSpace” reflects a change of paradigm in the space industry where new business models and processes are disrupting existing markets with more-affordable, faster-paced, innovative products and/or services.

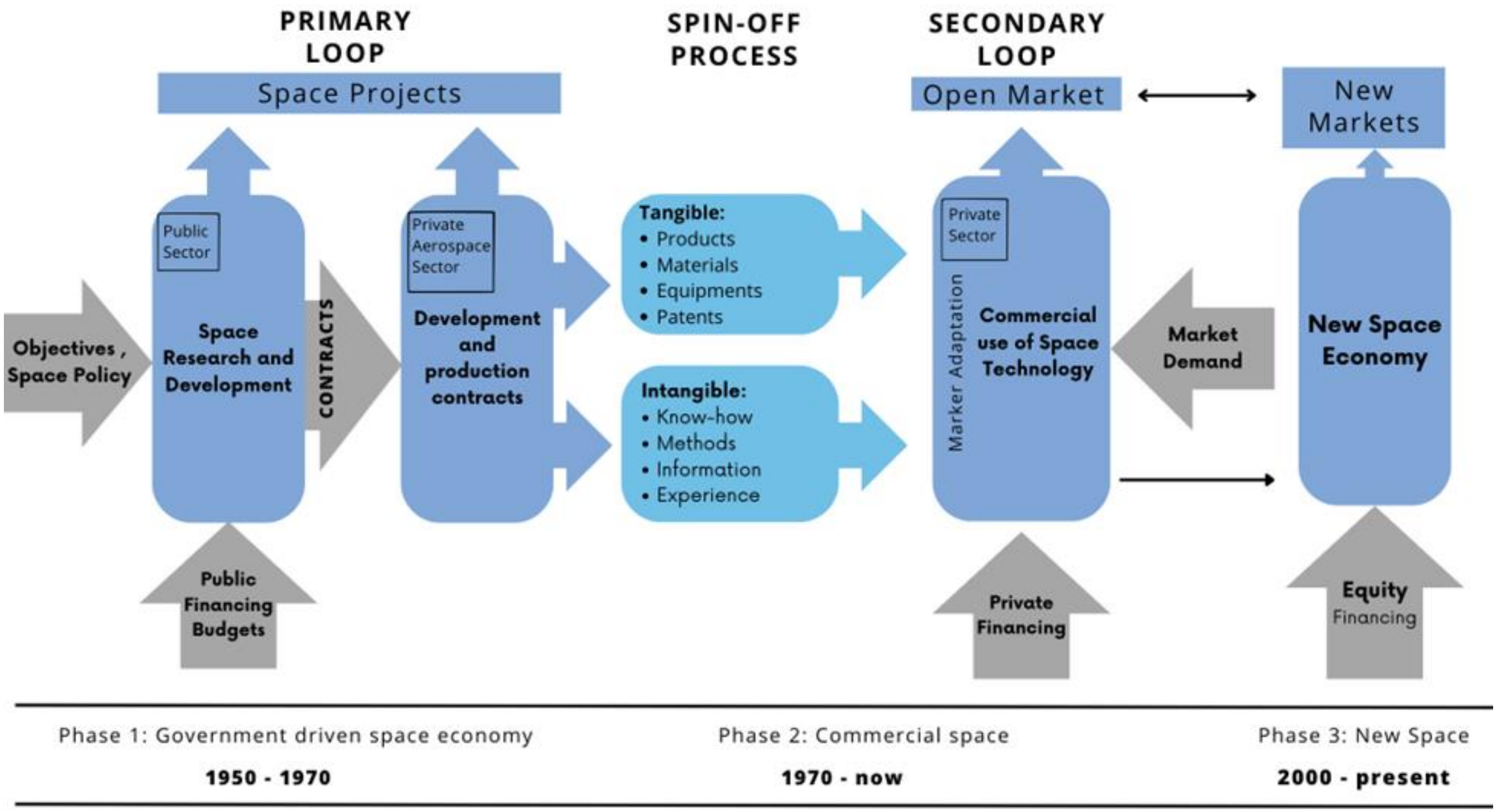
Proposed Definition:

Private companies which act independent of governmental space policies and funding, targeting equity funding and promoting affordable access to space and novel space applications

Differentiation

Characteristic	Traditional Space	New Space
Main Driver	Hardware Production	Software Application
Orientation	Techno-push	Application oriented
Design characteristics	High reliability and redundancy	Simple design, shorter lifetimes
Design philosophy	Customized	Standardization
Engineering	High Quality, High cost	Low-cost, low mass
Launch	Dedicated launcher	Shared launch
Intellectual Property	Patent protection	Technological advantage
Risk aspects	Risk Adverse	Accept business risks
Internal Organization	Hierarchical	Matrix
Financing	Company funds, debt financing	Equity financing

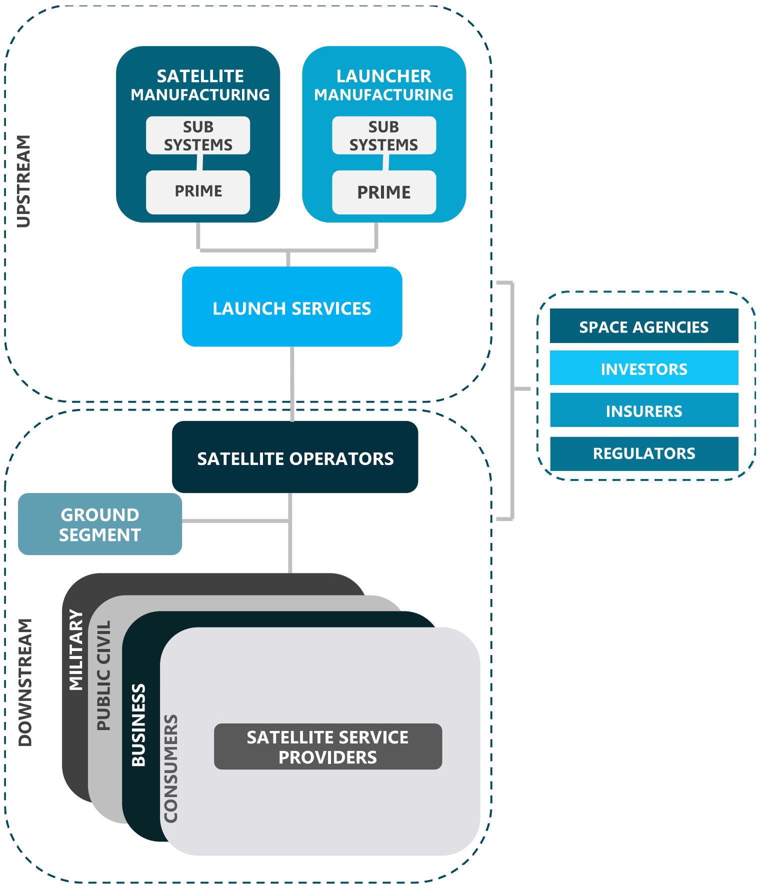
Space Business Financing



BUDGET FINANCING **DEBT FINANCING** **EQUITY FINANCING**

New Space companies

The Value Chain Concept



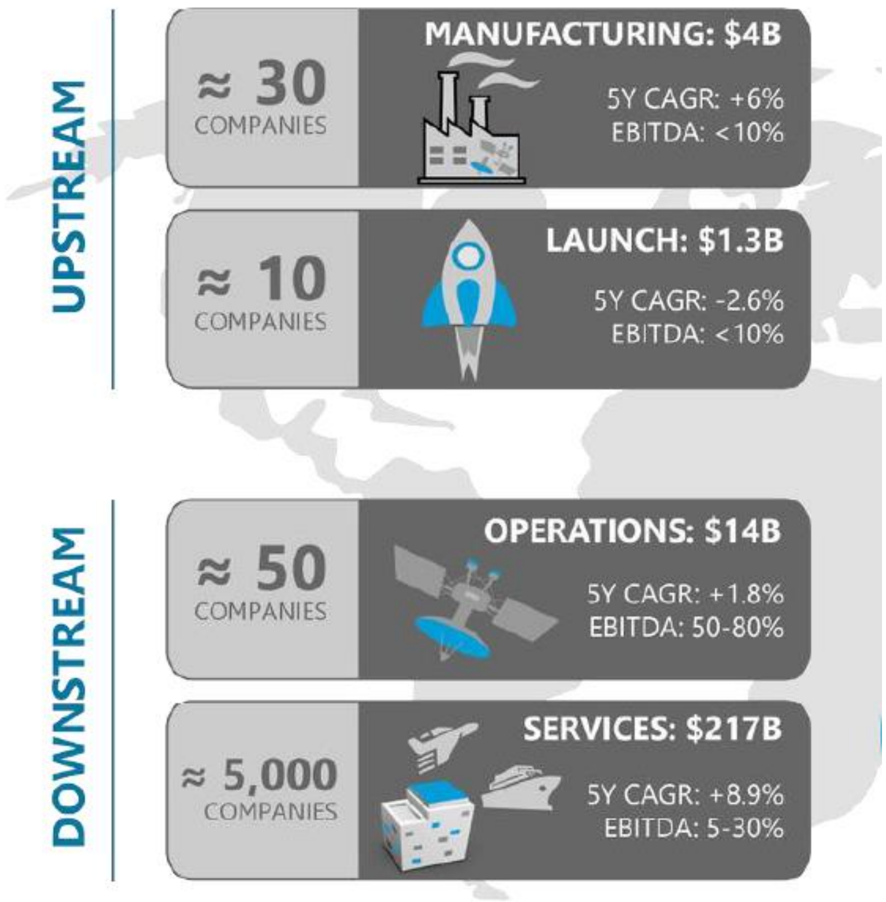
The satellite industry is an infrastructure supplier

Upstream → Downstream

Delivery of space-based services reliant on satellite technology

Source: Euroconsult

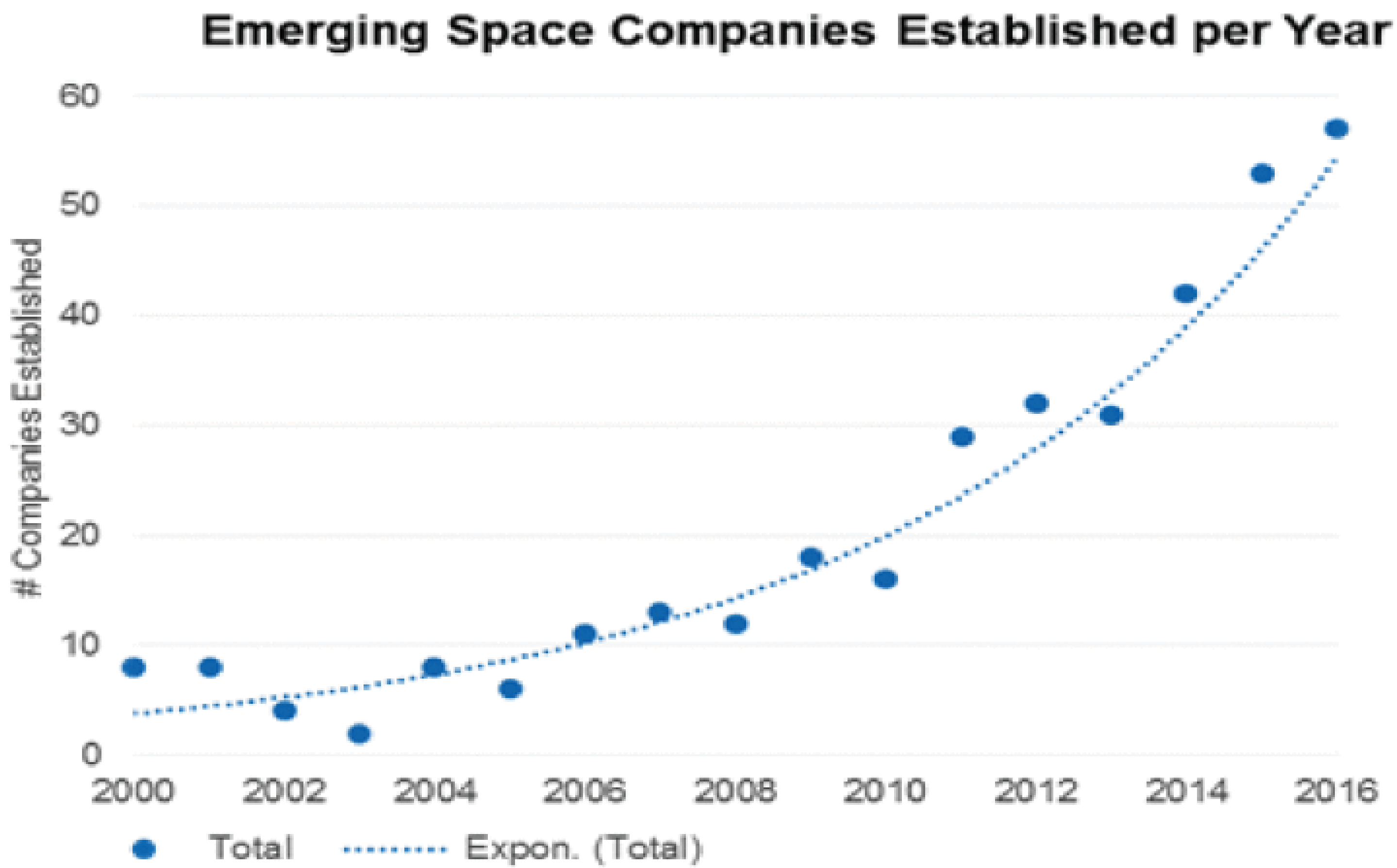
Strategic Axes : Value Chain



Source : Euroconsult

EBITDA : Earnings Before Interests, Taxes, Depreciation and Amortization
CAGR : Compound Annual Growth Rate

New Space Companies



Source: NSR

Side-effect : More countries active in space

2026 — **87 countries in total**
*47 Emerging Space Programs**

2016 — **70 countries**
28 ESPs

2006 — **51 countries**
13 ESPs

2000 — **26 countries**
8 ESPs

EMERGING SPACE PROGRAMS (ESPs)

*Countries that launched its 1st satellite > 50 kg after 1996

New Space = Democratization of space?

Source: Euroconsult

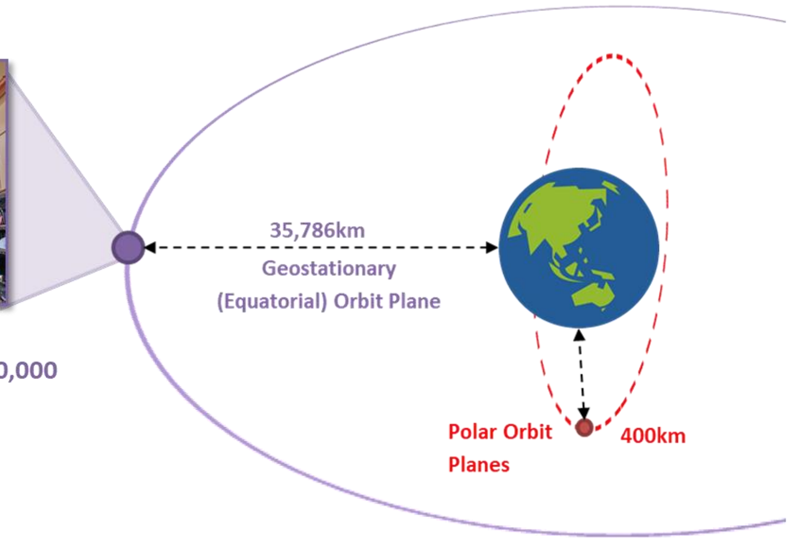
Why New Companies ?

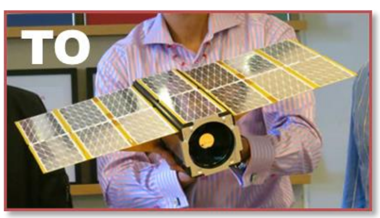
- Large commercial space companies have high overhead costs
- The design philosophy (company culture) is adapted towards large satellites
- They need a higher Return On Investment in view of the higher overheads
- They need large markets to reach their goals
- Therefore are less competitive in niche markets

Priority 1 : Use/combine existing data (low CAPEX)

Solution 2: For new services:

Mass: **4000kg**
Manufacture Cost: **US$200,000,000**
Launch Cost: **US$250,000,000**
Lifespan: **15 years**





Mass: **3kg**
Manufacture Cost: **US$200,000**
Launch Cost: **US$150,000**
Lifespan: **1-2 years**

- Internet of Things (IoT)
- 5G Connectivity
- Crop monitoring
- Environmental Monitoring
- Emergency Services
  - Bushfire Warning
  - Emergency Beacons
- Economic Zone Monitoring
- Mobile phones
- Precision Agriculture

CAPEX : Capital Expenditure

New Space Launch Approaches

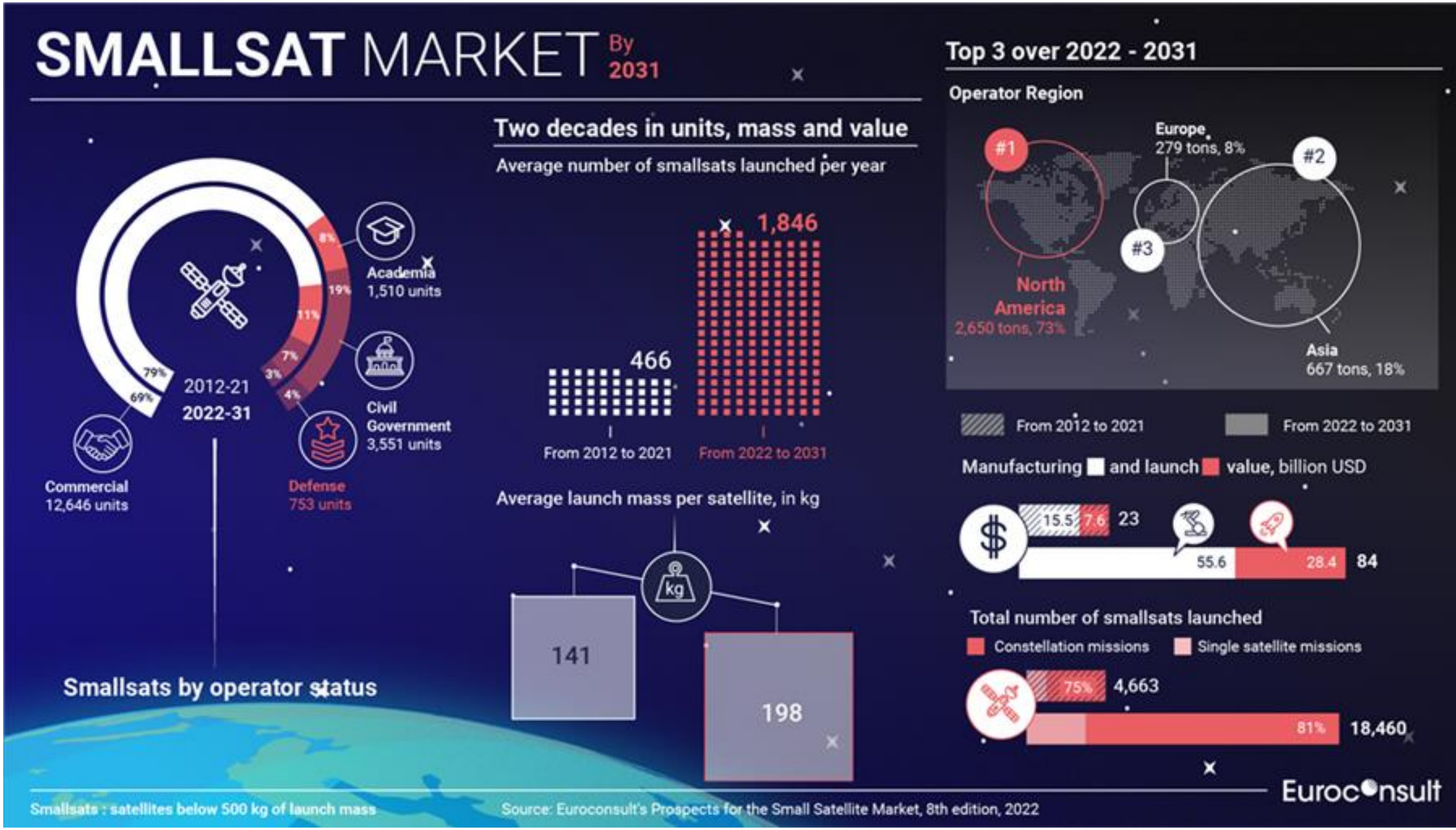
Image Credit:
Maxar/SSL

Image Credit:
SpaceX

Image Credit:
Planet

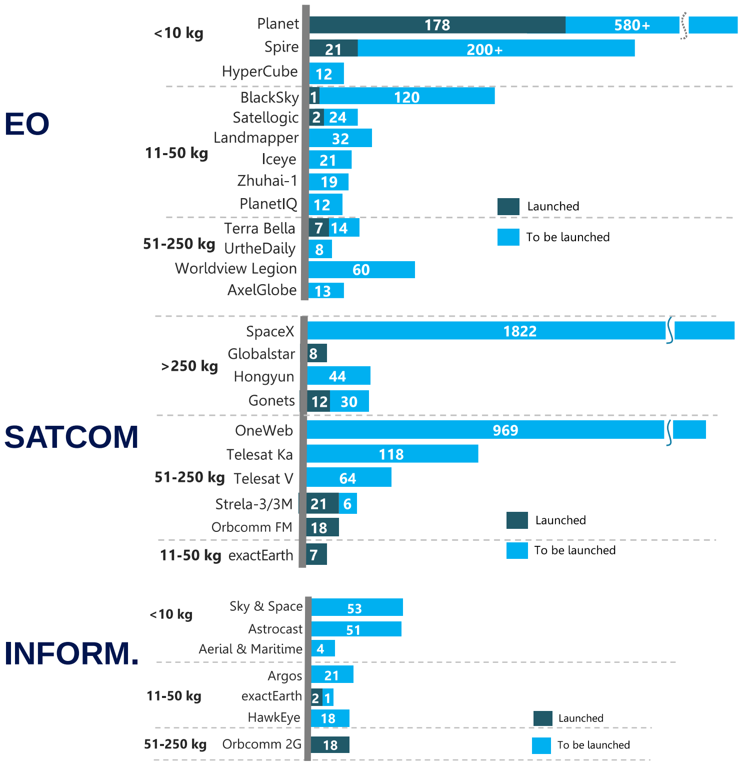
Image Credit:
IceEye

Smallsat Forecast



The Smallsat Market Constellations

CONSTELLATIONS



KEY ADDRESSABLE MARKETS

(Depending on the system)

Source: Euroconsult

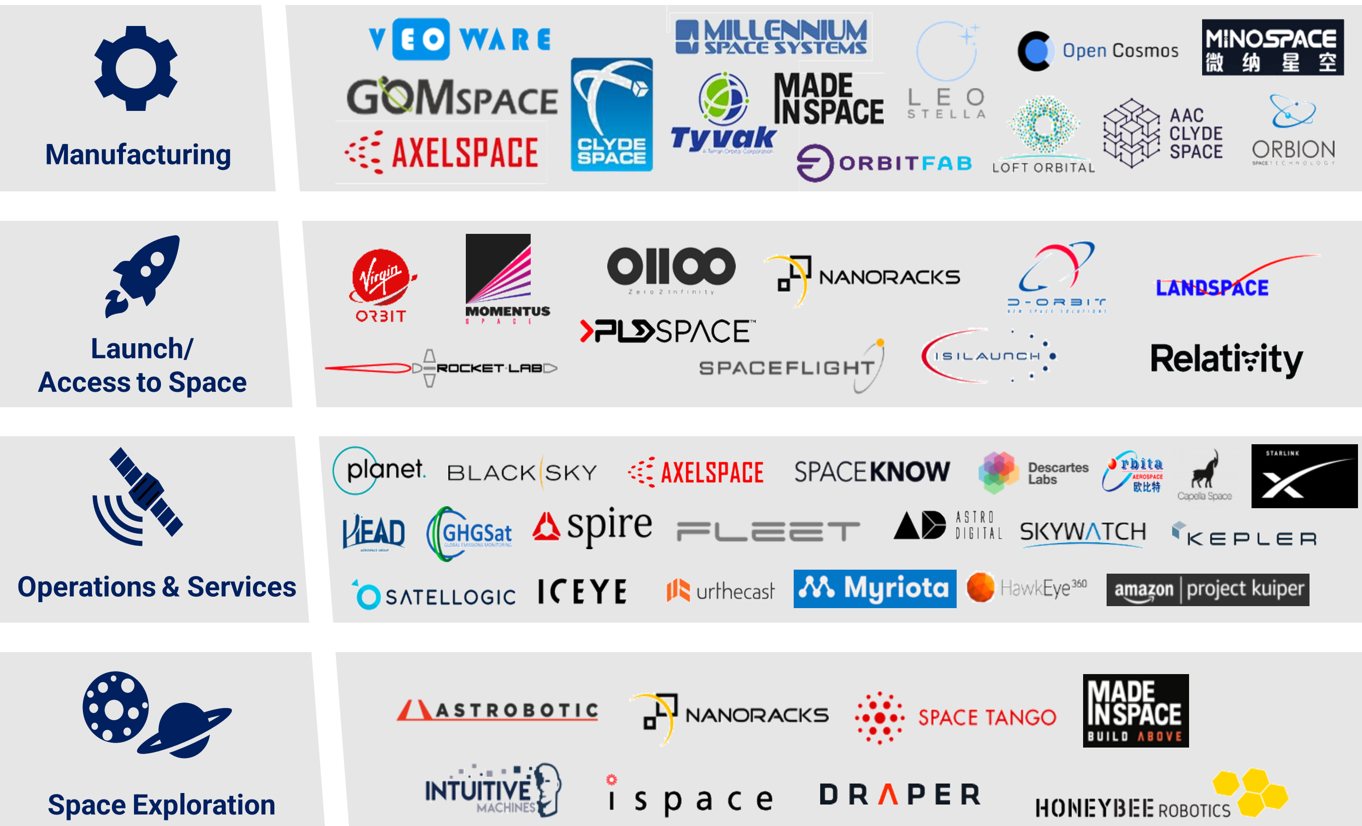
Microlaunchers

RFA One launch (artist impression)

PLD launch (Miura-1)

Many projects (>100) for Limited market besides constellations (Falcon9)

Newspace companies globally along the value chain



(EuroConsult, 2023)

New Space companies financing

INTERNATIONAL SPACE UNIVERSITY

Equity and Debt

Equity	Debt
Provided by investor	Provided by banks
Involves ownership	No ownership
No collateral needed	Requires collateral
Seeks capital Gains	Interest and repayments
Dividend payments, performance based	Interest payments, regardless performance

- Debt/Equity Ratio: Often used to evaluate the financial health of a corporation.

Equity Financing Sources

Investor	Motivation	Criteria
Founders, friends, family (FFF)	•Vision •Return	•Confidence
Incubators (local)	• Build a space ecosystem in the region	•Business Plan •Regional strategy
Private, Business Angels, BAN's	•Idealism (HNWI) •Return	•Opportunity
Financial, Venture capitalists, Private Equity	•Return	•IRR/Business Plan •Product •Management
Crowd Funding	• *Idealism* • *Participation (mini-equity*	•*Product* • *Opportunity*

Notes: HNWI= High Net-Worth Individuals BAN : Business Angel Network

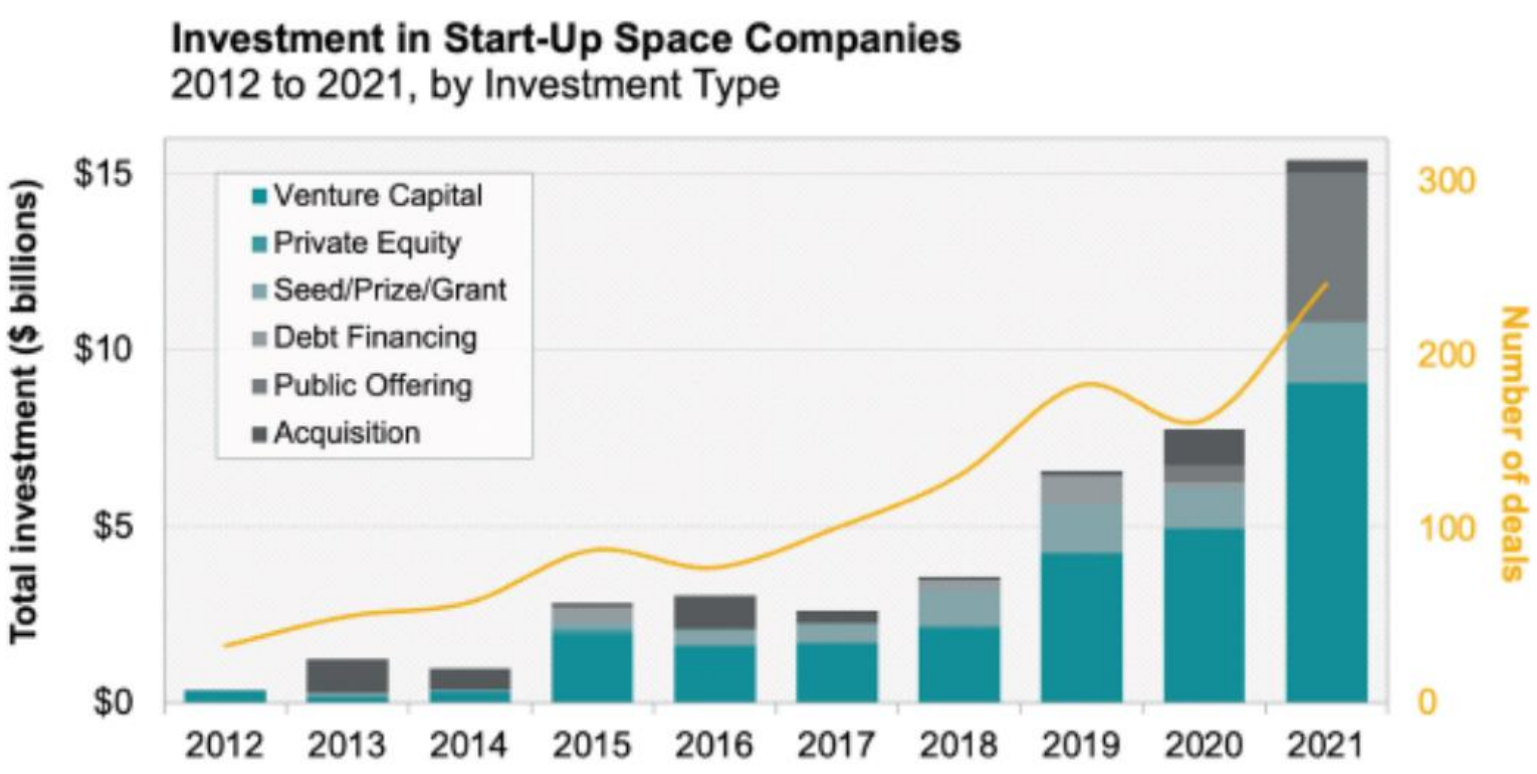
Investment Ranges

Type of investor	Typical Space Investment	Investment type	Recent examples
Business Angels	50K-1M$	Equity	York Space Systems: 250K (2015)
Venture Capital	2M-75M$	Equity	Kymeta 333M$ (2021)
Private Equity	100M-1B$	Equity	Virgin Galactic 490M$ (2011) OneWeb 4.4 B$ (2021)

Note: Incubators 30-200K

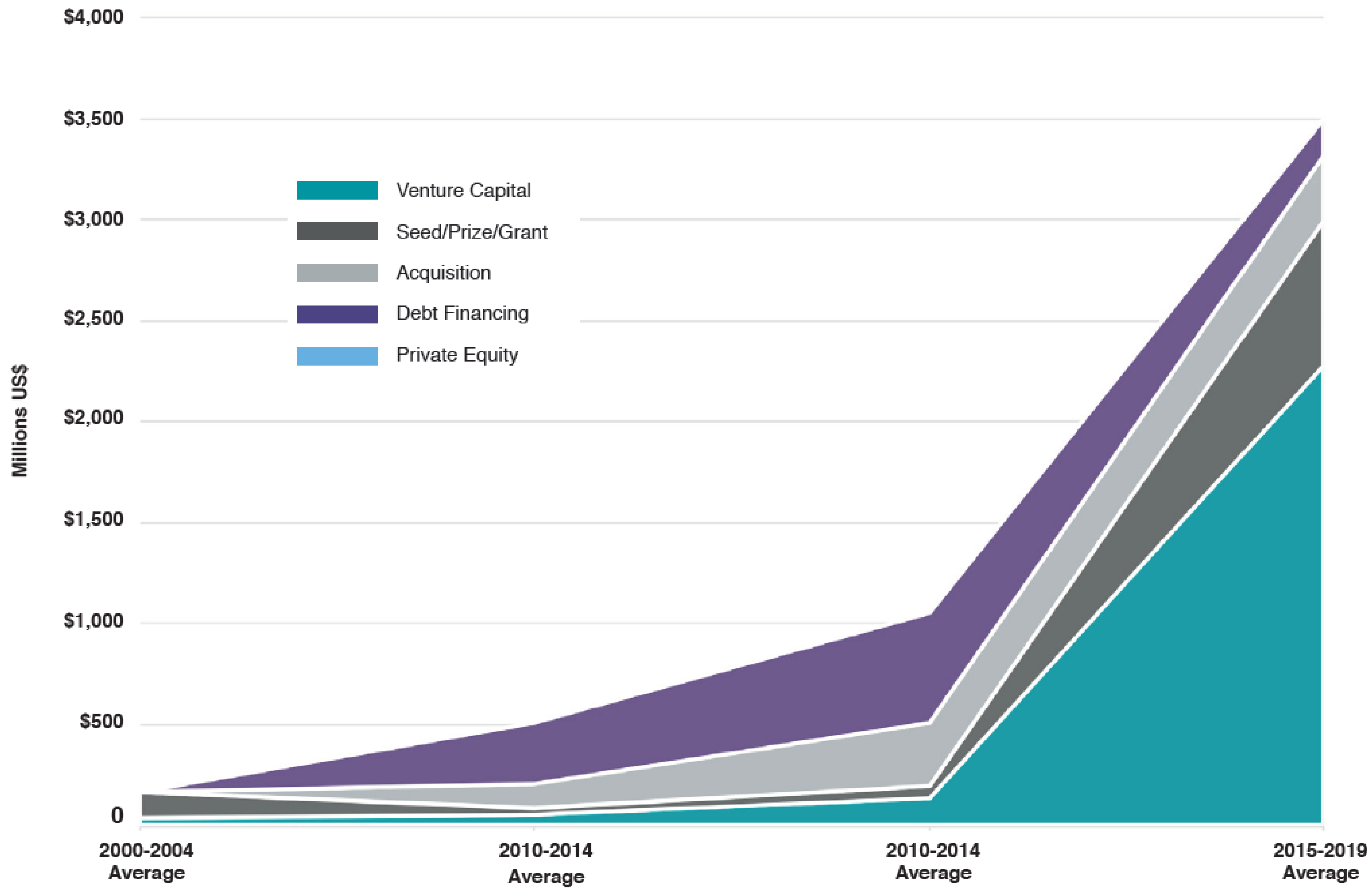
Source: Bryce (2022)

Growing investor interest in start-ups



Source : Bryce (2022)

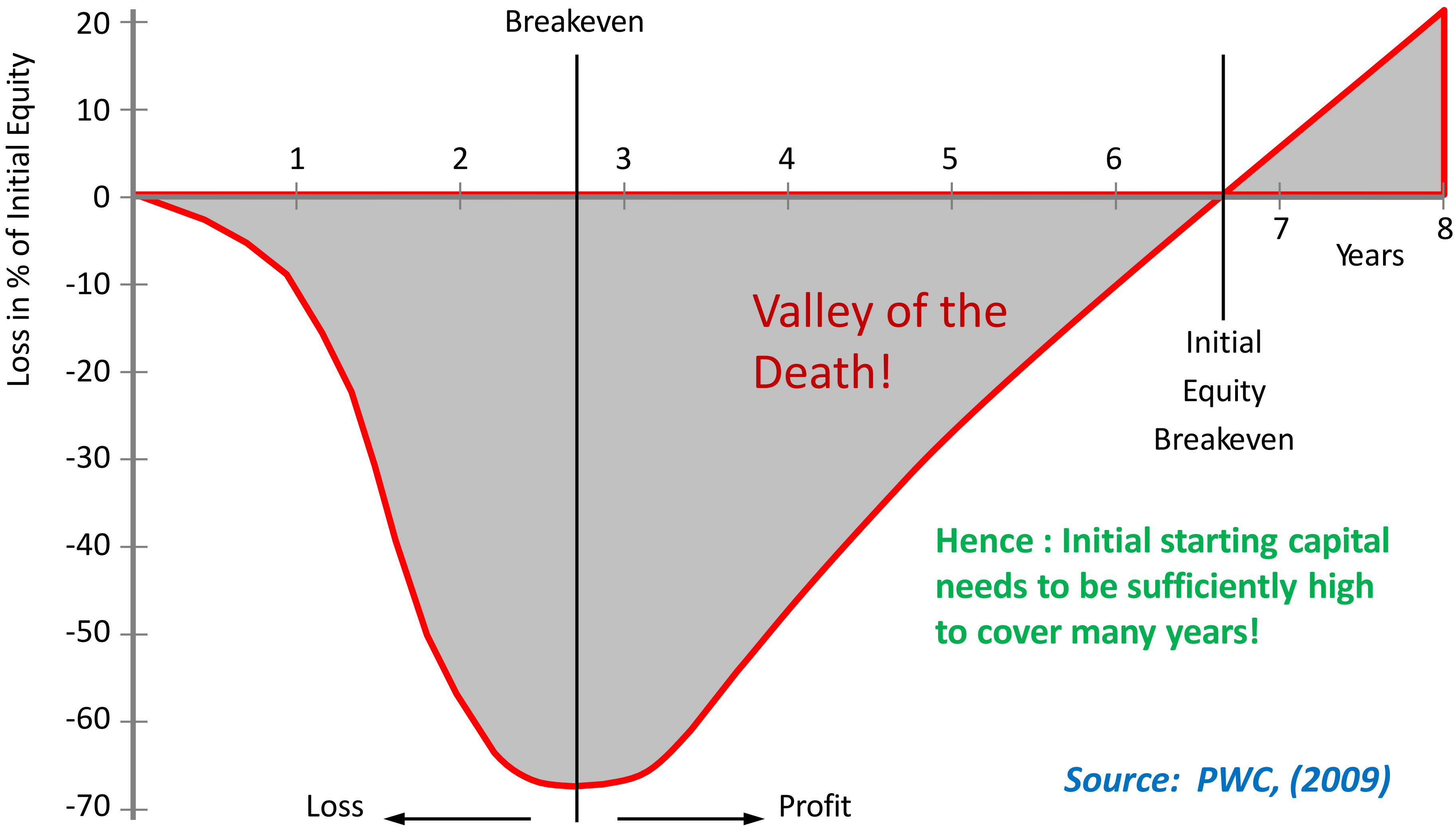
Space Financing Evolution



Note the growth of seed funding and Venture Capital recent years, facilitating the creation of start-ups

Source : Bryce (2020)

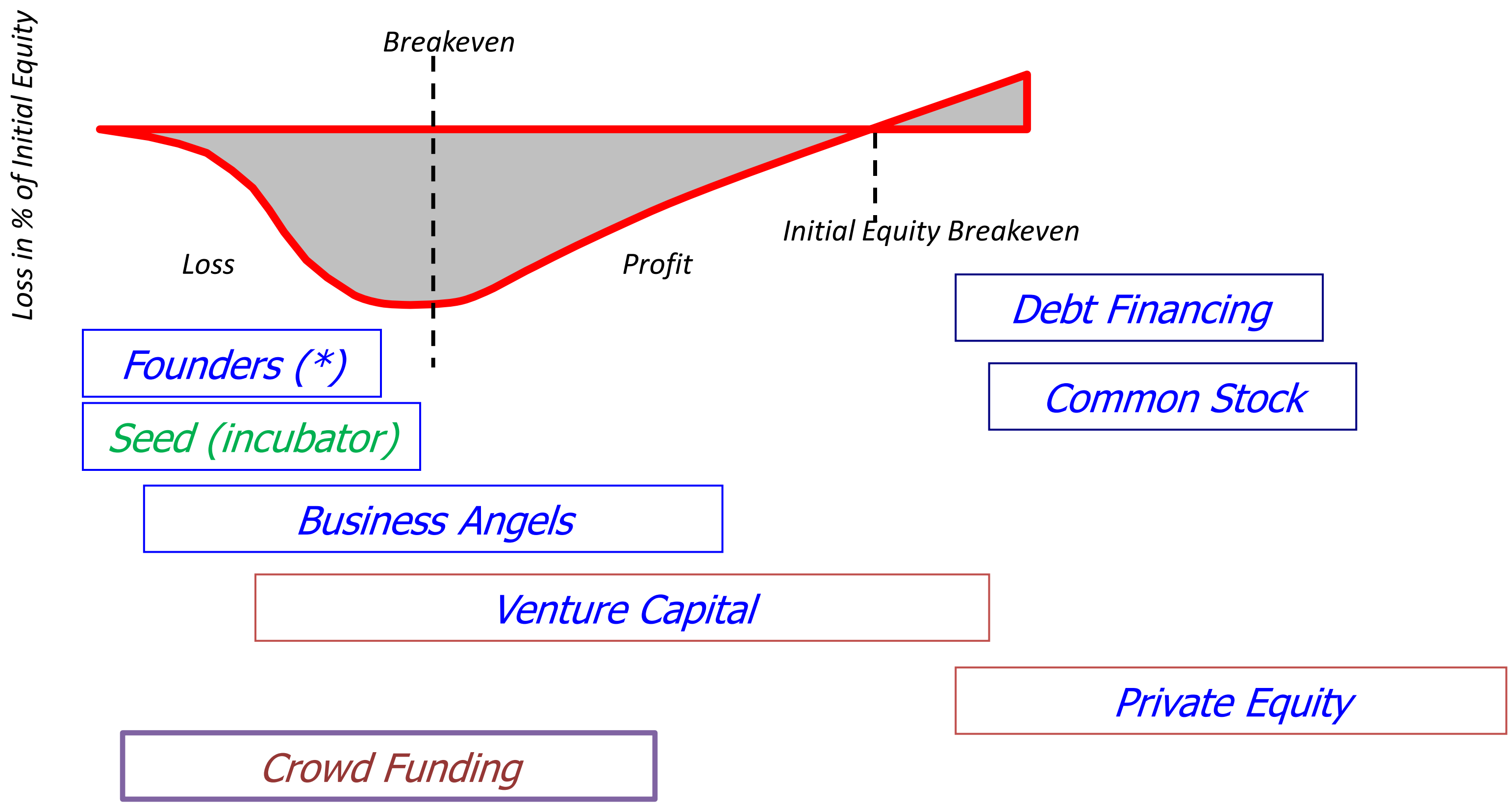
Reaching Equity Breakeven



Hence : Initial starting capital needs to be sufficiently high to cover many years!

Source: PWC, (2009)

Investor Flow



(*) : also in kind like working time

New Space start-up creation

New Space Creation flows (1)

1. Idea generation : Hackatons

- **Youngsters from different disciplines**
- **A few core lectures by specialists**
- **Participants group spontaneously and work out a space application proposal**
- **Mostly over a weekend**

New Space Creation flows (2)

2. Early competitions: Space-ups

- Group of young engineers present projects to a jury
- Best proposals get seed funding and work out a proposal
- Mostly over a weekend

SPACE UP

New Space Creation flows (3)

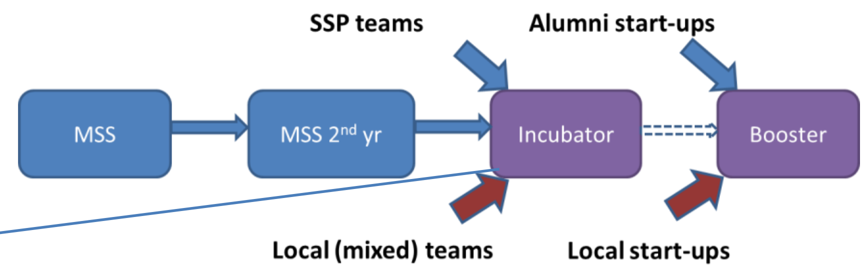
3. Incubators

- Based upon a business plan to be submitted to and approved by a jury
- Start-ups are accommodated for max. 2 years
- Early financing is provided (appr. 100,000 - 200,000 USD)

Seed funding: Example of ISU Incubator

ISU Incubator = Ecosystem Incubator (grant based)

Also : Business Incubators (take Equity)



Option 1 : **Incubator in ISU via ESA-BIC**

- 25,000€ from ESA, 30,000€ from local partners
- Potential additional local 40-80,000 € (max. 200,000€ / 2 years)
- Conditions :
  - Approval of a file by ESA
  - ESA funding restricted use
  - Stay 2 years in incubator
  - Form a local company

Option 2 : **Local (ecosystem) Incubator**

- 30,0000€ from local partners, support from SEMIA
- Potential additional local 40-80,000€ (max. 200,000€ / 2 years)
- Conditions :
  - Form a local company
  - Coherent with local strategy

NewSpace Slide-deck approach

10 – 20 – 30 rule

- 10 slides (slide deck)
- 20 minutes including Q@A
- Big font (30…)

See: Guy Kawasaki
https://guykawasaki.com/the_102030_rule/

Template ISU : see ***https://incubator.isunet.edu/wp-content/uploads/2022/09/PROPOSED-SLIDE-DECK-FOR-START-UP-PRESENTATION.pdf***

Business Plan Basics

1. Is there a need for your product/service?
2. What is your solution?
3. Is there a market now and in future?
4. Are there competitors? (web search!)
5. Which market share do you expect?
6. What is your strategy/marketing plan?
7. Do you have a credible team?
8. How much money do you need?
9. What deal do you propose to your investors?
10. What return can they expect from that deal (IRR)?

Private Financing Case Study

- **Case Study : Facebook**
- **Business idea : 2004 Mark Zuckerberg (28%) + three Harvard students**
  - 2004 : 500,000 $ Business Angel 2,5%
  - 2005 : 12.7 M$ Accel (VC) 11,4%
  - 2006 : 12.5 M$ Greylock (VC) 1,5%
  - 2007 : 240 M$ Microsoft 1,6%
  - …
  - 2010 : Accel sells part : 517 M$
  - 2010 : 500 M$ Goldman-Sachs (PE) 1,0%
  - 2012 : IPO of 460 million shares : 16 B$

References and further reading

- **Bryce**, *Start-up Report 2023* (on website)
- **Bryce Space and Technology**, various reports, under https://brycetech.com/reports.
- **EIB**, *The future of the European Space Sector* (EIB, 2020)
- **New Space journal**
- **Peeters, W.,** Towards a definition of New Space? *New Space* Vol 6(3) (2018), pp. 187-190.

eurospacehub

– Economic aspects of the space sector

UCM / EuroSpaceHub

Prof. W. Peeters (ISU)

November/2023

Learning outcomes

- L01: Understand the economic rationales of space activities.
- L02: Give key figures of the space economy turnover
- L03: Understand why NewSpace is a paradigm shift
- L04: Understand the trends in the space economy
- L05: Understand the principles of Purchasing Power Parity
- L06: Understand the importance of spin-off
- L07: Understand the importance of cost overrun avoidance
- L08: Understand the economic impact of space applications

Outline

SPACE BUSINESS

- Public/Governmental and Private/Commercial space activities
- The changing environment

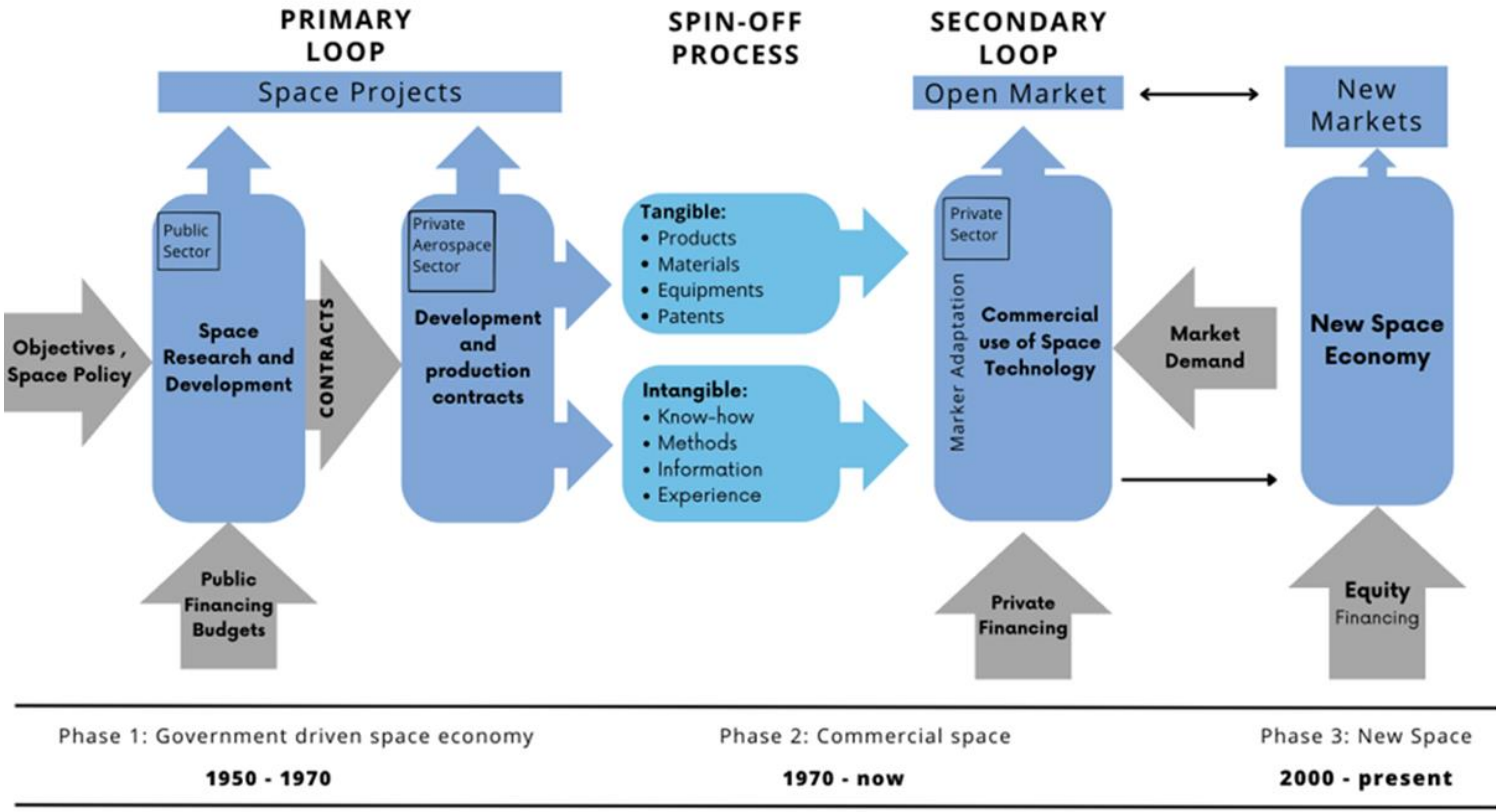
GEOGRAPHICAL SHIFTS

- Purchasing Power

SPACE AND COSTS

ROLE OF SPACE IN GLOBAL BUSINESS

Space Business Overview



GOVERNMENTAL SPACE BUDGETS

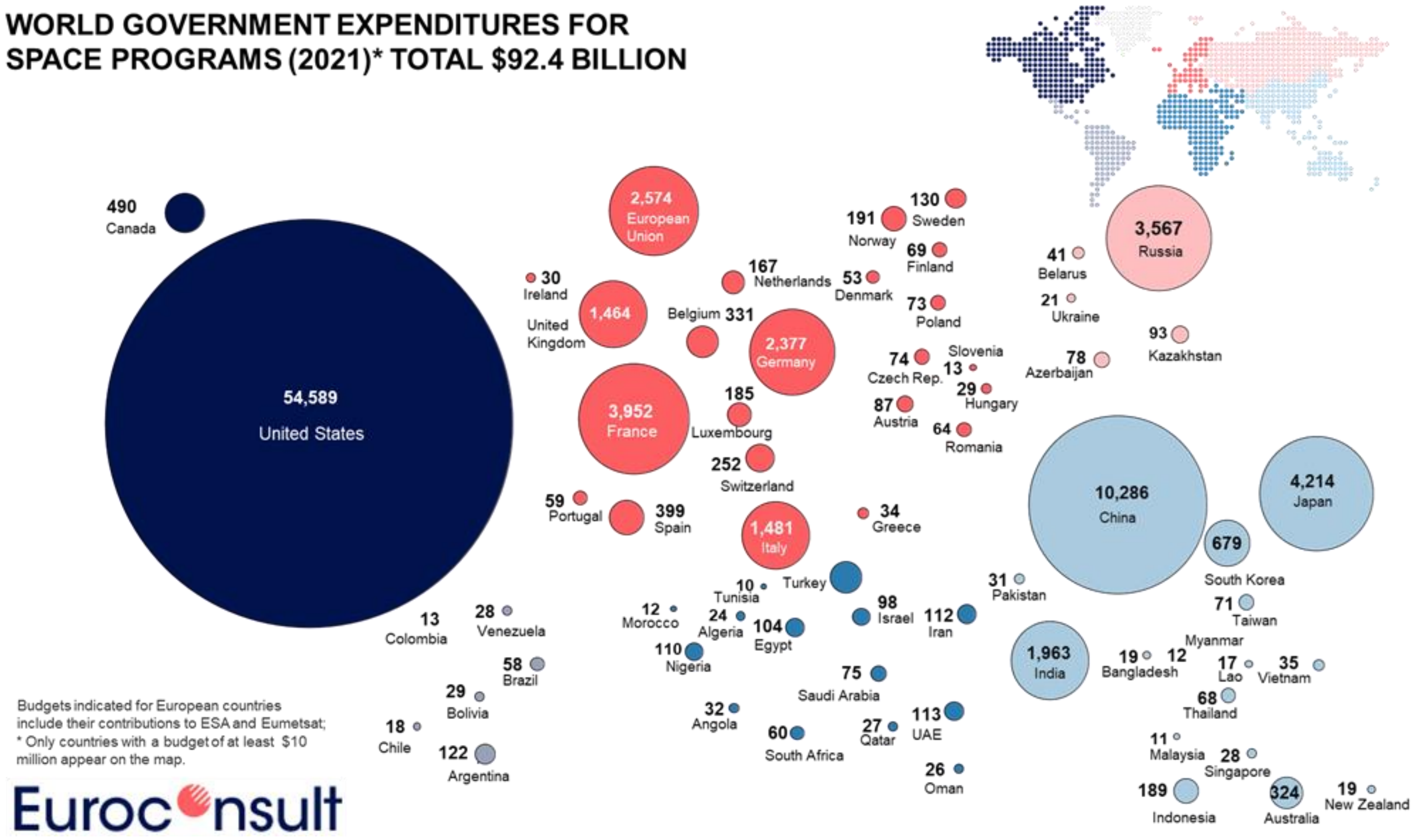
The Public (Governmental) Space Market

(sources ***Bryce, Euroconsult, ESA, Space Report)***

Country	Space Budget (2021, B$)	Remarks
USA	57.0	40% NASA and NOAA
Europe	10.1	70% ESA and EC
Russia	7.5	1.6 Roskosmos (civil)
China	15	Estimate (workforce based)
Japan	4.2	55% JAXA
India	2.0	Increased from 1.8
ROW	5	S-Korea (.7), Canada (.5), Australia (.3), Indonesia (.2) Arg. (.15) Israel (.1), UAE (.1), Brazil (.1) others (3)
Totals	**~100 B$**	**~40 B$ civil**

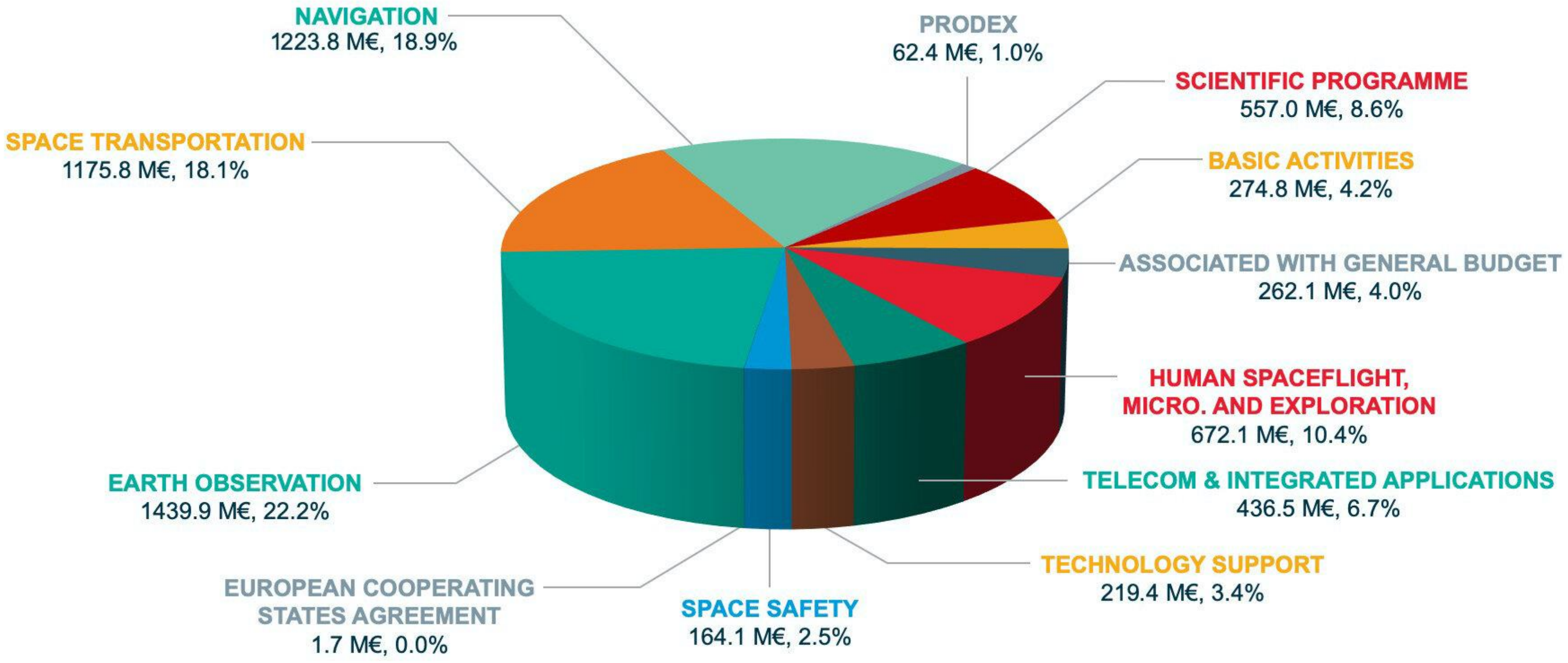
Notes: US : Classified activities are estimated besides DOD (24); NRO, NGA, NSA… ROW = Rest of the World

Government budgets per country



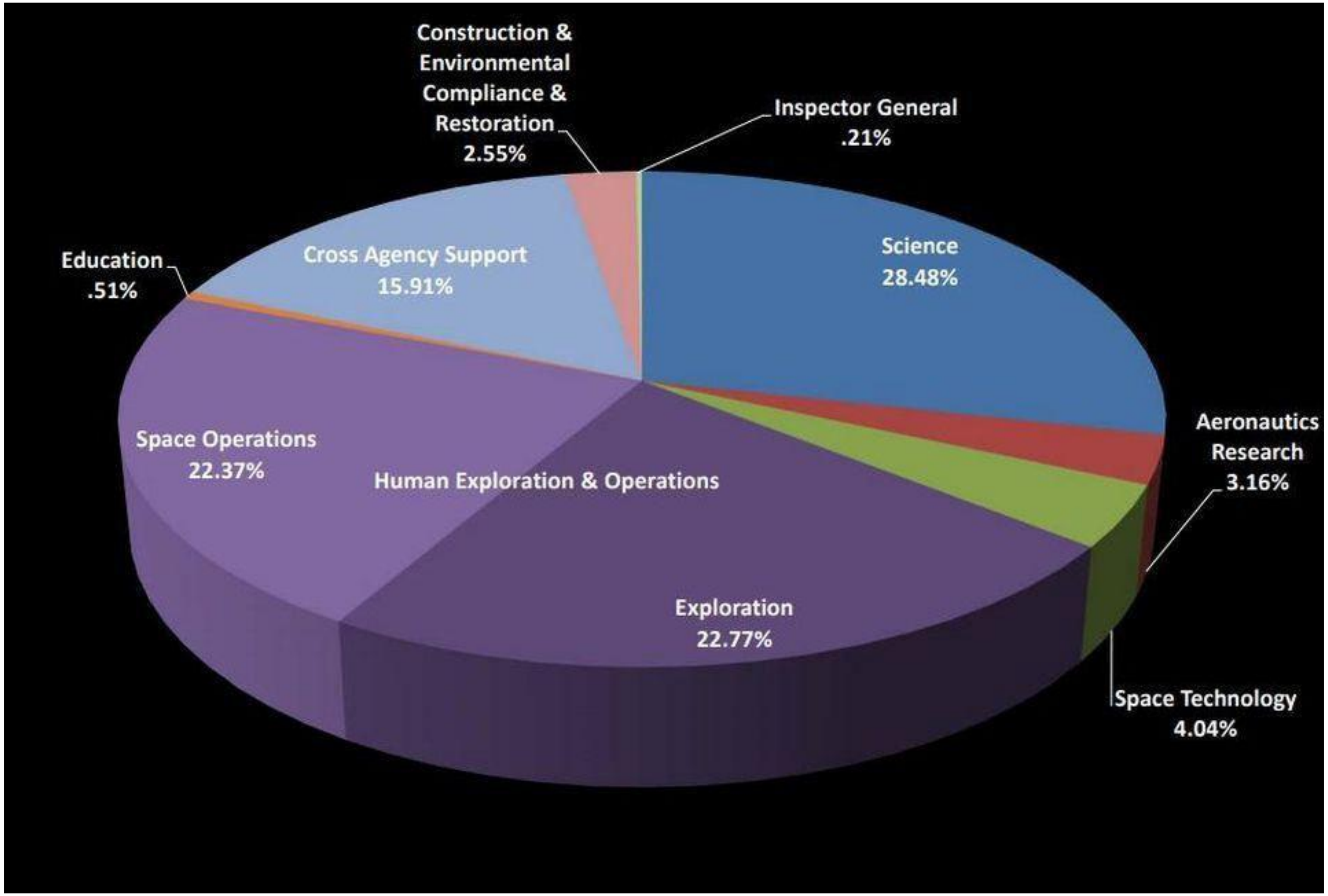
ESA Budget by Domain

ESA BUDGET BY DOMAIN FOR 2021: 6.49 B€*



*includes activities implemented for other institutional partners

NASA 2021 Budget by Domain



Public Space Expenditure and GDP

(expressed as per thousand) *(Euroconsult/ESA/OECD)*

Country	1987	1992	2005	2011	2021
U.S.	5.2	5.2	3.0	3.1	2.2
Europe	0.7	0.7	0.65	0.55*	0.6
Japan	0.45	0.5	0.45	0.65	0.7
France	1.1	1.1	1.0	0.8	1.2
Germany	0.5	0.4	0.5	0.5	0.5
India	1.2	1.4	1.0	0.9	0.5

(*) Equivalent to 10 Euro/capita

Note: 2021 figures : Source: Space Foundation

Expenditure per capita per year

Public space expenditure ***(EUROSPACE, ESA, Space Report)***

Country	Expenditure/capita in USD (2021)	Remark
USA	125	Uncertainty military budgets
Japan	22	Increasing
Europe	17	Relatively stable over last years

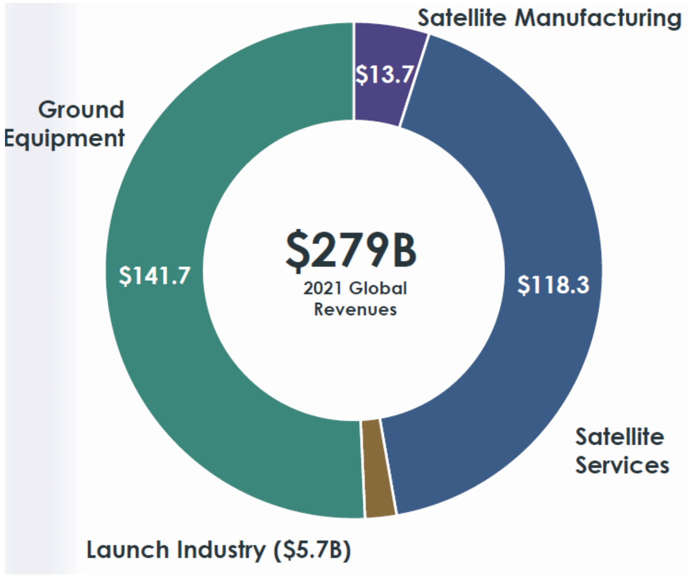
European benchmarks :

- ***Alcoholic beverages and tobacco ≈ 500***
- ***Gambling ≈ 130***

COMMERCIAL SPACE

Commercial space sector breakdown

2021 figures



(SIA/Bryce, 2022)

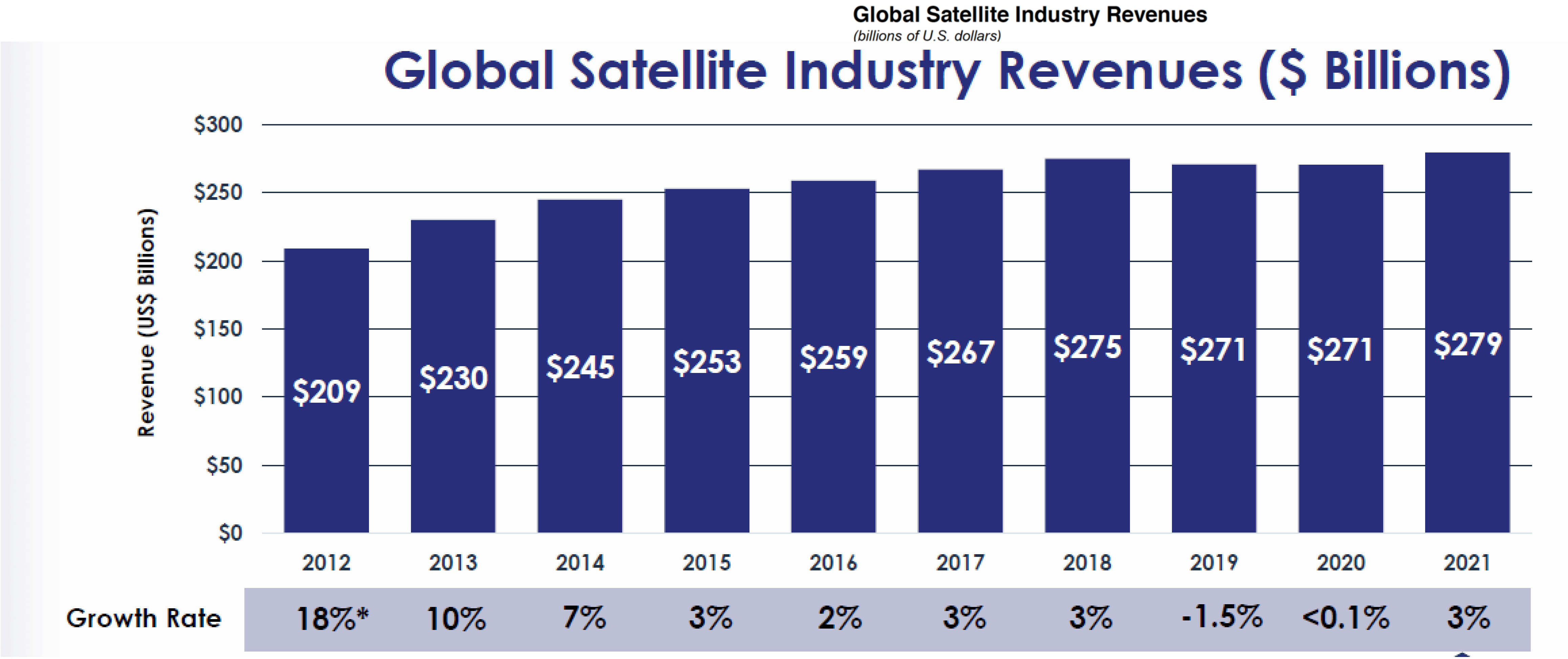
Note: Problem to have real figures:

- **No dedicated statistics**
- **Some figures not known (Russia, China)**
- **Delimitation, e.g. Telecommunications**

Space segment	**3.6 B$**
Satellite capacity	**11 B$**
Ground segment	**10-20 B$**
Added value	**50-80 B$**

COVID19 Impact (only now back to 2018 figures…)

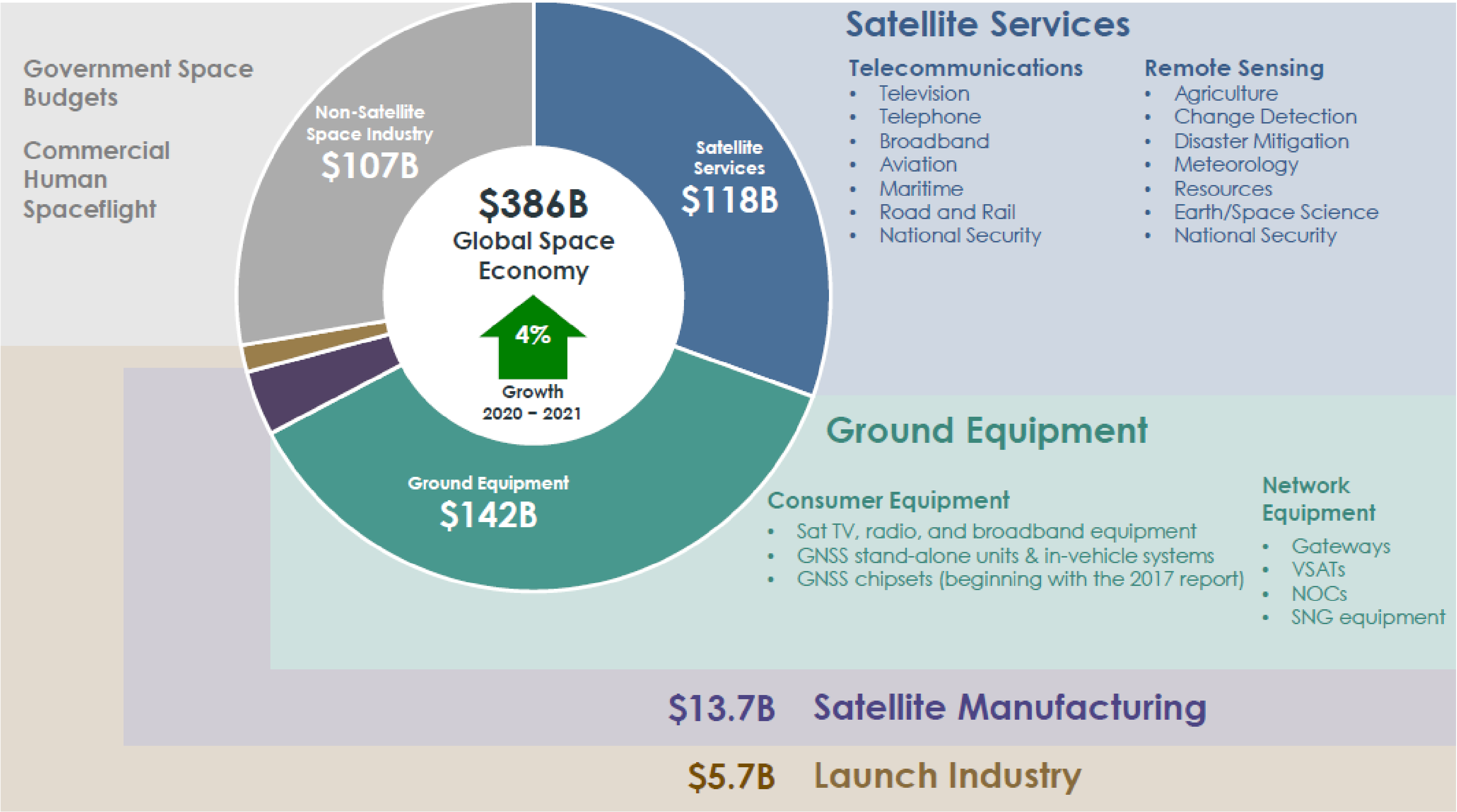
Space Business Evolution



(SIA/Bryce, 2022)

GLOBAL SPACE TURNOVER

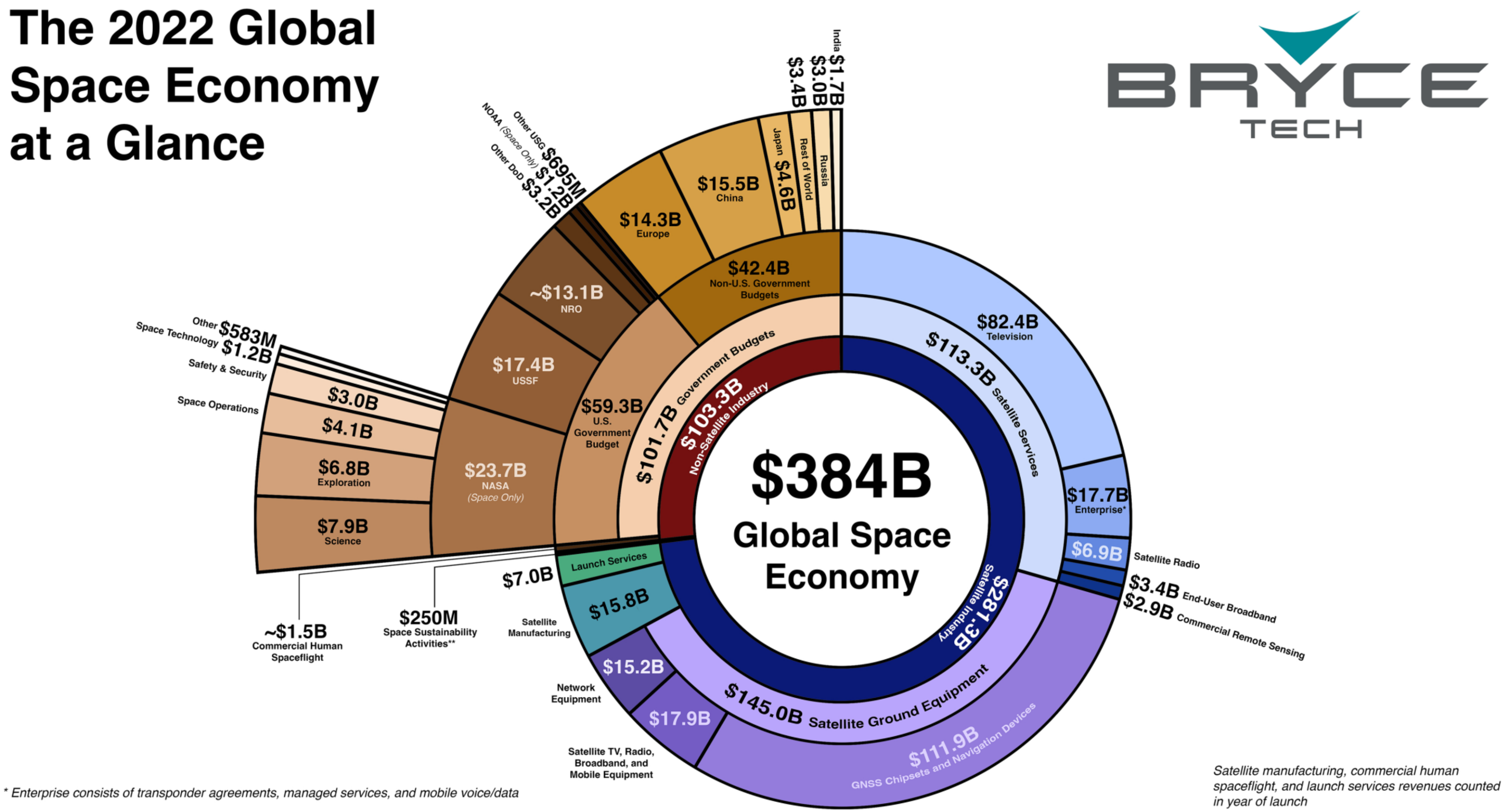
Overall space sector breakdown (2021)



(SIA/Bryce, 2022)

Commercial Space = ¾ overall space market !

Overall space sector breakdown (draft, 2022)



* Enterprise consists of transponder agreements, managed services, and mobile voice/data

** Space Sustainability Activities consist of debris removal, moving satellites, spacecraft life extension, space situational awareness, satellite servicing, and in-orbit assembly

Satellite manufacturing, commercial human spaceflight, and launch services revenues counted in year of launch

Numbers may not add up due to rounding

(SIA/Bryce, 2023)

Intermezzo Survey

The total space economy is presently some 380 Billion USD (2022)

What will this figure be in 2040 in **THEN** money?

A. 300 Billion
B. 400 Billion
C. 600 Billion
D. 800 Billion
E. 1,000 Billion
F. 1,500 Billion

Future Space Economy

NEWSPACE

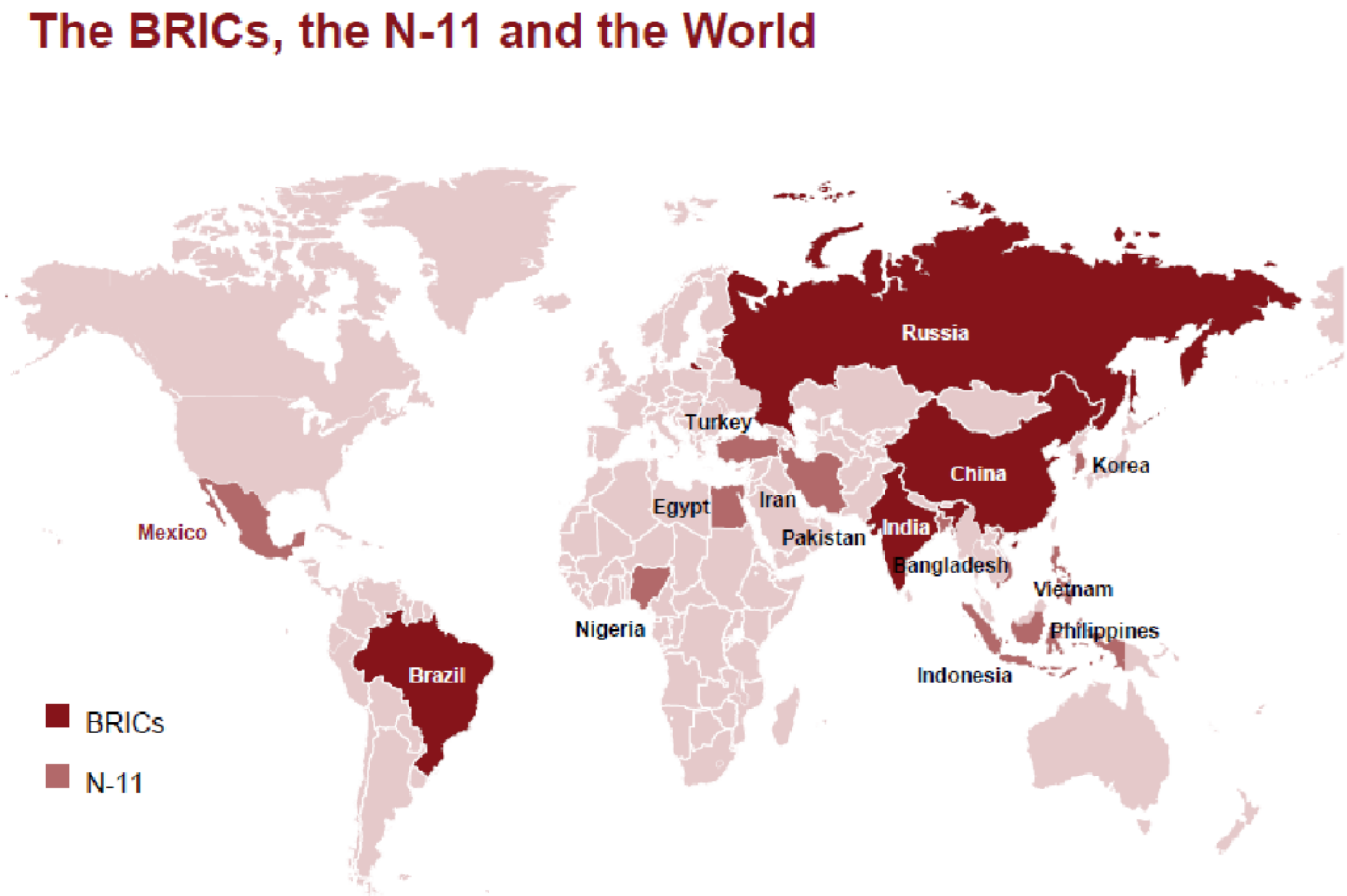
Institution	2016	2040	CAGR	Remark
UBS	340 B$	926 B$	4.3%	Pre-Covid
Morgan Stanley	339 B$	1,100 B$	4.9%	Slightly optimistic CAGR
US Chamber of Commerce	383.5 B$	1,500 B$	6%	High starting point
Goldman-Sachs	340 B$	> 3,000 B$	9,5%	Very high CAGR assumption

CAGR : Compound Annual Growth Rate

(source IDA, 2020)

A CHANGING SPACE WORLD

BRIC and N-11



Note : also other approaches like NEST and EAGLES etc.

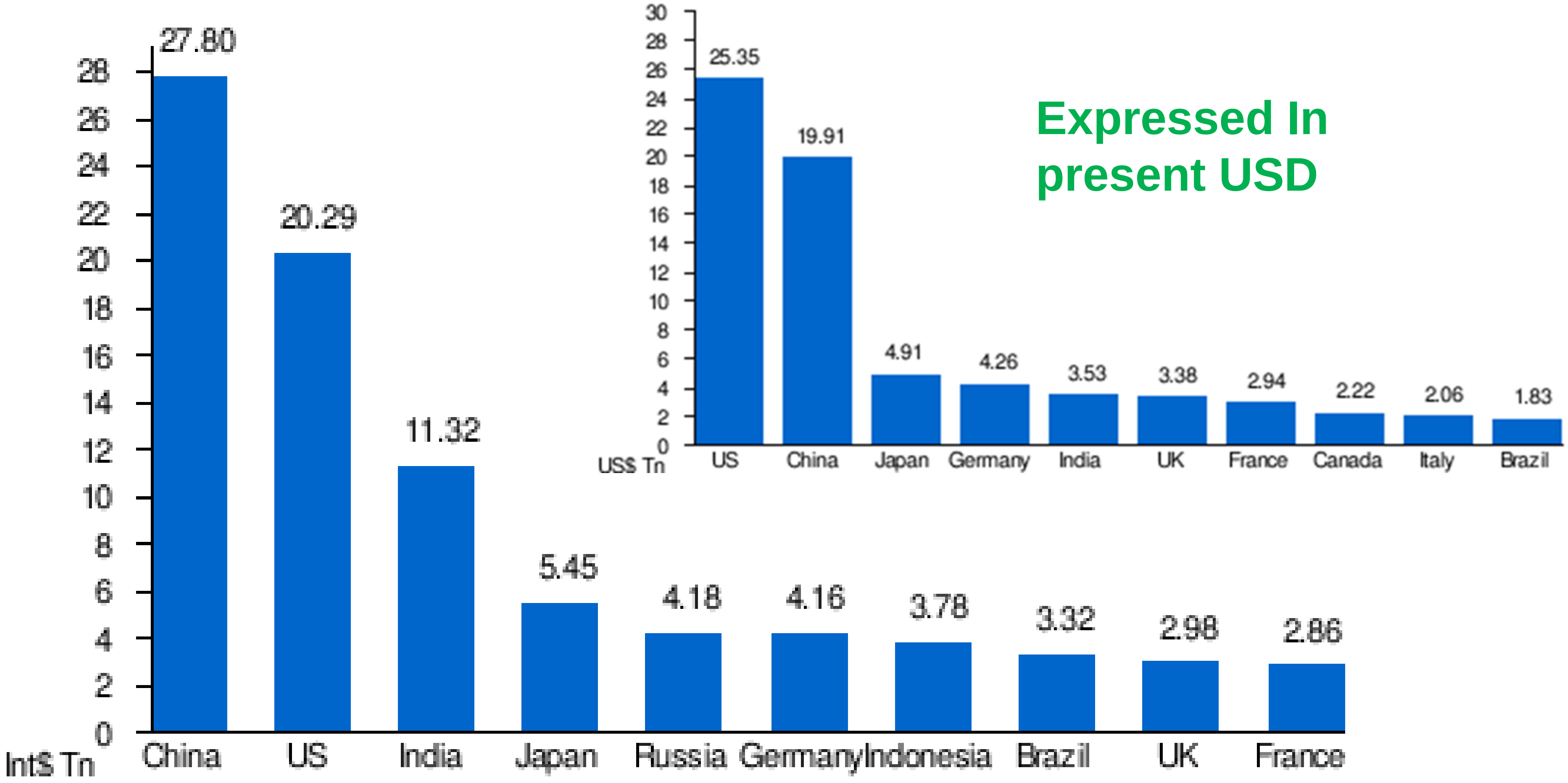
(Source: Goldman-Sachs)

PPP : Purchasing Power Parity

- **Purchasing Power Parity (PPP):** An adjustment factor which takes account of differences in price levels between countries. (food basket of common products, also used : ‘BigMac Index’, rather accurate as same ingredients are used worldwide…)
- **Examples in USD (2021, WTO, normalized US=100)**
  - US : 100
  - China : 57
  - India : 47
  - Russia : 36
  - France : 80
  - Switzerland : 111 (highest)
  - Spain : 85

Note : not to be confused with PPP = Public-Private-Partnership

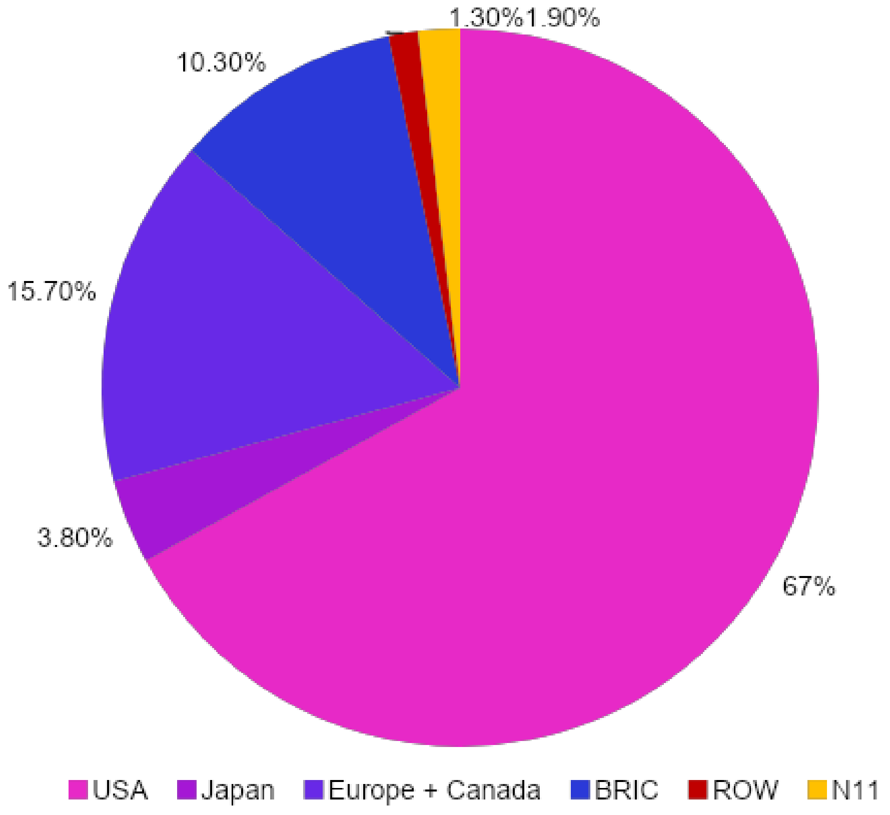
GDP in PPP terms (2021)



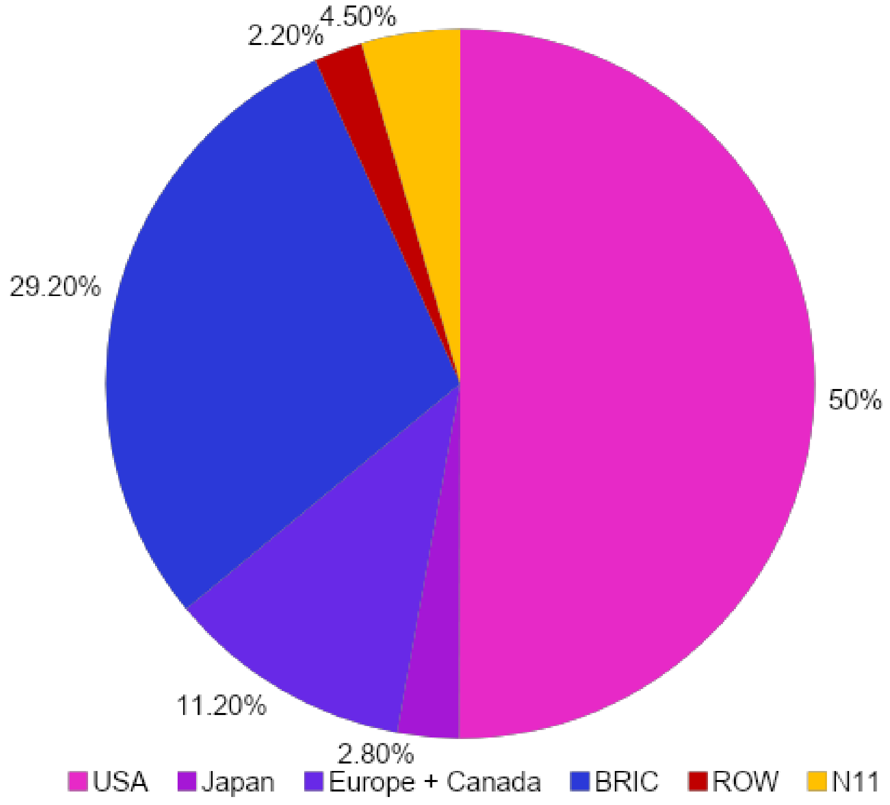
(source WTO, 2022)

Space turnover adjusted to PPP

Space Budget now : Distribution (%)



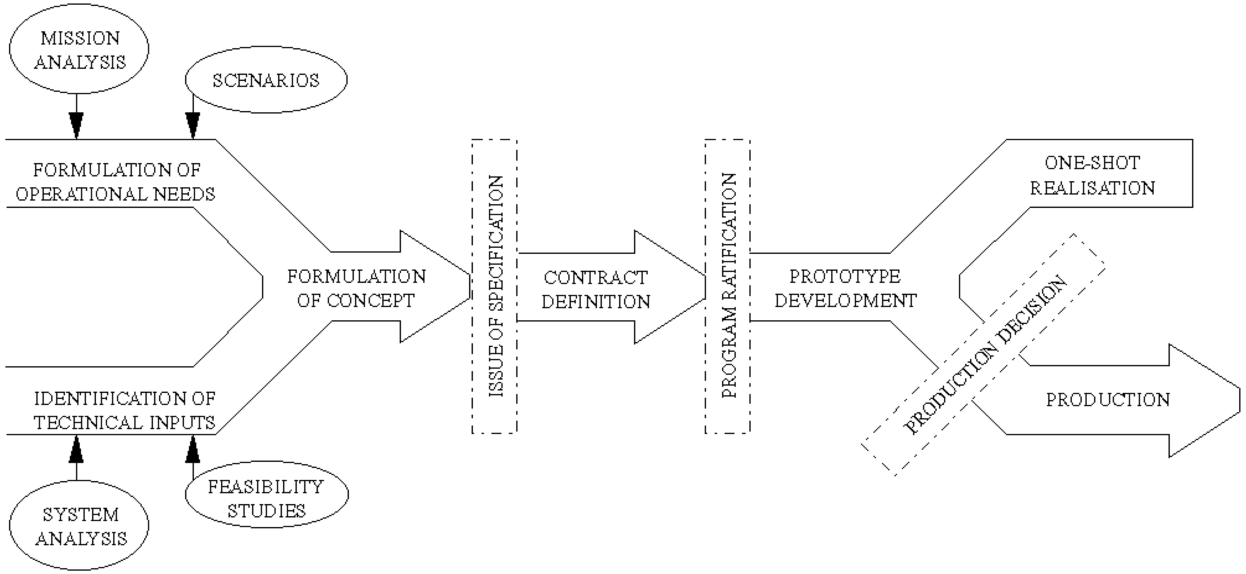
Space Budget : PPP Distribution (%)



SPACE AND COSTS

Apparent cost of space systems (1)

- **Prototyping**



Example

- **Airbus 380: list price 310-350 Million $**
- **Airbus 380: Development program 16 Billion $**
- **Breakeven : 420 units (early 2009)**

= Hubble Telescope

Apparent cost of space systems (2)

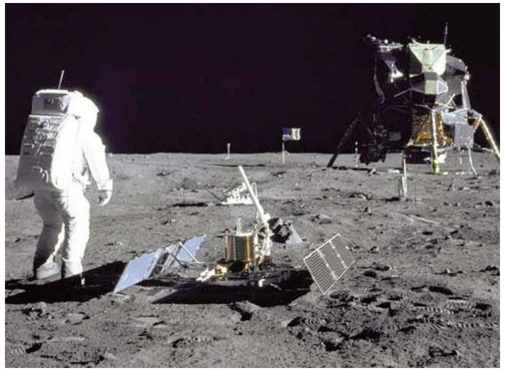
- Limited use of other ‘off-the-shelf’ equipment/materials due to the ‘dual conditions’
  - launch pad : vibrations, acoustic levels
  - in space : microgravity, vacuum, radiation, thermal, solar,...

- Advantage : spin-off of light, high reliable, resistant products
- See Annex for spin-off examples

Relative Cost of Space Systems

Use relative cost in comparison

- ISS in US = 1 cinema ticket
- Europe : average 17€ /person
  (= 5 Eurocent/day)
- Apollo: more spent on popcorn
- Galileo system = 150 Km highway
- Ice cream in Germany (2022) 8.3 l/person
  (= 2 x Space spending)



Source: NASA

Note : use appropriate and cultural-correct comparisons !

Cost Overruns

- **Mercury:**
  - Cost overrun of 120%
  - Development time: 2.25 times originally scheduled

- **Apollo:**
  - Cost overrun: 25% (time factor)

- **Also others: Berlin new airport**
  - 2006-2011 : 2 B€
  - Review 2020 : 7.3 B€ (+ 215%)
  - Real CTC (Cost To Completion) : ?

Cost Overrun Countermeasures (5C)

- **Before the contract:**
  - Own Cost Estimate
  - Consider the Life Cycle Cost

- **Negotiation:**
  - Choice of the Contract type

- **Project execution:**
  - Cost Control and Risk management
  - Communication with Insurance Broker

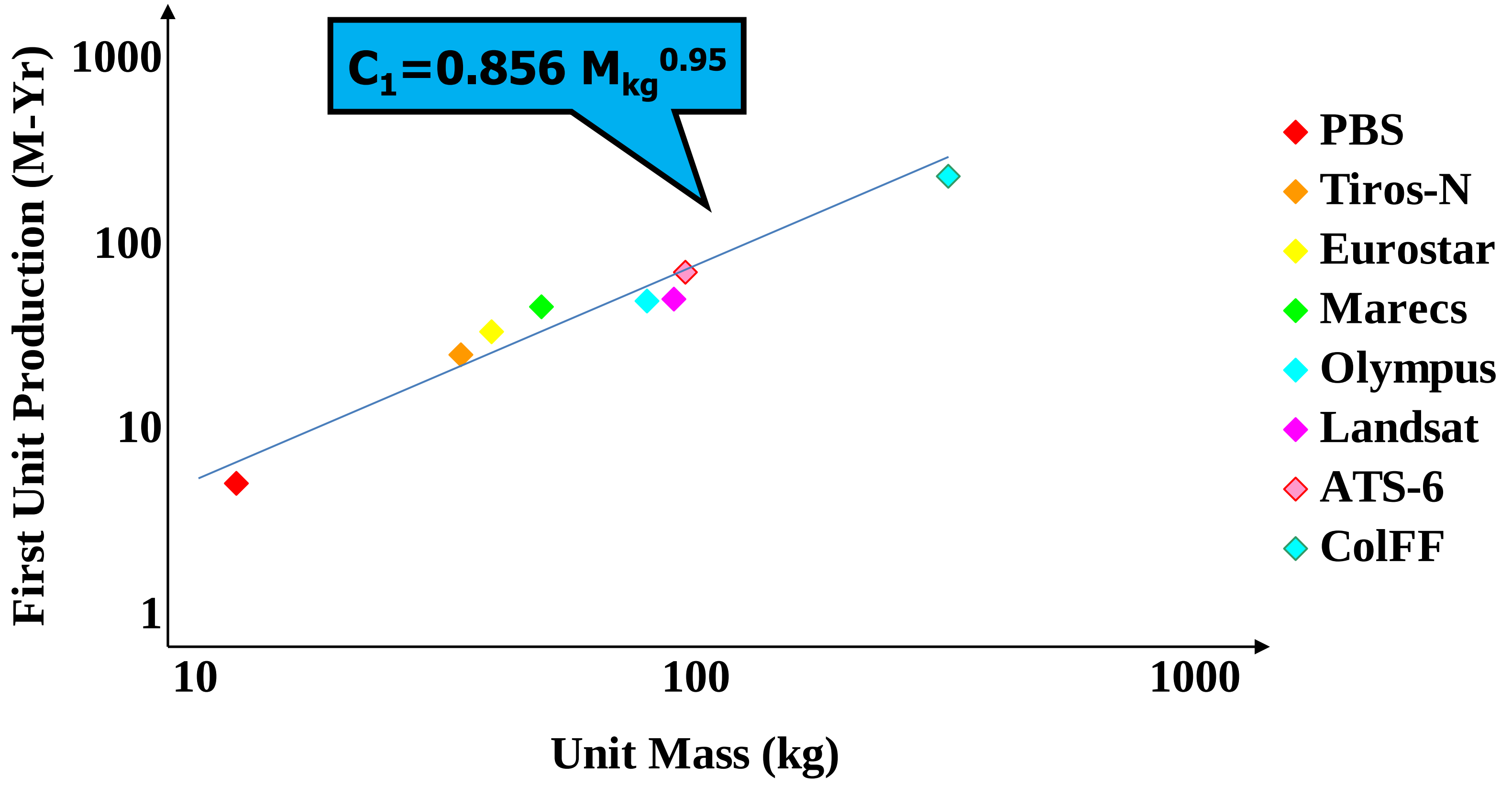
Detailed 5C article distributed as backup material

Costing Methods (1)

- **Three main techniques (in order of complexity):**
  - **Cost by Analogy**
  - **Parametric Cost Estimation**
  - **Engineering Cost Estimation ('Grassroots')**

- ***Note : Cost by Comparison not considered as we are working in an oligopolistic environment***

Parametric Costing (Avionics)



Parametric Costing (General)

$$\text{Cost} = \text{constant. f. (size)}^{xp}$$

- **Cost in eng-yr**
- **Often Mass**
- **Best fit from past projects or fit to similar example**
- **Similarity multiplier**
- **$0.3 < xp < 1.0$**

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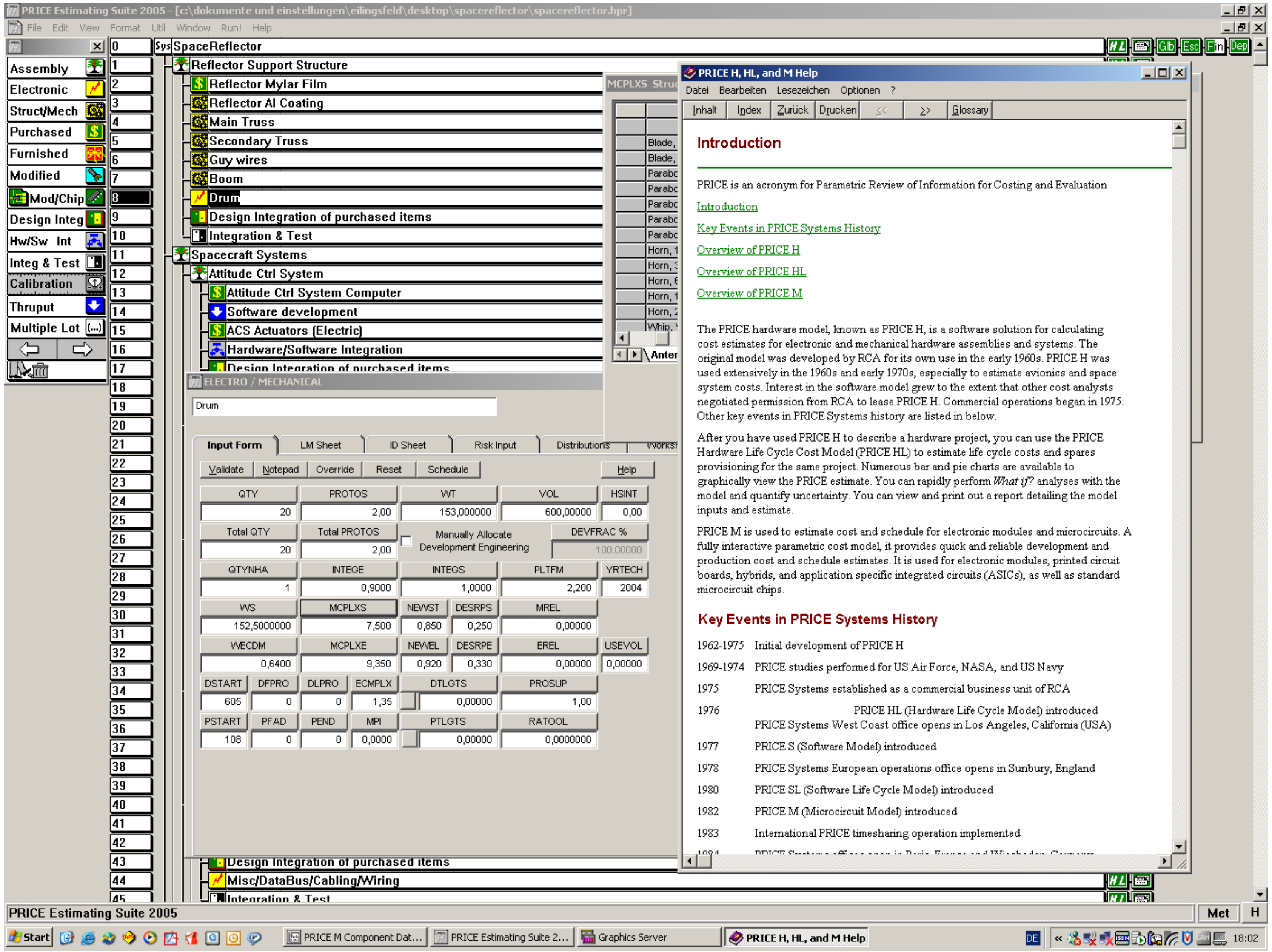
Parametric Costing Model

PRICE True Program Success™



Smallsat Parametric Costing Model

THE AEROSPACE CORPORATION **SSCM98 P**

Cost Input Data

Retrieve Inputs | Save Inputs | Estimate | List of Programs | Print sheet

Test

Cost Driver (Units)	Value	Valid Range		
		Low	High	Outside range
End-of-Life Power (W)	130.	5	500	
Pointing Accuracy (degrees)	5.	0.05	5	
TT&C/C&DH Subsystem Mass (kg)	18.6	3	30	
Payload Power (W)	66.	10	120	
Downlink Data Rate (kbps)	524.	1	2,000	
On-orbit Average Power (W)	91.	5	200	
Propulsion Subsystem Dry Mass (kg)	15.	0	35	
Satellite Dry Mass (kg)	214.	20	400	
Solar Array Area (m^2)	2.	0.3	10	
ACS Type — GG/Spin Stabilized	1			
Power Subsystem Mass (kg)	40.6	7	70	

Note: If a cost driver is unknown, be certain that the value is blank (use the Delete key), or the cost estimate may be in error.

Legend	
	required input
	do not change!

SPACE AND WORLD ECONOMY

Note: Based upon a previous ISU SH/SSP TP

Economy in a world without satellites? (1)

Assumptions : ALL satellites in space are deactivated beyond repair due to a global cyberattack, a larger solar storm or a space debris Kessler effect.

T0

- All planes grounded, trains stopped, road transport traffic jams (suddenly no GNSS signals)
- Drones will become uncontrollable (military)
- Delayed intervention police/ambulances/fire brigades (no GNSS)
- Cash-dispensers stop working (GNSS controlled timestamp)

T + 2hrs

- Stock markets drop considerably
- Congestion terrestrial communications and remote access (oceanic/polar) interrupted

T + 7 hrs

- News Agencies and energy companies hit

T + 11 hrs

- No thunderstorm/hurricane/natural disaster warnings anymore

Economy in a world without satellites? (2)

T + 1 day

- Government limits public access to give priority to crisis communication
- No public access to social media

T+2days

- Financial transactions stop (no timestamp)
- Breakdowns of power stations (uncontrolled overload)

T+3 days

- Power blackouts (no power synchronization)
- Food and temperature sensitive medicaments affected

T+4 days

- Food supply chain starts to break down
- Panic-buying of food, plundering

T+ 5 days

- Fresh water shortage
- Tourism heavily affected (massive cancelations)

Economy in a world without satellites? (3)

T+1 week

- **Slow economic collapse**
- **No funding transactions/ no new contracts**

T+2 weeks

- **No forecasting of solar storms**
- **Disrupted power grids (in particular if solar storm)**

T+ 2 months

- **Economy strongly effected (2 Trillion USD?)**
- **Communication companies bankrupt**
- **Factories with complex delivery systems bankrupt**

T+4 months : Strong public interest to increase space budgets immediately! (Rapid LEO Deployments)

T+12 months : new constellations operational (first LEO, then GEO)

Summary of Key Points

- Worldwide only some 0.4 % of the GDP is spent on space activities, with an expenditure per capita lower than assumed
- Due to reduced government spending space shifts to commercial space took place
- At present, about ¾ of space turnover is commercial
- Space Agencies have a trend to concentrate on technologies, and let applications to private sector
- Also due to Purchasing-Power differences, space activities are shifting the next decades
- New Space Economy is a paradigm shift towards more affordable space applications
- The general public, with better information flows, is very sensitive about cost overruns in the space sector.
- The general public is unaware of the fact that without space applications the world economy will collapse

References & Additional Reading

- Web sites (e.g. www.space.com; www.eurospace.org; www.spacefoundation.org; …)
- **SIA/Bryce**, *State of the Satellite Industry Report* (yearly),
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- **Peeters, W.**, Evolution of the Space Economy: Government Space to Commercial Space and New Space, *Astropolitics*, DOI: 10.1080/14777622.2021.1984001 (2022)
- **Peeters, W. and Madauss, B.,** A Proposed strategy against cost overruns in the space sector : The 5C approach. *Space Policy,* April, 2008**.**

THANK YOU!

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Space Economics

QUESTIONS?

Annex : Spin-off Examples

Annex : Spin-off examples (1)

PRODUCT	SPACE ROOT
Fire fighter suits	Apollo suit
Tumor tomography	NASA scanner for testing
Battery powered surgical instruments	Apollo moon program
Anesthetic gasses monitoring	Apollo suit respiratory system
Non-reflective coating on PC screens	Gemini window coating
Emergency blankets (survival)	Satellite thermal insulation
Mammogram screening	Space Telescope instruments
Heart assist pump	Space Shuttle technology
Plant photon-counting technology	Hubble Space Telescope
Skin cancer detection	ROSAT X-ray detection
Dental orthodontic spring	Space Shape Memory Alloys
Early cancer cell detection	Microwave spectroscopy
Railway scheduling	Ariane check-out software
Coatings for clearer plastics	Material for Shuttle bearings

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Annex Spin-off examples (2)

PRODUCT	SPACE ROOT
Fuel cell driven car	Energy source for satellites
Carbon-composite car brakes	Solid rocket motor nozzles
Car assembly robots	Space robotics
Flameproof textile	Ariane protective layers
Lightweight Car frames	Space Shuttle
Fresh water systems	ISS technology
Computer game sticks	Space Shuttle hand controller
Golf shoes with inner liner	Space suit cooling systems
Non-skid road paint	Shuttle booster coating
Corrosion-free coating (statues)	Launch pad protection
Ski-boots flexibility	Space suit design
Health food	Space food
Fuel tank insulation	Ariane polymer blankets
Light allergy protection	Space suits

Annex Spin-off examples (3)

PRODUCT	SPACE ROOT
Airbag sensors	Robotic arm ISS (CSA)
Cabriolet stiffness	Ariane (vibro-acoustics)
Metro fire detection	MIR station
Car assembly alignment	ATV sensors
Prosthesis	Ariane
Bio-contaminants air purification	MIR
Insulin pumps	Rosetta
Security scanners	Investa Terrs-Hz technology
Nuclear detection	Integral

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Annex Spin-off examples (4)

PRODUCT	SPACE ROOT
Programmable Pacemaker	Satellite control
Solar Energy	Solar Panels
Robotic Surgery	ISS
Lithium/Ion Batteries	Satellite power subsystems
Deep-sea diver suits	EVA - suits
Pollution sources	Skylab
Panoramic pictures	Mars Exploration Rovers
AeroGarden Plants / vegetables	MIR
Food Conservation	ISS/MIR

Annex Spin-off examples (5)

PRODUCT	SPACE ROOT
Safe drinking water	Shuttle water purifiers
Solar Energy	Solar Panels
Knowledge based software	Mars rovers (SHINE)
Virtual Reality visors	Robonauts
3-D street mapping (Google)	Mars Exploration Rovers
Welding (Friction Stir Welding)	Shuttle tanks welding

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