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Mission-oriented policies in context

What can we learn from space agencies orientation to « new » missions.

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EUSPRI 2018,
6th June, Paris

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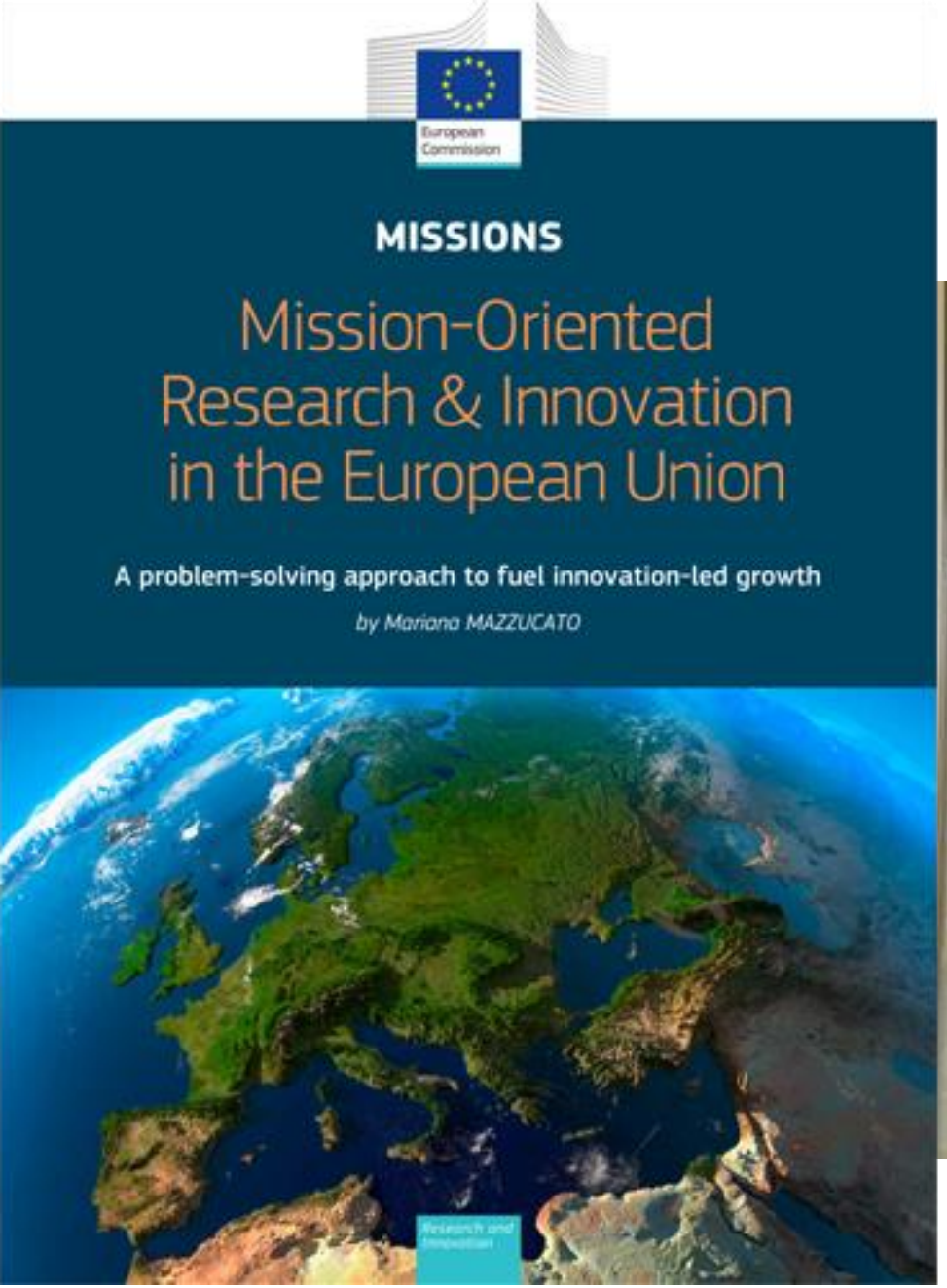

European Commission
MISSIONS
Mission-Oriented Research & Innovation in the European Union
A problem-solving approach to fuel innovation-led growth
by Mariana MAZZUCATO
Research and Innovation

What are mission-oriented policies?

- Mission-oriented policies target the development of *specific* technologies in line with state-*defined* goals (missions); this differs from more horizontal policies aimed at institutional development in a systems of innovation approach (Ergas, 1987; Cantner & Pyka, 2001).
- Mission-oriented policies require support from specific sectors but they are not sectoral policies; they are policies that get many sectors to work together in new ways
- Missions are for radical change

Missions old idea / new role?

- Mission-oriented policy is not new (Apollo programme, Manhattan project). What IS new is the aim to facilitate the addressing of Grand Challenges which require transformative change.
- ”Missions” are more than broad principles…they “**privilege impact**” have a “**clear goal**” and “**mobilise many different actors**” (quotes from Pascal Lamy from the LAMY REPORT 2017)
- The **translation of grand challenges into “doable” problems** is the key role for mission-oriented policy . A key aspect here is the level of articulation of issues to be dealt with and the location of action. `
- A hierarchy of (a) broad challenge, (b) well-articulated mission and (c) clearly identified problems to be solved allows connected innovation policy that can lead to market creation and fixing directional failures. (Robinson and Mazzucato forthcoming Research Policy)

Political Agenda Setting and Civic Engagement

Clear Targeted Missions

Portfolio of projects and bottom-up experimentation

”Type 1” and ”Type 2“ Missions and contexts

- In the **past**, missions were often related to a **well-defined outcome**, such as putting a man on the moon, which mostly entailed technological challenges.

- However, modern missions, ranging from the demographic/ageing problem being faced by Western nations to the global challenges concerning climate change, are **more complex** because there are **fewer clear technological challenges** and **outcomes are less clearly defined** (Foray et al., 2012).

- Contemporary missions aim to address broader challenges that **require long-term commitment** to the development of many technological solutions and ‘a continuing high rate of technical change *and* a set of institutional changes’ (Freeman, 1996, p. 34).

- However, grand societal challenges concern the socio-economic system as a whole, which often implies large-scale transformations with multiple actors and elements (Kuhlmann & Rip, 2015; Geels, 2004).

Changing drivers for the space sector

New challenges for the space economy

- **More actors:** More than 60 space nations around globe
- **Global value chains:** requiring global competitiveness
- **Rise in "New Space":** commercial cargo services, small satellites; mega constellations, space-support big data services, broker services on the ISS etc.
- **Post Financial Crisis, Austerity & "Valorization":** Pressures to deliver socio-economic benefits (justify expenditure)

UNITED NATIONS
Office for Outer Space Affairs

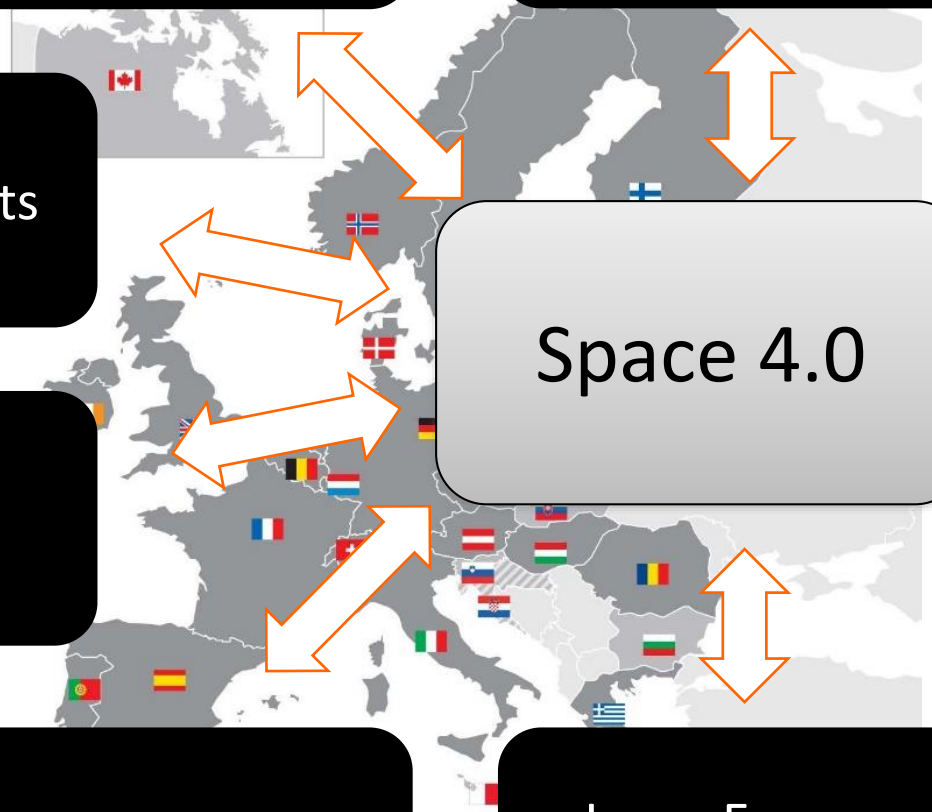
2030 Agenda: Relevance of Space Technology

SOURCE: Balogh, W., Czaran, L., Chandran, R.(2016) Space Technology and Applications for Monitoring and Protecting Biodiversity and Ecosystems. 67th IAC Congress, Guadalajara, Mexico, IAC-16,B1,6,8

More space faring nations

Digital *Society* and Industry 4.0

Domestic markets



Space 4.0

Public-Private Partnerships

New Space

Large European Societal Challenges

New Space Arrangements

in a European Space Ecosystem

(more actors, more types of relationships, more need for innovation policy)

Managing, **Directing** and **Catalysing** desirable change requires specific types of management, tools and policies.

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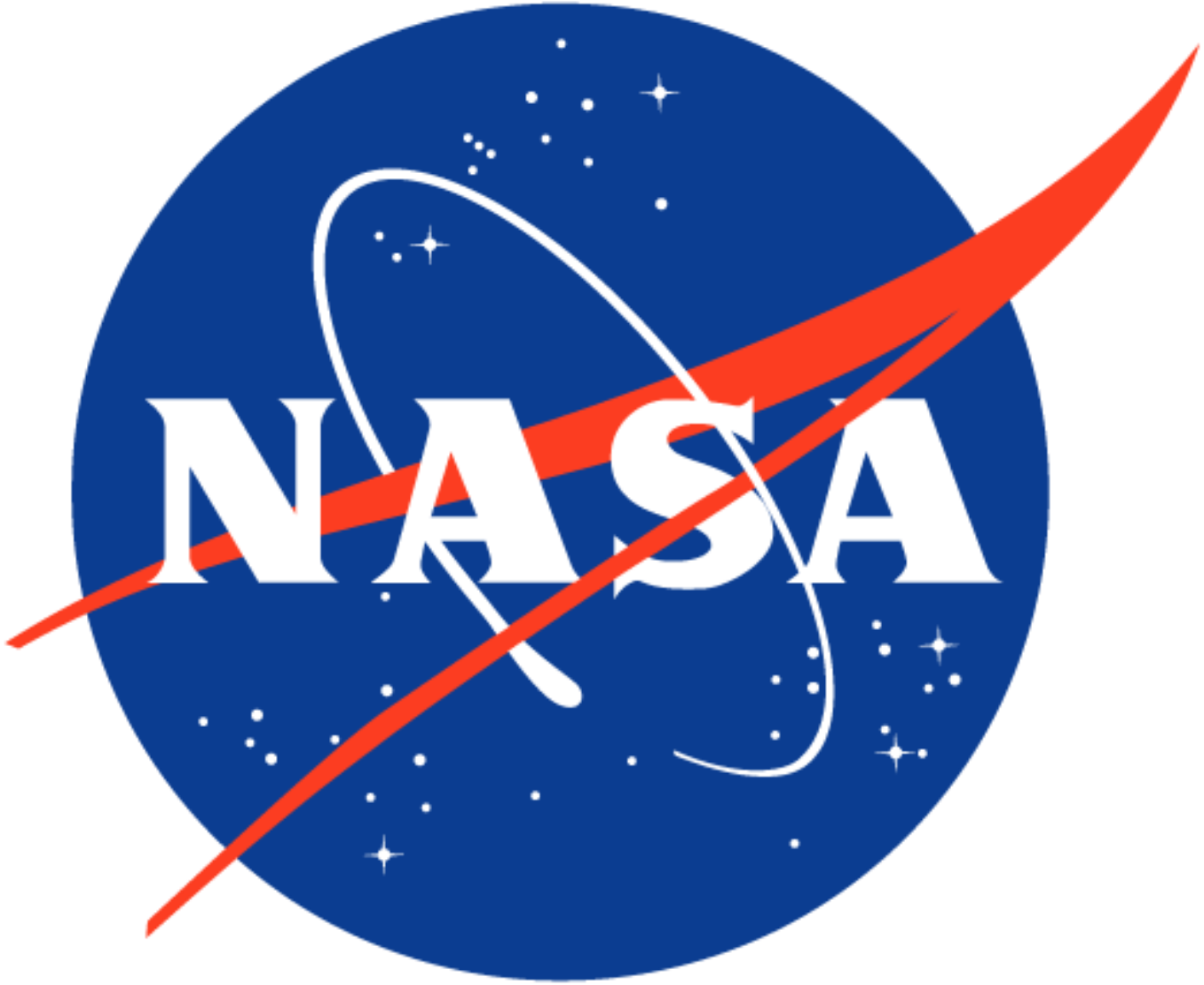
New forms of Mission-Oriented Innovation Policies are required

Institute for Innovation and Public Purpose

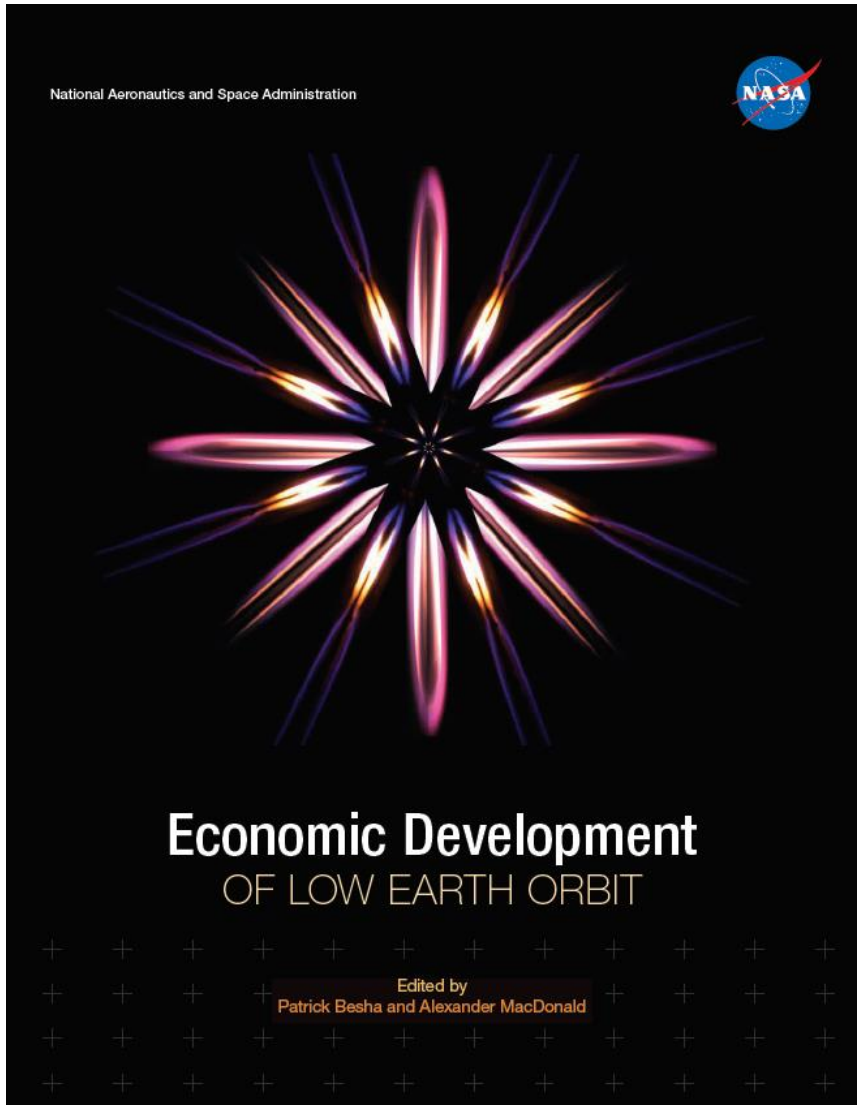
Our activities so far


NASA

NASA study: “New Space Arrangements” towards a LEO economic ecosystem

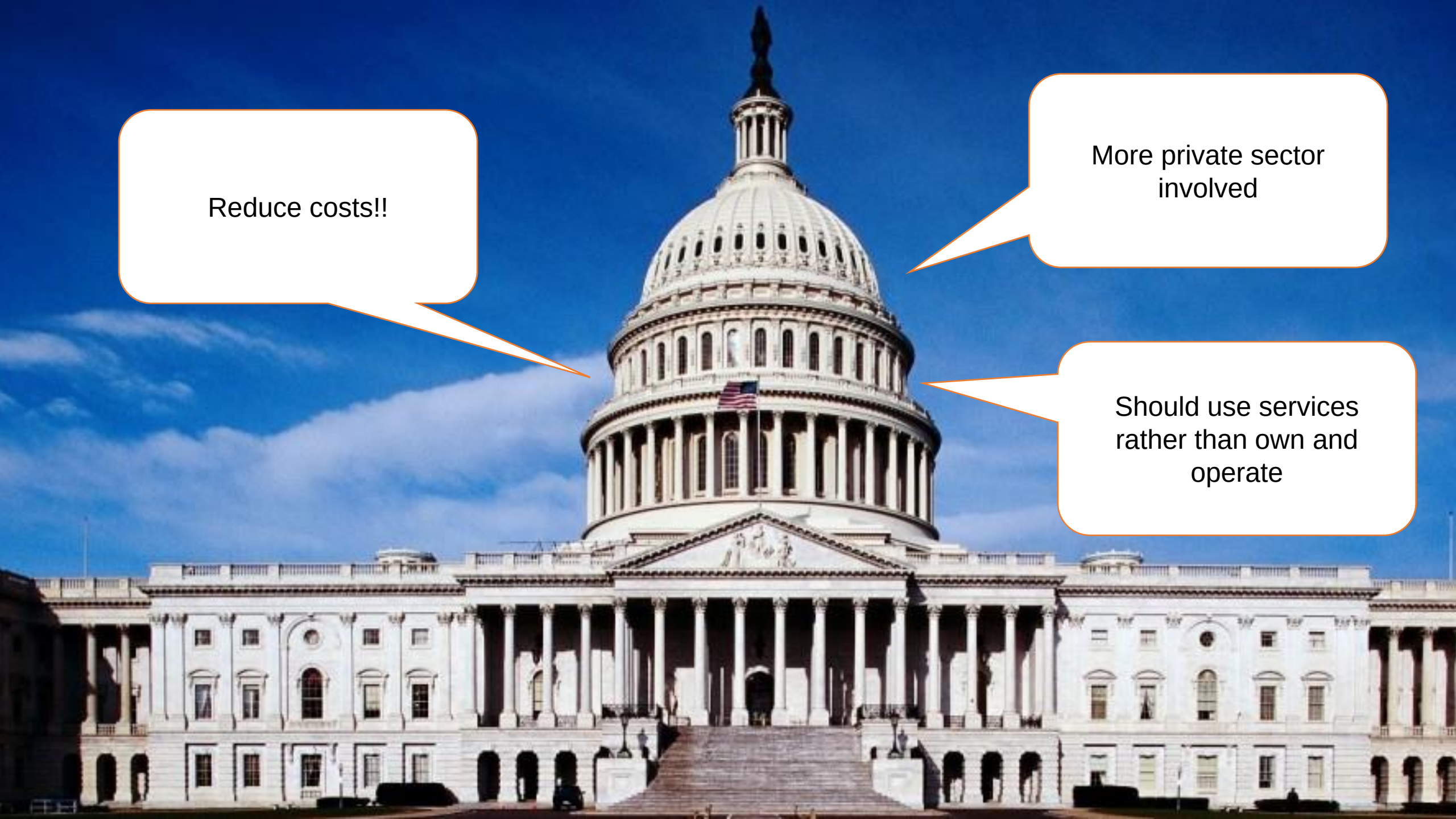
- Tasked by NASA to explore industrial policy considerations for LEO economy

- Our entrance point was to look at the “new arrangements” in the current ecosystem of public and private actors in LEO



NASA : innovation policy ‘frame 1’

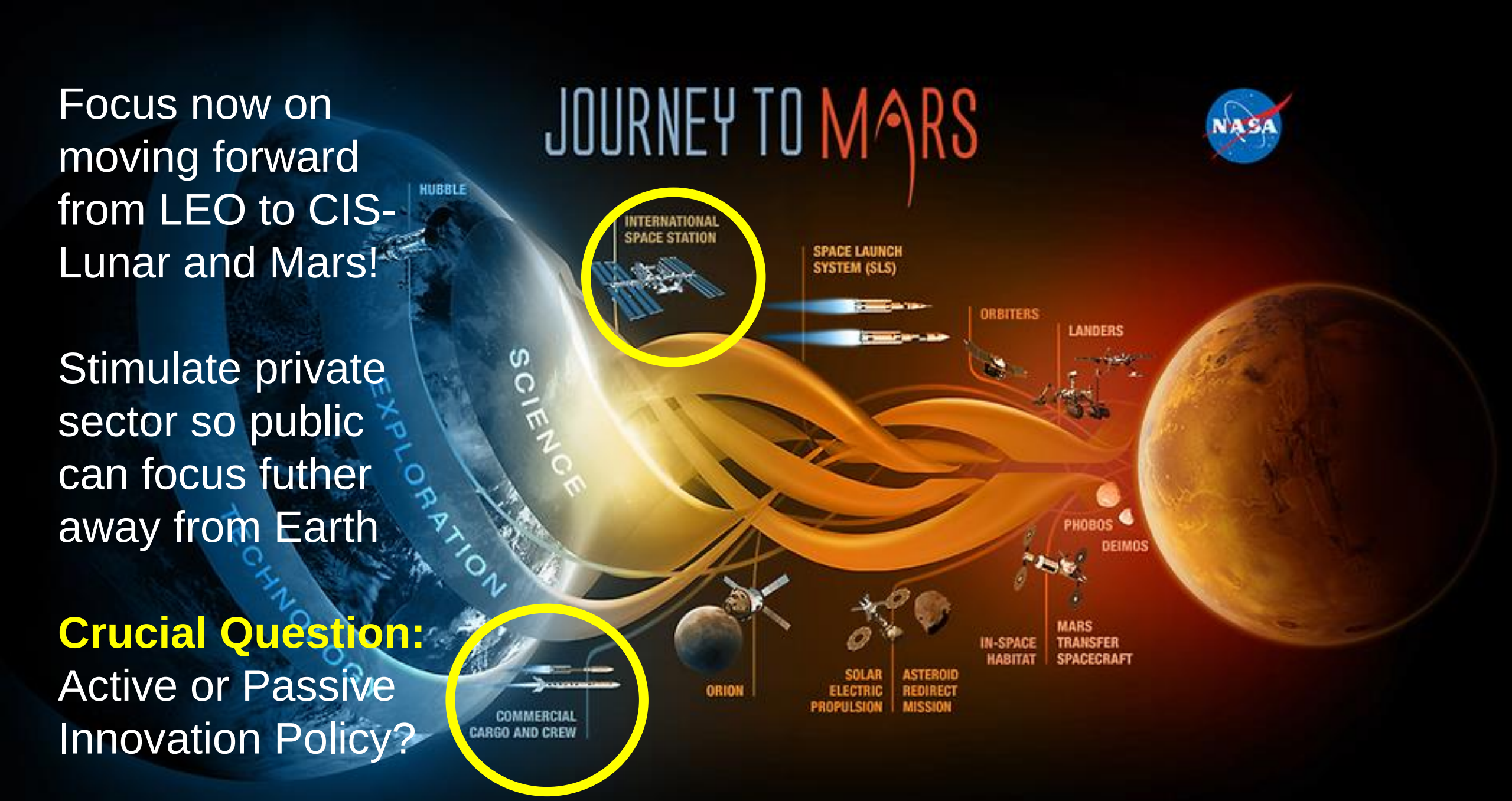
The central position of NASA in the space ‘system of innovation’ has meant that, for more than fifty years, NASA has directly financed technological innovation to achieve its missions, *setting the directions of change* and overseeing the private-sector companies that have been contracted to deliver the technologies.


Reduce costs!!
More private sector involved
Should use services rather than own and operate

Focus now on moving forward from LEO to CIS-Lunar and Mars!

Stimulate private sector so public can focus futher away from Earth

Crucial Question:
Active or Passive Innovation Policy?



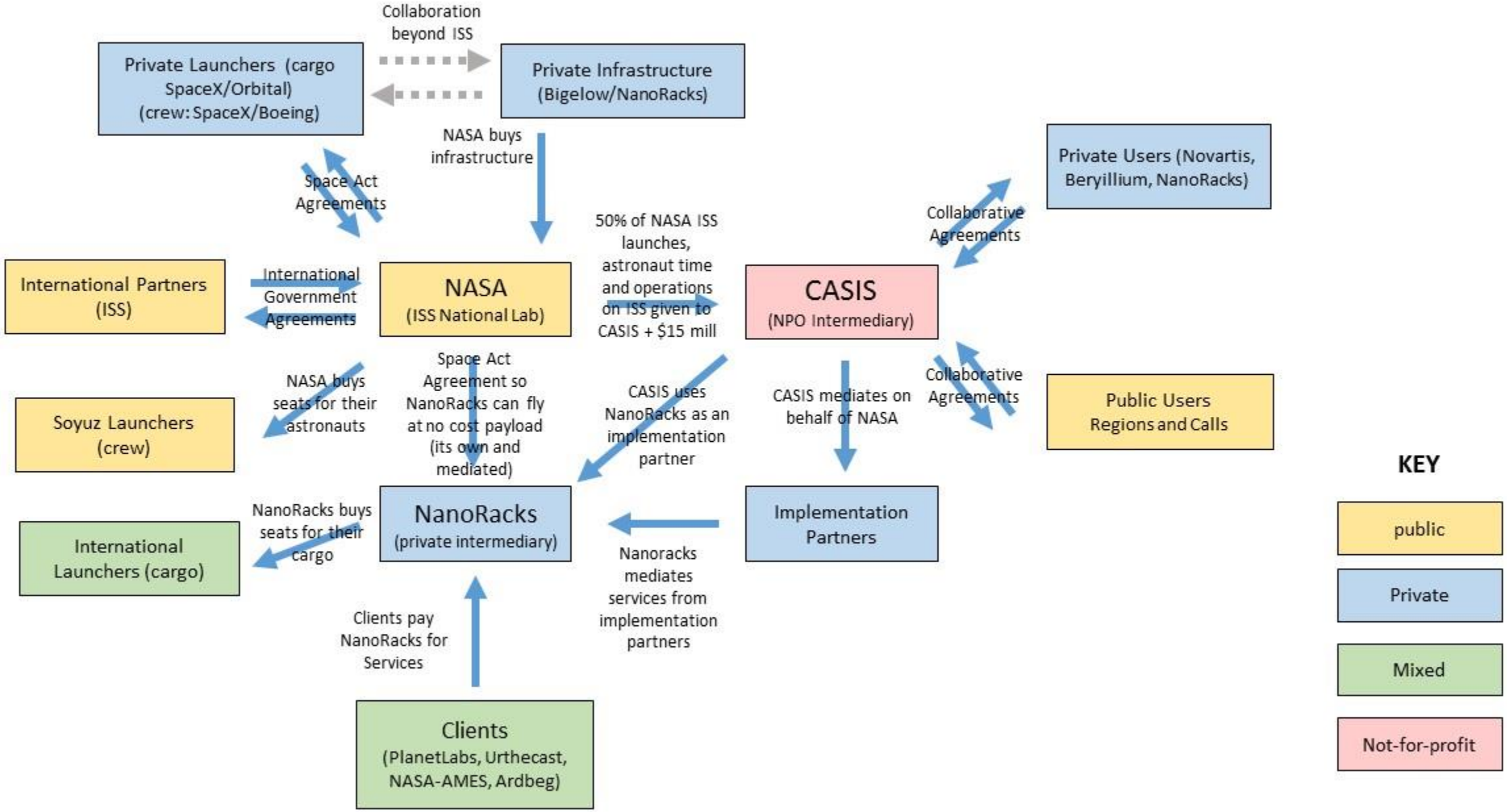
Source: http://www.nasa.gov/sites/default/files/thumbnails/image/journey_to_mars.jpeg

NASA : interest to expand to include ‘frame 2’

- Today, the missions of technological innovation in space exploration are being **broadened to include commercialization objectives**.

- NASA is attempting to create new markets that fuel a sustainable Earth-Low-Earth-Orbit (LEO) economy, or, as Sam Scimemi, director of the ISS, put it, to *“sustain economic activity in LEO enabled by human spaceflight, driven by private investments, creating value through commercial supply and demand”* where the *“destiny of LEO beyond ISS is in the hands of private industry outside the government box.”*

- It’s approach is to build (in NASA’s phrasing) a Low-Earth Orbit economic ecosystem and frame innovation policy around that


Collaboration beyond ISS
Private Launchers (cargo SpaceX/Orbital) (crew: SpaceX/Boeing)
Private Infrastructure (Bigelow/NanoRacks)
NASA buys infrastructure
Space Act Agreements
Private Users (Novartis, Beryillium, NanoRacks)
Collaborative Agreements
International Partners (ISS)
International Government Agreements
NASA (ISS National Lab)
50% of NASA ISS launches, astronaut time and operations on ISS given to CASIS + $15 mill
CASIS (NPO Intermediary)
NASA buys seats for their astronauts
Space Act Agreement so NanoRacks can fly at no cost payload (its own and mediated)
CASIS uses NanoRacks as an implementation partner
CASIS mediates on behalf of NASA
Collaborative Agreements
Public Users Regions and Calls
Soyuz Launchers (crew)
NanoRacks buys seats for their cargo
NanoRacks (private intermediary)
Implementation Partners
International Launchers (cargo)
Nanoracks mediates services from implementation partners
Clients pay NanoRacks for Services
Clients (PlanetLabs, Urthecast, NASA-AMES, Ardbeg)
KEY
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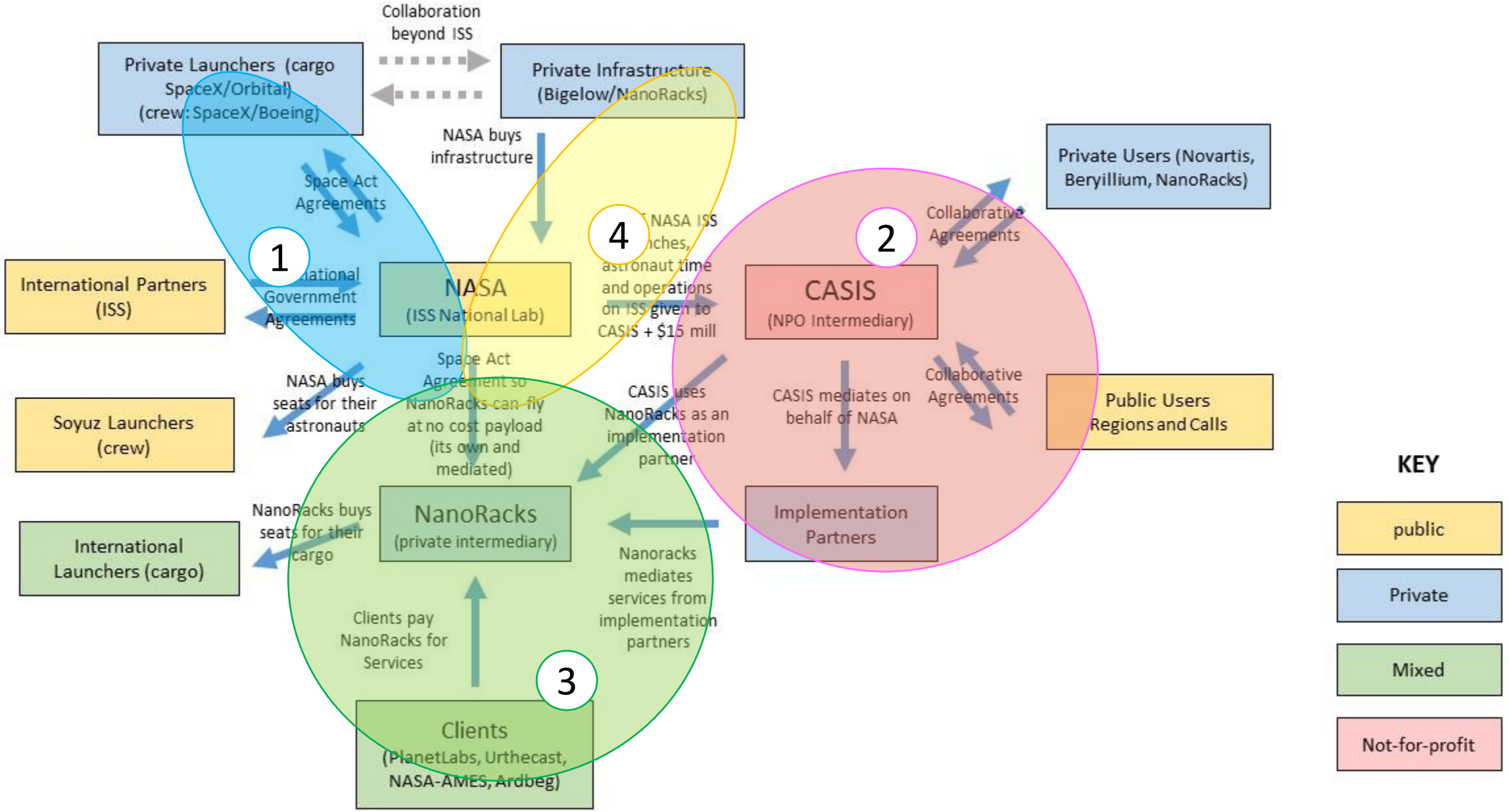
Private
Mixed
Not-for-profit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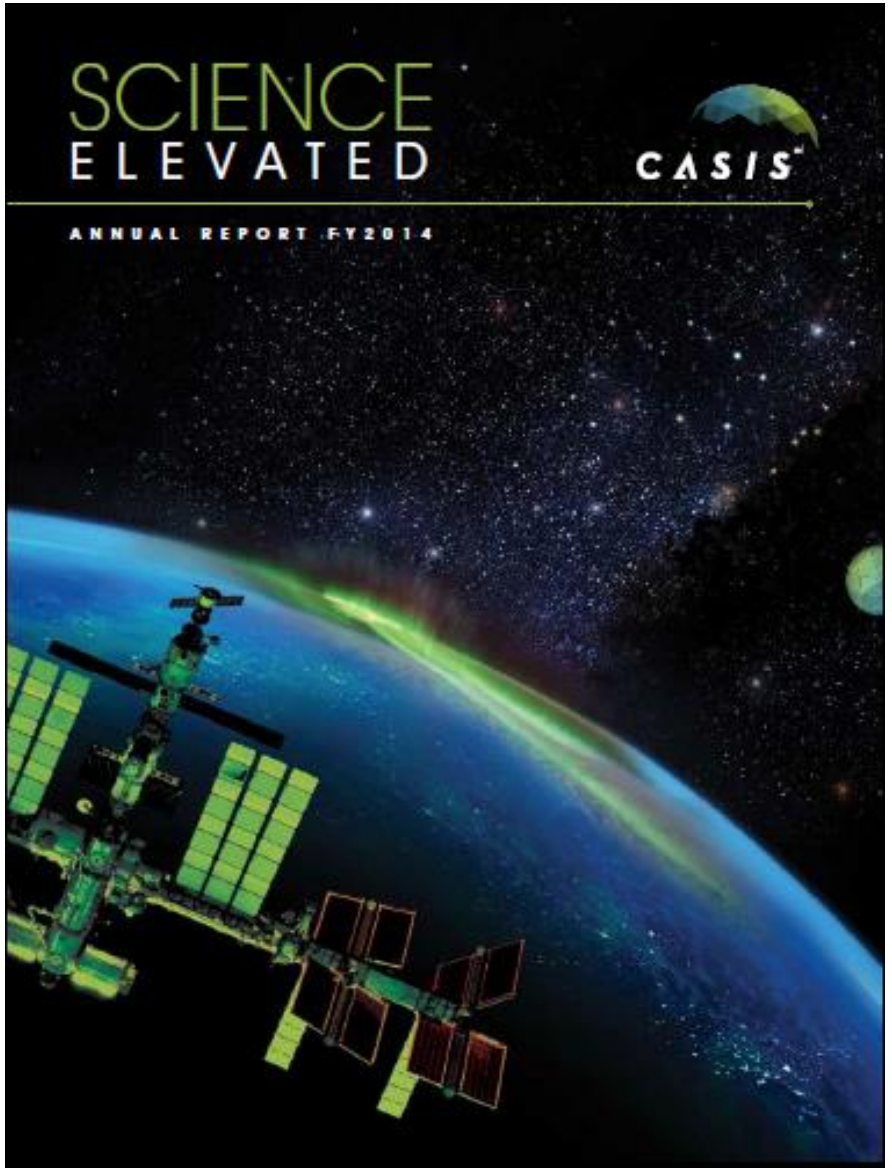
Delegating power to direct to a broker: CASIS

- Congress push for increased use of US part of ISS and triggered Call for Not-for-profit org to stimulate use (“build demand”)
- 15 million with 4 million to develop technology demonstration
- CASIS with guidance from NASA and its advisory board, choose topics of interest,
- Thus CASIS is steering 50% of the R&D “directions” in the US part of the ISS. 50% of what is launched, 50% of astronauts time.
- Trickle-down approach to socio-economic impact though providing use of ISS and launch mass to the private sector for free.



(source: Mazzucato and Robinson, 2015)

SPACEX FALCON 9 LAUNCH AND LANDING PROFILE

NOTE: NOT TO SCALE/TRAJECTORY IS NOT EXACT

LIFTOFF
T+0:00

SOFT LANDING AT LC-1
T+9:00 to T+11:00

SINGLE ENGINE LANDING BURN BEGINS
about 30 seconds prior to landing

REENTRY BURN ENDS
at about 25 miles above the earth

THREE ENGINE REENTRY BURN BEGINS
as the booster passes through about 45 miles in altitude

MAIN ENGINE CUTOFF
about T+2:30 seconds (exact time varies per mission)

STAGE SEPARATION
a few seconds after MECO

SECOND STAGE ENGINE IGNITION
a few seconds after stage separation

THREE ENGINE BOOSTBACK BURN BEGINS
to reverse the velocity of the booster

THREE ENGINE BOOSTBACK BURN ENDS
when the booster's trajectory intersects the landing pad

BOOSTER REACHES ITS PEAK ALTITUDE
over 100 miles above the earth's surface

FAIRING SEPARATION
T+3:00 to T+4:00

SECOND STAGE ENGINE CUTOFF
T+9:00 to T+11:00

PAYLOAD SEPARATION
exact timing depends on customer

LAUNCH COMPLEX 40

LANDING COMPLEX 1

BOOSTER LANDING CLOSEUP

LANDING BURN BEGINS
grid fins begin steering the booster

GRID FINS STEER BOOSTER
as it falls towards the landing pad

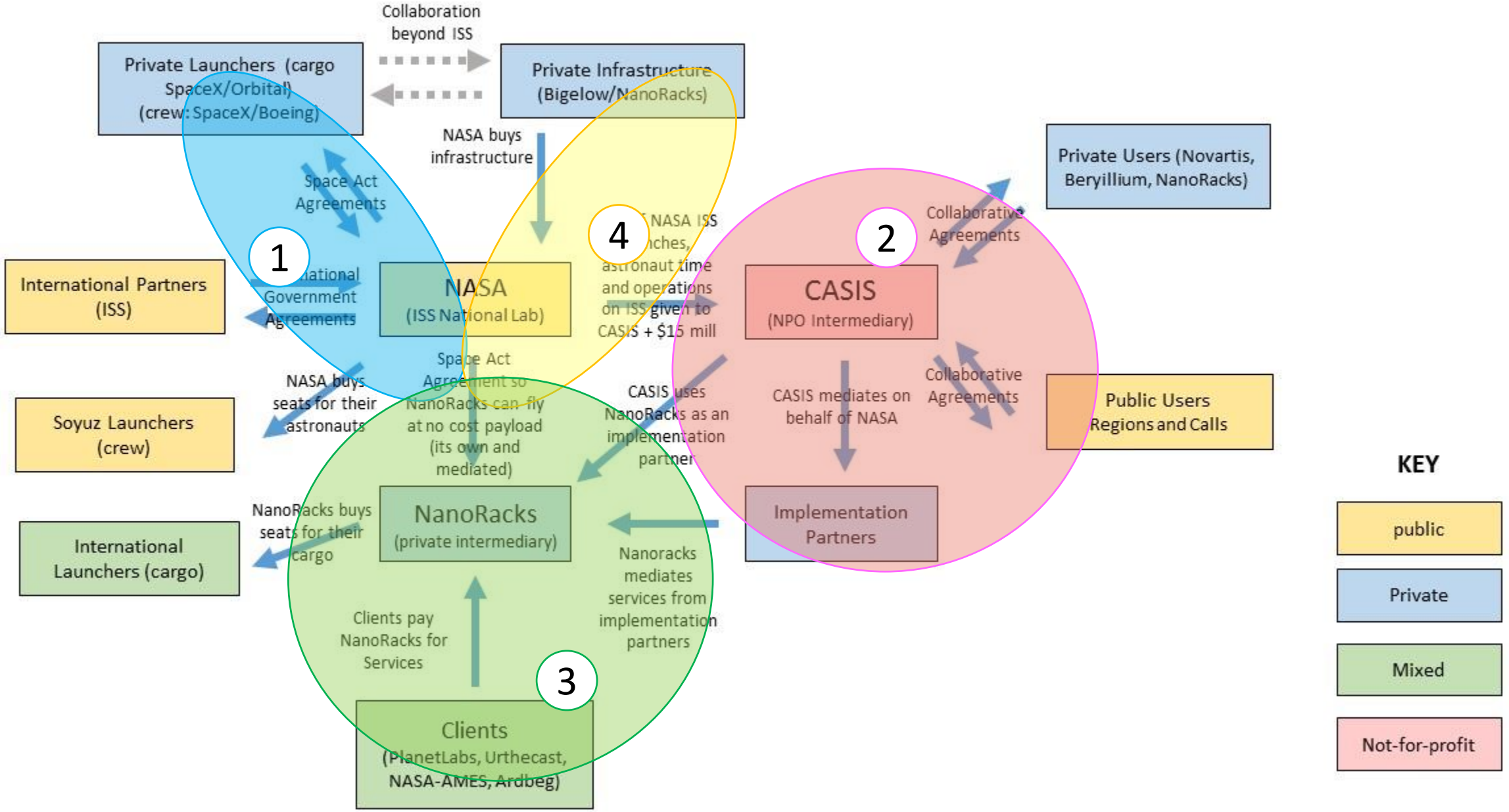
BALLISTIC TRAJECTORY
booster falls harmlessly into ocean
in the case of an engine failure

LANDING LEGS DEPLOY
only moments before touchdown

by zlsadesign

THIS IS AN UNOFFICIAL FANMADE INFOGRAPHIC

made on December 19, 2015, prior to OG2 Launch 2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	Directionality	Risk and Rewards	Who is directing?
New forms of Procurement using SAA (emphasis on Earth-LEO transportation)	Vertical moving to Horizontal	Risk and rewards shared, between the public agency (who foots the bill but gains transport services) and the SAA contractor.	NASA is directing in terms of developing a capability and paying for services. Use of fixed-term contracts. Beyond those contracts, uncertainty on the development of future launch capabilities. Examples include SpaceX, Orbital-ATK, Boeing
Brokering (emphasis on use of the ISS)	Horizontal (Market led)	Use of the ISS is fully subsidized by NASA.	Brokers have a strong influence over what is done on the ISS. For both brokers, this is directly influenced by the clients. Examples include CASIS and NanoRacks
Private sector investing building on initial NASA investments (emphasis on stimulating private solutions to NASA needs)	Horizontal (Market led)	Risk taken and rewards received by the licensing actor or competitor for the space prize.	NASA creates opportunities for the private sector to provide solutions to support NASA's missions. Example includes Bigelow and The Right Stuff.
SBIR **(and other small business** support activities)	Vertical (innovation led)	Fully subsidized by NASA	NASA funding high risk potentially breakthrough technologies through a number of stages of finance. Examples include Made-in-Space.

1. Who is directing?

Unclear in the new situation. Brokers such as CASIS control 50% of launcher space and operations on the US part of the Space Station.
They attract and make deals with private sector and other actors to use the ISS for free, with no reinvestment

2. Co-risk and co-benefit

Also unclear in the new situation. Companies such as SpaceX are benefiting from NASA's new procurement policy, but also benefiting from large governmental loans. Whilst SpaceX is already launching commercial payloads, and providing services to NASA, the prciign strategy is not clear.

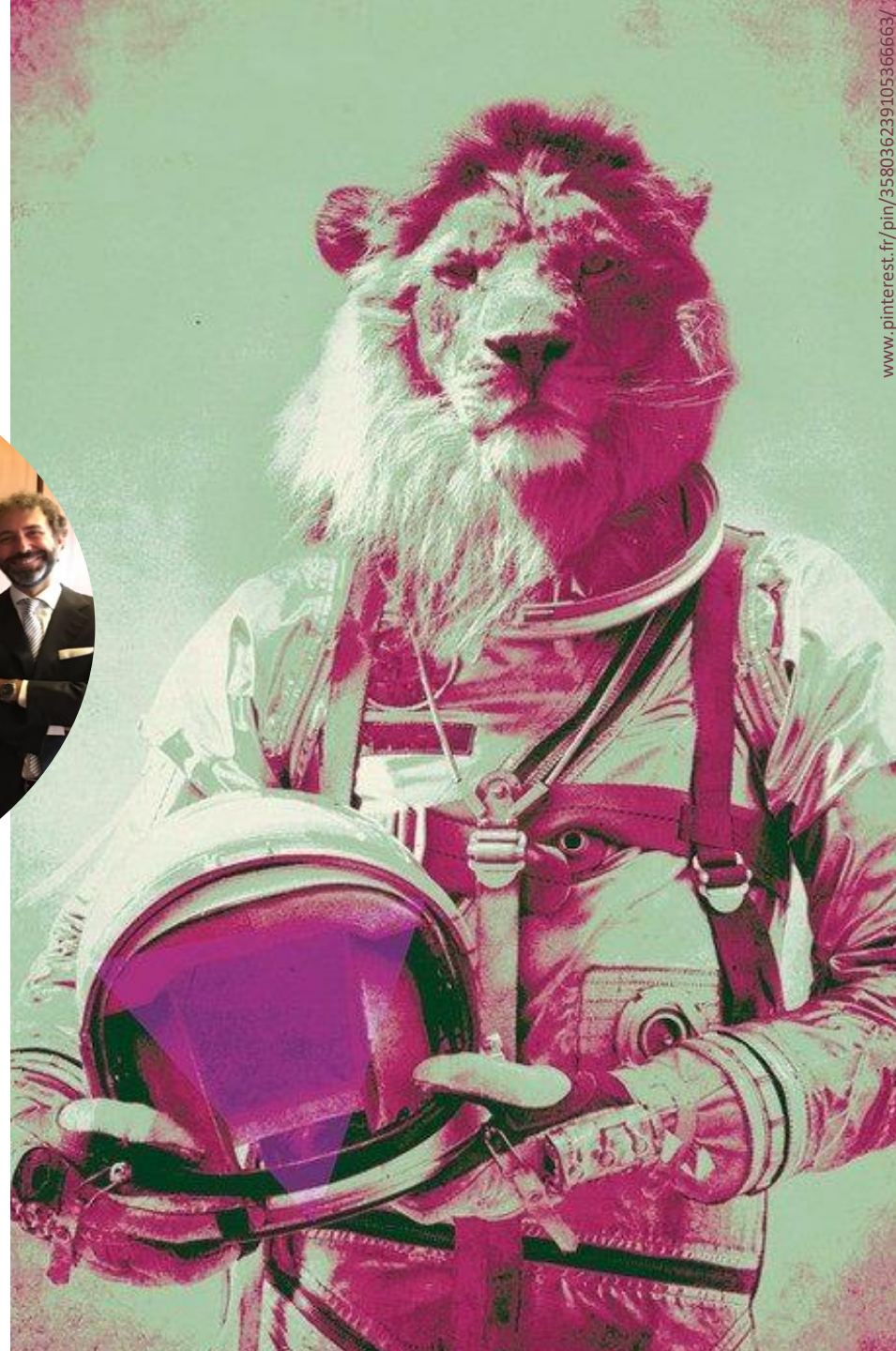

esa

'THIS IS A BOOK WHOSE TIME HAS COME.'
—PROFESSOR DANI RODRIK, HARVARD UNIVERSITY

THE ENTREPRENEURIAL STATE

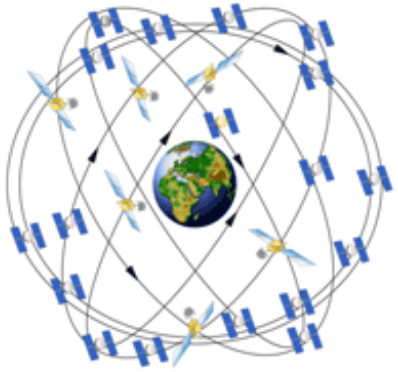
Debunking Public vs. Private Sector Myths

'Conventional economics offers abstract models: conventional wisdom insists that the answer lies with private entrepreneurship. In this brilliant book, Mariana Mazzucato... argues that the former is useless and the latter incomplete.'
—*Martin Wolf, 'Financial Times'*



New challenges driving change towards alternative policy mix

- New procurement process
- Mixture of relationships with private sector
- Challenge: stimulate and directe value creation from large infrastructure project: Galileo (satellite navigation) and Copernicus (Images of Earth, land, sea and atmosphere)
- NOTE :Copernicus freebys



- As mission-oriented agency, guiding ecosystem towards broad societal goals requires focus.
- Attempts to focus on sustainable development goals

Five challenges in innovation policy evolution for both ESA and NASA

Challenge 1: Create a dynamic combination of horizontal and vertical policies

Challenge 2: Bottom-Up Experimentation

Challenge 3: New forms of partnerships and relationships

Challenge 4: Co-risk and Co-benefit

Challenge 5: Dynamic Evaluation and Assessment

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Challenge 1: Create a dynamic combination of horizontal and vertical policies

- industrial policy must be mapped across the entire innovation chain, including demand side policies, via procurement, which are especially key in building the animal spirits of the business sector in seeing market opportunities in space.

- Mission-oriented vertical (direct) policies need to work hand in hand with horizontal framework (indirect) policies. Both types of policies should be targeted at different stages of the innovation chain.

- Mission-oriented policies can actively create new landscapes that increase the expectations in the private sector for new growth opportunities. The aim should be to create profitable products and services, with public value, which benefit European civil society.

Challenge 2: Bottom-Up Experimentation

- A dynamic mix of vertical and horizontal policies should focus on achieving bottom-up experimentation, where new sources of value and growth are explored and catalysed by new forms of public–private partnerships.

- Lessons can be learned from space districts, examples include Harwell (UK) for satellite applications and Aerospace Valley (France).

- Vertical and horizontal interventions should be linked to ESA's and NASA's missions, which can then invite private sector interactions based on these missions, through specific projects, and through instruments, like prizes, that reward success on key metrics.

Challenge 3: New forms of partnerships and relationships

- Brokers and intermediaries are emerging as players in the transfer of space technologies from ESA space programmes to other sectors (spin-offs).
- However, for such activities to be fruitful, *demand-pull initiatives* and *spin-in* opportunities must be explored.
- There is a trend in NASA and ESA for outsourcing spin-in and demand-pull activities to intermediaries or brokers.
- This is a challenge for mission-oriented agencies to harmonise space-centric *supply-side policies* to seek alignments (and misalignments), which require more active engagement with other sectors and perhaps the pursuit of demand articulation forums.

Challenge 4: Co-risk and Co-benefit (1)

- Co-sharing of risks and benefits requires dedicated policies.

- Using Europe's Copernicus Programme of Earth Observation imagery as an example,
    - the world benefits from FREE Images from the European Space Agency Sentinels,
    - but various areas of the world are *better prepared* to exploit these images than others.
    - The US is in a strong position globally because of the rise of *New Space* companies like Planet Labs, Space X and Nanoracks.

- Therefore, in our advice to ESA, we emphasised that it is not a matter of whether the images are free or not, it is a matter of an innovation ecosystems ability to capitalise and benefit.

- Different modes of exploitation and innovation need to be explored in Europe to be able to compete in the exploitation of Sentinel images.

Challenge 4: Co-risk and Co-benefit (2) Explore alternative risk/benefit sharing options

- Learning from Bell Labs: reinvestment of profits into R&D ("closing the loop")
- Public retaining 'golden share' of IPR ("inventions *not* for free")
- Capping prices on services using public funded infrastructures (Bayh Dole act allows it): (consider private sector added value services for Galileo and other large infrastructures)
- Income contingent loans
- Portfolio investment & equity (Tesla & Solyndra lesson)
- % payback into an 'innovation fund'

Challenge 5: Dynamic Evaluation and Assessment (1)

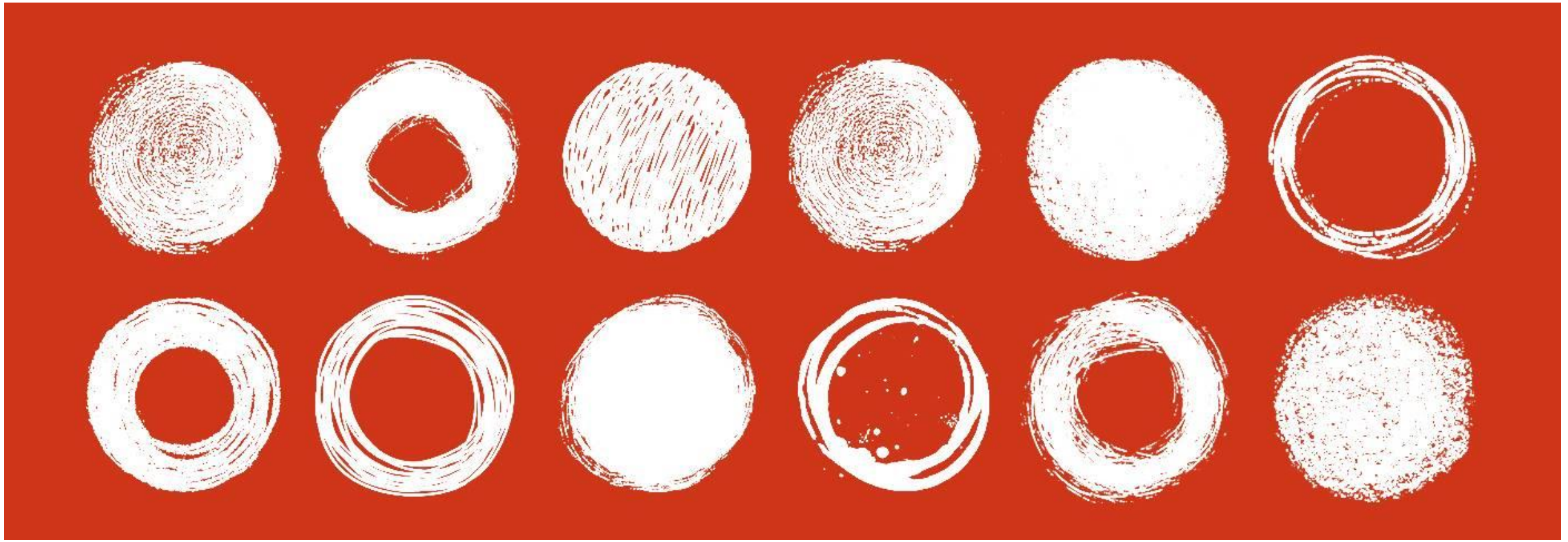
- Public policies too often rely on static approaches to assessment, such as cost-benefit analysis.
- More dynamic measures are needed in order to measure the socio-economic impact of space.
- Such measures should be focussed on the entire innovation chain, with spillovers being the focus upstream, and formation of high-growth innovative companies downstream.

Challenge 5: Dynamic Evaluation and Assessment (2)

- If *societal development goals* for example are to be combined with horizontal policies, then the growth of the companies might also be measured in terms of the value of the products and services they produce. In this way, societal challenges can help steer the metrics so that public funds produce public value, and not just gadgets sold by start-ups.

- if bottom-up experimentation is an objective, then success can be based on the extent of downstream private sector experimentation with space application development.

- Finally, to achieve symbiosis, metrics should be developed that capture the degree to which both the risks and the rewards of innovation in space are socialised.



Broader Refections

Implementing Missions

- Mission discussions have been naturally “broad brush” with the fine detail left to be filled in
- This is the challenge for scholars and practitioners: how to best TAILOR and IMPLEMENT mission oriented policies?
- Requires a look at:
  - A variety of innovation contexts and an innovation ecosystem perspective
  - Questioning of impacts and their dynamics (including evaluations)
  - Exploring the role of the state in a complex system (and mechanisms for directing)
  - Defining (including learning from the past) what are Robust Missions
- I am coordinating/chairing a track at the EU-SPRI 2018 entitled “Societal Change and Implications for STI Policy”

Further Reading

Evolving frames of market creating innovation policy: US and European mission-oriented space agencies in an era of Industry 4.0. Research Policy. Douglas Robinson and Mariana Mazzucato (forthcoming 2018)

Co-creating and directing Innovation Ecosystems? NASA's changing approach to public-private partnerships in low-earth orbit. Technological Forecasting and Social Change. Mariana Mazzucato and Douglas Robinson (2017),

"Directing vs. Facilitating the economic development of Low Earth Orbit", NASA book chapter. Mariana Mazzucato and Douglas Robinson (2016),

"Market Creation and the European Space Agency", ESA research. Mariana Mazzucato and Douglas Robinson (2016)

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Thank You

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