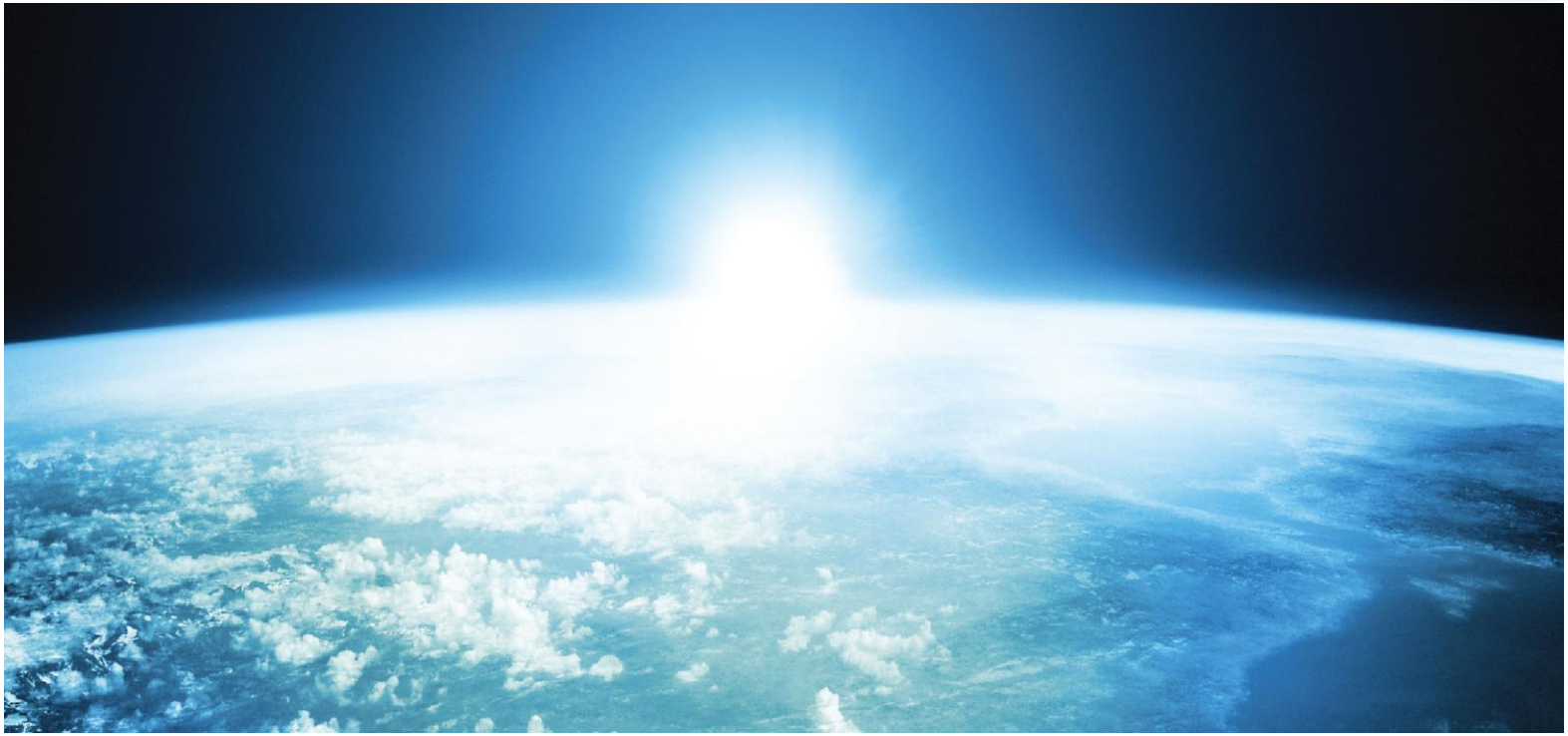
Access to Finance for Space Infrastructure



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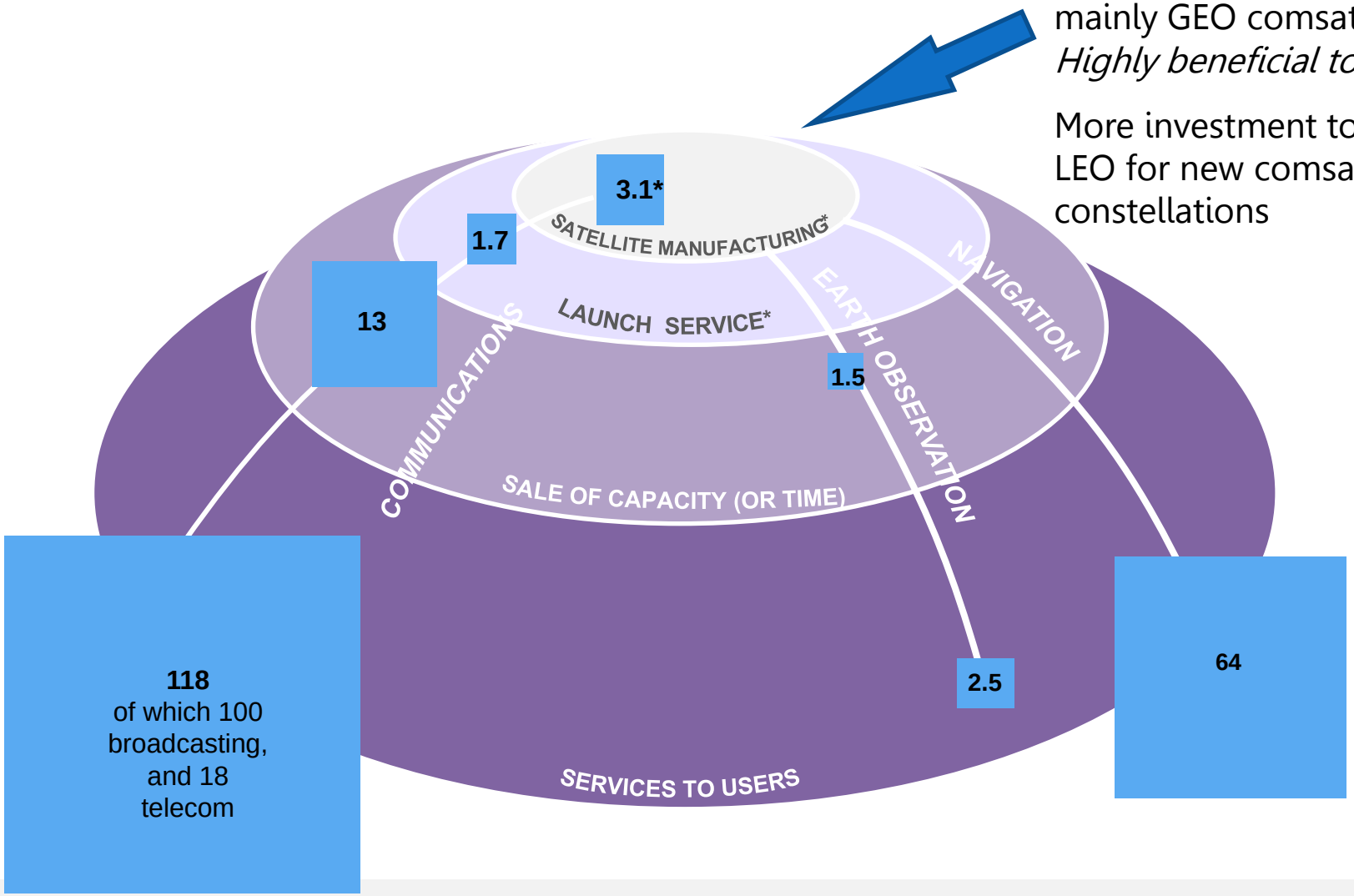
The 3 value chains in commercial space: from infrastructure upstream to services downstream

($ in billions in 2013)

$5 billion/year of private investment in satellite systems, mainly GEO comsat
Highly beneficial to Europe

More investment to come in LEO for new comsat & EOsat constellations



Challenges in the financing of new private space ventures

Challenges in fund-raising for new space ventures differ according to

> **geography:** nothing like the USA for PE and VC; in the RoW, corporate or sovereignty investment funds do not go to space to date and there is no «space billionaire »

> **capital intensity**: satellite systems are highly capitalistic (from $500 m for a high performance GEO comsat to several billions for LEO constellations) while satellite services have a lower entry cost (but also a lower profitability)

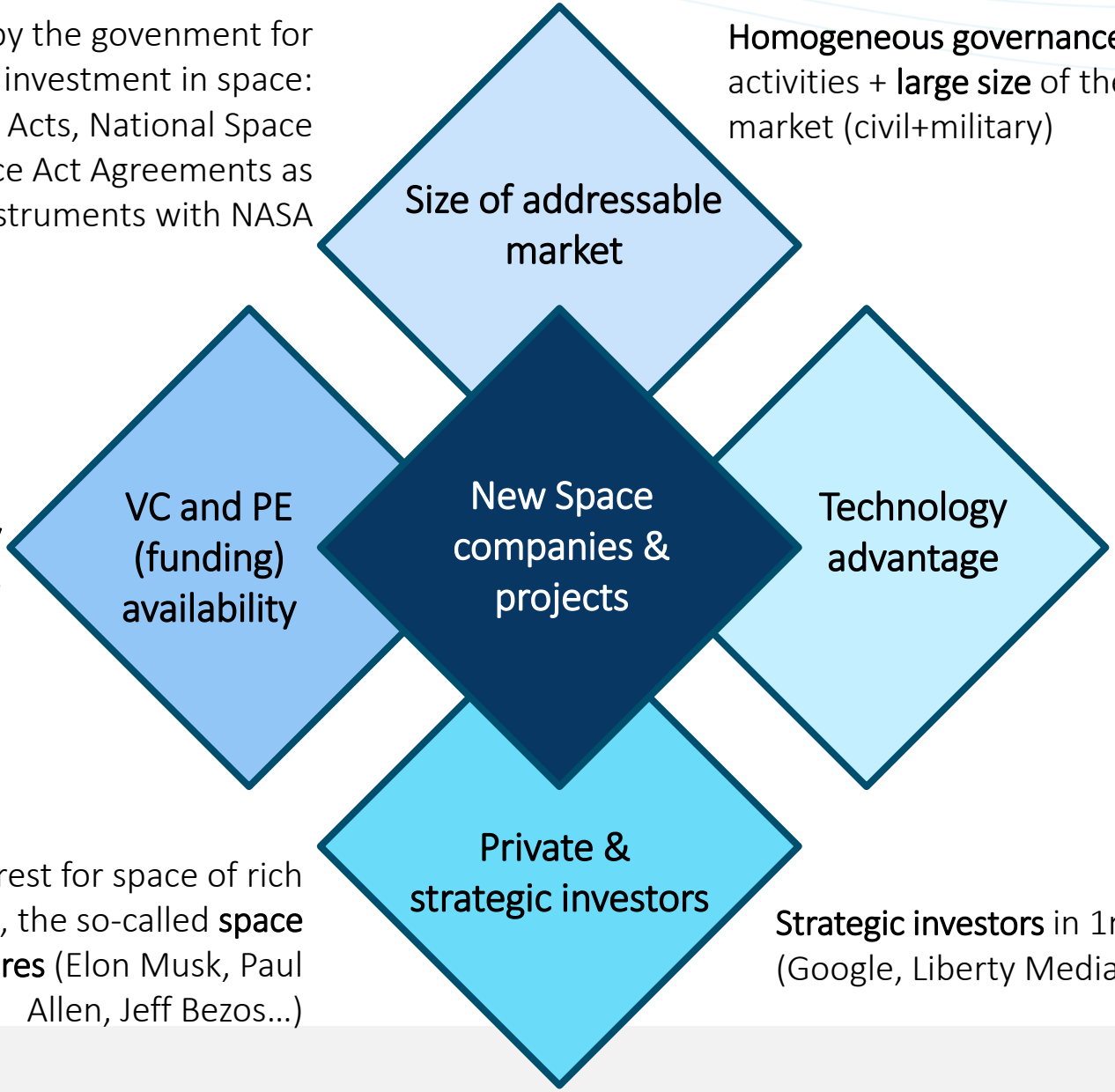
Financing is a project stopper #1 for green-field satellite systems (i.e. not a replacement capacity), either for comsat (GEO and constellation) and for EOsat. **Spectrum** rights can be #1 stopper for comsat (e.g. Protostar)

	Logics & challenges	Examples
Corporate finance	Diversification into new businesses that may develop into complementary or substitute to existing businesses. Generally coming from non-aerospace companies	- GE in TV satellites in the past - SES in O3b for BB communications - Google in SpaceX and in Skybox
Venture capital	Large volume of VC in the USA (e.g. DFJ, RRE, Khosla in CA) with strong resilience and long lock-up. Risk of speculative bubble in smallsat constellations for satcom & EO	- SpaceX, Virgin Galactic, Skybox Imaging, Planet Labs, Spire
Vendor finance	Stock in lieu of cash payment for hardware delivery. Also in-kind contribution (facilities, HR, ..)	- HNS in Globalstar 2G
ECA	Commercial credit guarantee by the export credit agency of the country of the vendor (e.g. Exim, EDC, Coface). Risk of default if business due diligence not independent	- Iridium Next, Globalstar 2G, O3b for constellations - Inmarsat GX, SES, Avanti, Newsat
Crow-funding	Low volume of funds collected from individuals that are rewarded by in-kind advantages. Risk of fraud as funding comes from space enthusiasts	- cubesat/nanosat demonstrator (Spire, Skycube, Kicksat, …) - Planetary Resources for a telescope

The US recipe for private investment in space is unique

Incentives by the govenment for private investment in space: Commercial Acts, National Space Policy, Space Act Agreements as partnership instruments with NASA

Homogeneous governance of space activities + **large size** of the government market (civil+military)



~$1 billion raised by **Silicon Valley** companies (from >$20m to $500m)

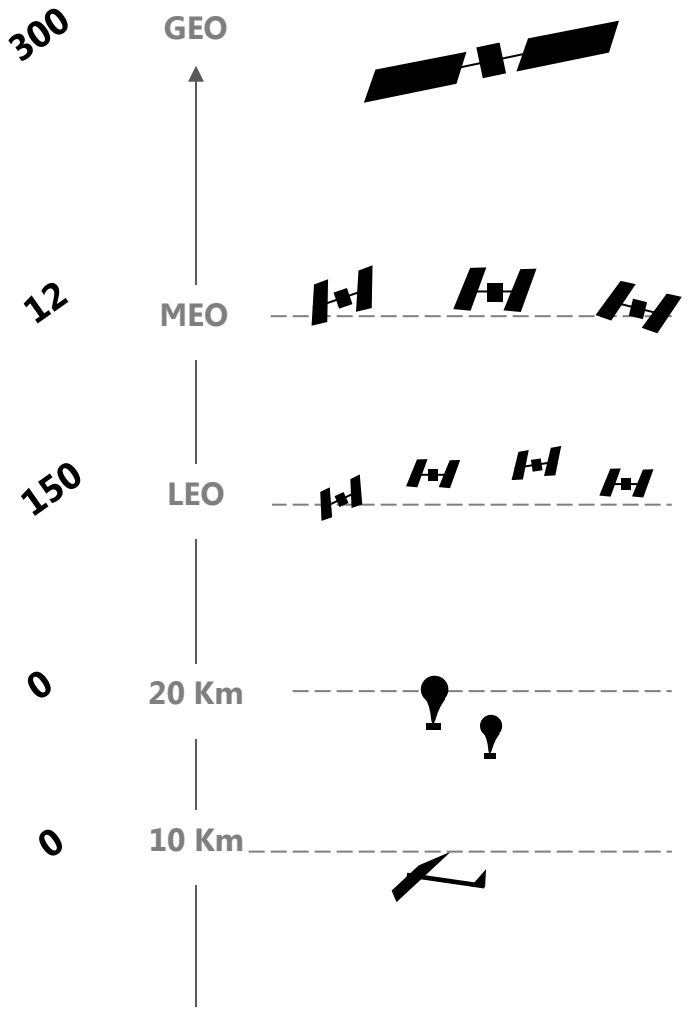
Productivity gains & new usages permitted by technology & process innovation

Interest for space of rich individuals, the so-called **space billionaires** (Elon Musk, Paul Allen, Jeff Bezos…)

Strategic investors in 1rst round investment (Google, Liberty Media, …)

New investors in new communications infrastructure

# of vehicles in operation today



2 teleport companies that become operators of GEO comsat for broadband communications (ECA). NewSat bankrupted in 2015 (1rst big failure of Exim)

O3b launched 12 satellites with PE (incl. SES) and ECA

Sirion plans 10 satellites for M2M

OneWeb plans 650 smallsats with a $3.5b investment ($500m raised from strategic investors of which Airbus which is also supplier)
At least 6 other constellations projects filed at the ITU

Google tests high altitude ballons in partnership with CNES

Facebook tests a UAV for connectivity.
The lease of satellite capacity (to Eutelsat) has been preferred to the purchase of a proprietary GEO comsat

New ventures in space by domains, most of them US-backed

Skybox Imaging
Planet Labs
BlackSky Global
UrtheCast

OneWeb
LeoSat

Earth observation

PlanetIQ
OmniEarth
AxelGlobe
Perseus
Hera Systems

Communications

SpaceX/Google
Sirion
MCSat
CANPOL
3ECOM
ASK
LaserLight

SpaceX
Blue Origin
Generation Orbit
Stratolaunch Systems

Access to space

RocketLab
Firefly
Swiss Space Systems
Reaction Engines

Made in Space
Shackleton Energy

In-space operation

Planetary Ressources
Deep Space Industries

Altius Space Machines
Astroscale

Debris capture

Nova Works
Clean-mE

Bigelow Aerospace

Human spaceflight

Paragon Space Dev.
Golden Spike
Inspiration Mars
Mars Foundation

Virgin Galactic
XCOR Aerospace
Scaled Composites

Suborbital: techno. test & tourism

Final Frontier Design
Masten Space System
ZeroGravity
Up Aerospace
Zero2Infinity
Copenhagen Suborbital

B612 Foundation

Science and others

Digital Solid State
Moon Express
Exolance
TimeCapsule2Mars

Urthecast

ISS utilization

NanoRacks