The European Launchers between Commerce and Geopolitics

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Objectives and Overview

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This Report:

- Assesses the medium-term prospects of Europe's access to space, following the ESA C/M 14 Resolution
- Provides a quantitative analysis of commercial and political dynamics shaping the sector, including unfolding trends and their future impact
- Elaborates on how to ensure the long-term competitiveness and optimise political benefits of Europe's autonomous access to space

Main Elements:

1. Overview of Europe's Access to Space and the ESA C/M14
2. Description of Worldwide Policies and Developments
3. Analysis of Current Dynamics and Future Trends
4. Assessment of Europe's Strategy on Access to Space
5. Reflections and Recommendations on Europe's Way Forward

Background: Access to Space in Europe

The European launchers are a symbol of outstanding success for Europe in the global space sector.

Ariane 5

- Heavy payloads to (up to 10 t in GTO)
- 84 launches since 1996 (70 successes in a row)

Soyuz-ST

- Medium payloads (up to 3.2 t in GTO)
- 13 launches since 2011 (26 from Baikonur with Starsem)

Vega

- Small payloads to LEO and SSO orbits
- 6 successful launches since 2012

Arianespace

- More than 500 satellites in orbit (half of telecom satellites)
- More than €1.4 billion in revenues (2015)
- Order book worth €5.5 billion for 55 launches and 39 clients
  (25 Ariane 5 / 24 Soyuz-ST / 10 Vega)

Background: Challenges for the European launchers

European launchers boast praiseworthy accomplishments and promising prospects in the future. Yet:

- The succesful exploitation of Ariane 5 on the commercial market relies on continuous and substantial support from ESA MS.
- A significant part of European institutional missions are dependent on the Soyuz launcher.
- The deficit of commonalities between Ariane 5, Soyuz and Vega strongly limit synergies in their exploitation.
- The successful (and aggressive) commercialisation of competing launchers and the changes in the global satellite launch industry challenge Europe's future outlook on the worldwide commercial market.

ESA Ministerial Council
2 December 2014

«maintain an independent, reliable and affordable access to Space for institutional and commercial European customers»

Resolution ESA C/M 2014

Key Decisions:

- Development of Ariane 6, Vega-C
- GSC launch pad upgrade
- Launcher Exploitation Accompaniment Programme (LEAP)
- Future Launcher Preparatory Programme (FLPP)

Main drivers:

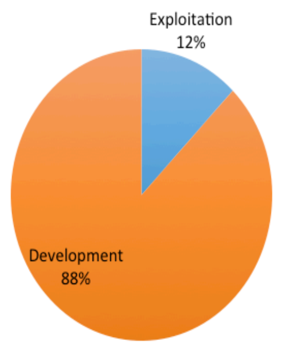
- Maintaining commercial competitiveness without direct public funding
- Ensuring independence from Soyuz

Levers:

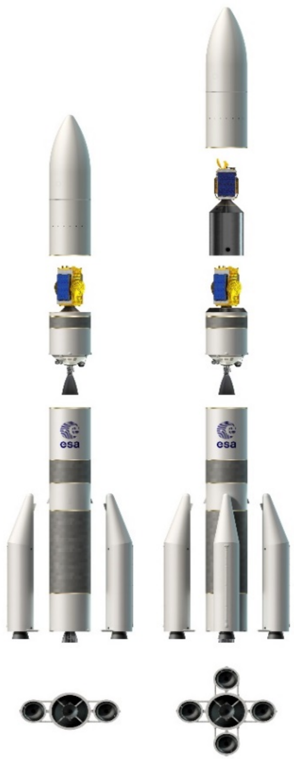
- Maximisation of common elements and the creation of synergies between different market segments
- Utilisation of heritage hardware
- Streamlining of industrial organisation and new governance, including guarantee of five institutional launches

Member State	Total LAU	
	%	M€
France	44,47	2135,5
Germany	20,78	997,9
Italy	10,19	489,2
Spain	4,68	224,6
Belgium	4,12	197,9
Switzerland	2,53	121,5
Sweden	1,65	79,3
Netherlands	1,56	75,0
Romania	0,72	34,5
Other	1,92	31,4
Covered	92,62	4386,8
Uncovered	7,38	415,6
Total	**100,00**	**4802,4**

Subscription by Nature of Activity



Europe’s Future Launchers



Ariane 62
Performance
5t to GTO
Launch cost / price
€78 / €70

Ariane 64
Performance
10.5t to GTO
Launch cost /price
€90 / €115 (dual)

Qualification flight 2020

Maximizing Commonalities

Vulcain 2 main stage engine from Ariane 5 ECA

Vinci upper stage engine from Ariane 5 ME

Common solid rocket motor P120 from P80

Zefiro 40 from Zefiro 23

Vega-C
Performance
2.2t to LEO
Launch cost / price
€26 / €35-45

P120

Qualification flight 2018

Modularity and joint exploitation: generating economies of scale and decreasing launch costs!

A Revolution in Governance

- New governance based on balanced cost & risk-sharing scheme between ESA and ASL

New Governance Principles	
Industry	**Public Sector**
• Industry is Design Authority for launcher • **Bearing risks in commercial exploitation** • Industrial investment > 10% of development costs	• Only high level contractual requirements (HLR) • No public funding in commercial exploitation • **Minimum number of launch services (five) contracted by European Institutional Users**

- Success will rely, de facto, on the guarantee of a launch business base
- Not just an industrial reorganisation!! > A complete paradigm-shift in the launcher sector
  - **ASL full control** of the entire life-cycle of A6
  - Key steps: control of Arianespace, also through acquisition of CNES shares
- Pending questions:
  - What kind of safeguards? What about AVIO?
  - PDR in June 2016

→ **What Prospects for European Launchers?**

Worldwide Policies and Programmes

Current Worldwide Policies and Developments

United States of America

2013 Space Transportation Policy :

- Re-affirmed assured access to space through american-built launch vehicles, developed and exploited by private entities through a continued public support.
- NASA role redirected towards beyond-LEO exploration & strong focus on Mars.

Status:

- Comprehensiveness of launch options.
- World's largest captive institutional market.
- Favourable political and financial environment for new entrants.
- COTS Programme...

Current Worldwide Policies and Developments

United States of America

Issues:

- National security payloads launched by Atlas V, which relies on Russian-made RD-180 engine.
- Lack of autonomous manned access to space after the retirement of the Space Shuttle, reliance on Russian Soyuz.
- ULA monopoly among the causes of skyrocketing launch prices (up to 400 M$).

Perceived reduced autonomy

Positive up-turn in the medium term:

- Development of U.S.-made engines, and overall reduction of launch costs.
- DoD-induced break-up of monopoly: competition with SpaceX.
- Re-establishment of manned spaceflight capabilities to the ISS and beyond (SLS?).
- Reusable launch vehicles: potentially disruptive innovation?

Current Worldwide Policies and Developments

Russia

Status: Evolution from post-cold-war status quo, amid on-going severe economic difficulties and budget cuts in the space sector.

Strive for autonomy:

- Severing the ties with the Ukrainian space sector (Dnepr/Rockot phase-off).
- Easing reliance on Kazakhstan's Baikonur launch site.
- New Angara modular family, new Vostochny cosmodrome.

Governance reform:

- Re-nationalization of the whole space sector under one single state-owned company - also in order to address strong quality-assurance problems.

Outlook:

- Despite Proton comeback and still strong internal demand, commercial prospects of current and new launchers remain unclear.

Current Worldwide Policies and Developments

China

Status: A self-sufficient and highly ambitious space programme, with ever-increasing budget and workforce, supported by a comprehensive and evolving array of launch options.

Developments:

- New Long March families of all sizes and performances.
- New Wenchang spaceport: advantageous location, allowing for increased performance and safety.

Outlook:

- Despite low pricing, the commercial presence of Chinese launchers is strongly curbed by geopolitical constrains, first and foremost U.S. policies and export control regulations (ITAR).
- Possible increase use of launchers as a geopolitical tool: providing a "full package" composed of the launch of a Chinese-built satellite through a Chinese rocket, targeting resources-rich countries (e.g. Venezuela).

Current Worldwide Policies and Developments

Japan

2013 Basic Plan: space policy evolution reflecting Japan's increased geopolitical awareness. With Chinese space activities perceived as a threat, gradual abandonment of the strict "peaceful purposes" interpretation, towards a more general concept of "non-aggressiveness".

Developments:

- New medium-heavy vehicle, H-III, and upgraded small launcher Epsilon.
- Developments mirror to a certain extent, as for same purposes, performance and timeframe, those currently being undertaken by Europe.
- Provision of ODAs for space-related developments (e.g. Vietnam).

Outlook:

- Success of future commercial competitiveness for H-III strongly dependent on achieving the anticipated reduced costs (as well as future economic conditions).

Current Worldwide Policies and Developments

India

Status: national space programme strongly focused on a civilian scope (EO, TLC). Launchers programme aimed at satisfying domestic needs, with priority to achieve complete autonomy in the 2010-2020 decade.

Developments:

- Highly-sought heavy lift GTO launcher, GSLV Mk-III, in its final phases of development. Will allow India to launch autonomously its multi-purpose INSAT satellite series.
- Small but noticeable success in the commercial market for small satellites with PSLV.

Outlook:

- A substantial presence of GSLV Mk-III on the future market is unlikely, due to low production rates and having to satisfy internal demand first.

Current Worldwide Policies and Developments

Other Actors

- Other countries with access limited to LEO:
  - Israel
  - Iran
  - North Korea
  - South Korea
  - Ukraine

Satisfying national security purposes (Israel, Iran, North Korea, South Korea)

- Countries which could achieve access to LEO in the next decade:
  - Argentina
  - Brazil

Worldwide Policy Dynamics

- Strengthening of **autonomy** and reduced interdependence.
  - *U.S.* *(American-made rocket engines and human-rated capsules)*
  - *Europe* *(Phase-off of Soyuz-ST from GSC)*
  - *Russia* *(New Vostochny cosmodrome)*

- Development of **new modular families** of launchers, and substantial efforts to **decrease launch costs**.
  - *U.S.* *(Vulcan, Falcon 9R/Heavy…)*
  - *Europe* *(Ariane 6, Vega-C)*
  - *Russia* *(Angara A3, A5, A7)*
  - *China* *(Long March 5, 7, 9)*
  - *Japan* *(H-III, Epsilon)*
  - *India* *(GSLV Mk-III)*

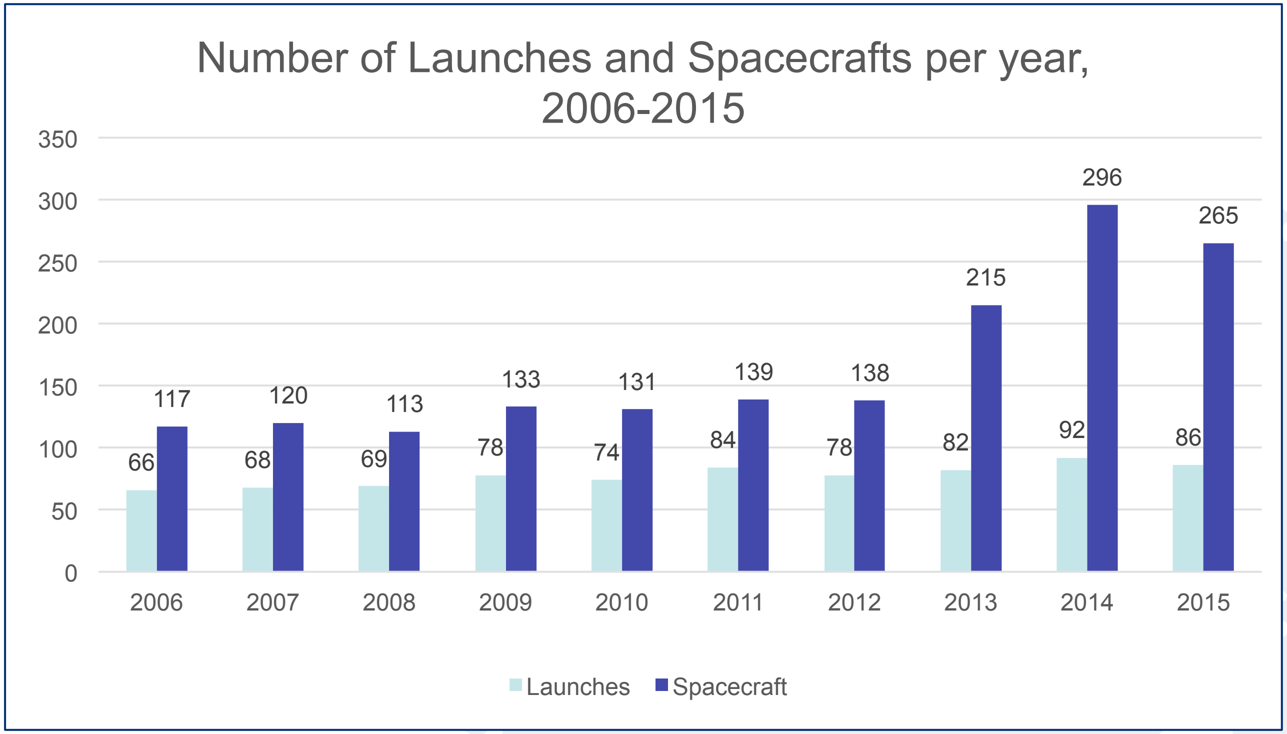
Worldwide Policy Dynamics

- Increasing role of the **private actor**, both in development and exploitation.
  - *U.S.* *(SpaceX, Orbital, Blue Origin…)*
  - *Europe* *(Airbus-Safran Launchers + Arianespace)*
  - *Japan* *(MHI)*
  - *India* *(Privatization of PSLV by 2020)*

- Decline of technology transfers, and possible rise of dedicated "**launch packages**" (satellite + launcher + ground support), targeting countries of interest.
  - *China* *("Launchers 4 Resources")*
  - *Japan* *(Provision of ODA loans)*

Global Dynamics and Trends: The Current Landscape

Launch Activity Outlook (2006-2015)



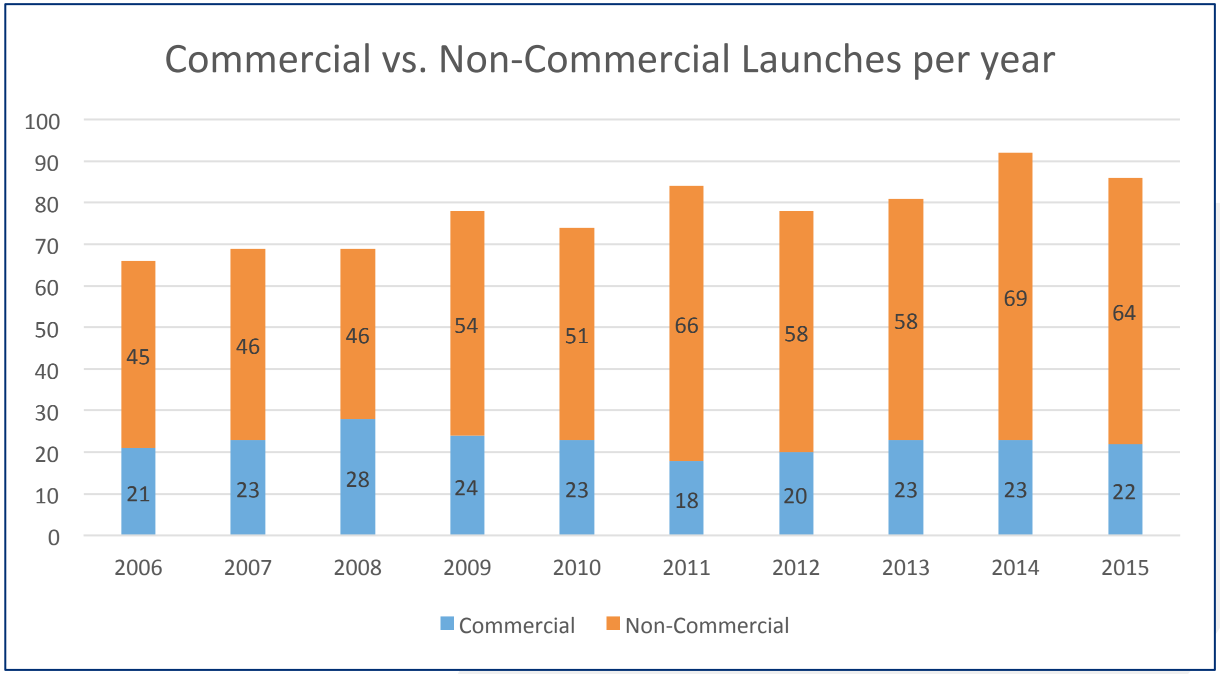
Total number of Launches: 777

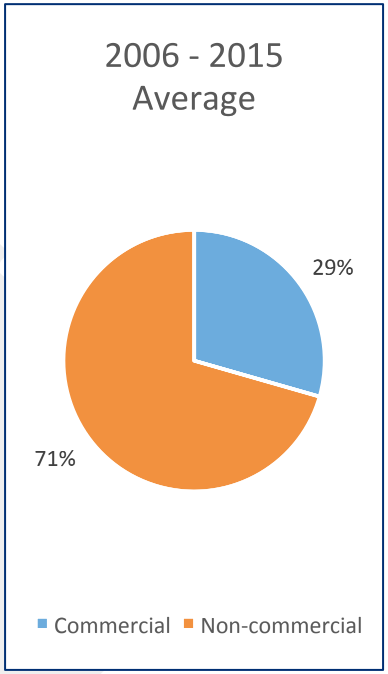
Russia	282 (36.6%)
US	184 (23.7%)
China	136 (17.5%)
Europe	76 (9.8%)
Other	100 (12.7%)

Total number of Spacecrafts: 1688

- Progressive rebound of orbital space activities
  - From 66 in 2006 to 86 in 2015 >>> level of early 1990s
- Substantial increase in the number of spacecraft
  - From 117 in 2006 to 265 in 2015 >>> advent of small satellites

Launch Activity Outlook (2006-2015)

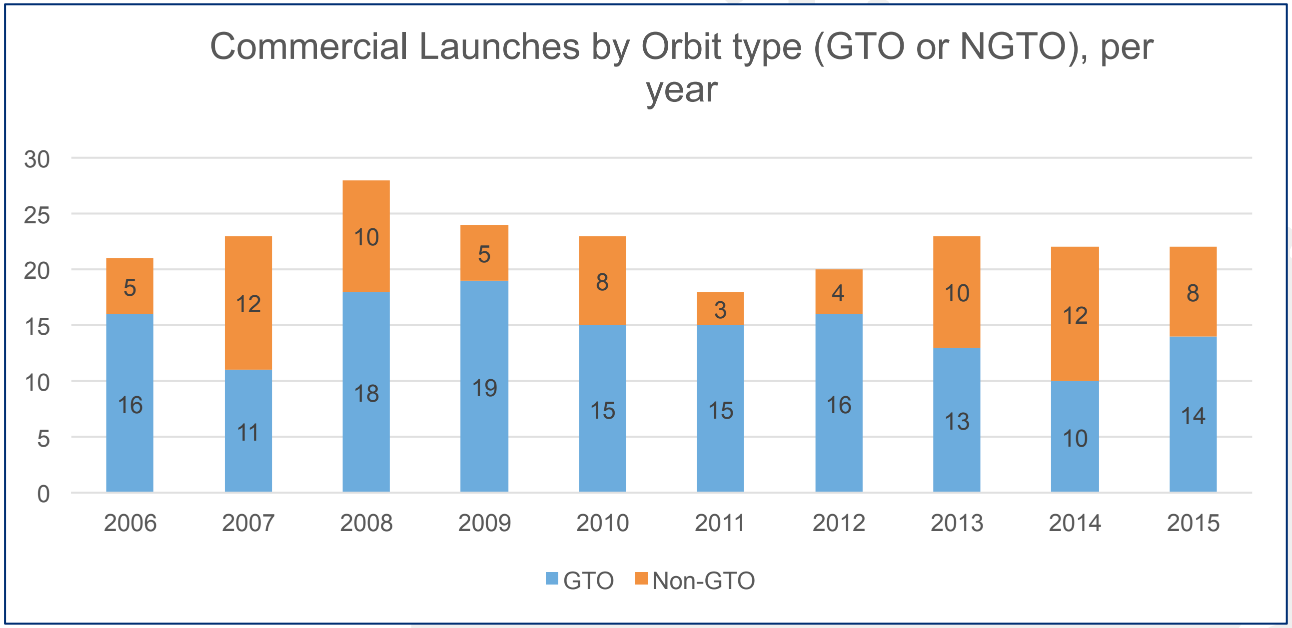


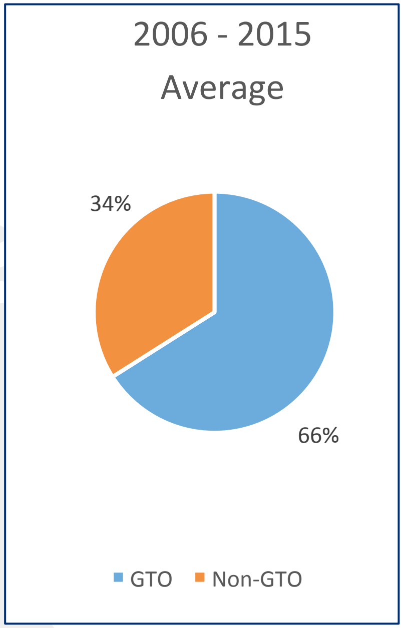


Global market: captive + commercial

- 552 Non-commercial launches (55 per year)
  - Progressive increase from 45 in 2006 to 64 in 2015
- 225 Commercial launches launches (22 per year)
  - Fluctuation from a peak of 28 in 2008 to a valley of 18 in 2011

Launch Activity Outlook (2006-2015)





GTO (148)

- Payloads largely open to international competition.
- Demand mainly driven by commercial satellite operators (SES, Intelsat, Eutelsat).

NGTO (77)

- Predominantly captive institutional demand (Russia,U.S, China).
- Commercial demand mainly driven by countries with no launch capacity.

Geo-economics of Launchers

Any assessment of the commercial launch market proves highly problematic

- ➢ Practical complexities in the construction of economic data
- ➢ Launchers are NOT "just another commodity"

Launch Demand

- Price only one of the criteria for selecting a launch service
  - ➢ Reliability, Performance, Availably, Flexibility, Security
- Demand irresponsive to conditions on supply side
  - ➢ Inelasticity of demand ⟷ Marginal improvements on supply

Launch Supply

- Government backing for both Development and Exploitation
  - ➢ Guarantee of a Launch Business Base
  - ➢ Injection of Public Funding to cover exploitation costs
- Government Policies sustaining launchers' competitiveness
  - ➢ Quotas for Foreign Launches
  - ➢ Export Credit Agencies
  - ➢ Export Control *de facto* Limiting Foreign Competition

No "free and fair" competition

⬇

Market dynamics based on a "**geo-economic**" paradigm

Geo-economics of Launchers

GTO

- Europe-Russia duopoly > Over in 2014
- Launch services contracts dominated by **Arianespace** and **SpaceX**

- Competitors: Europe (Ariane 5), U.S. (Falcon 9), Russia (Proton), U.S. (Atlas V)
- De facto inactive: Sea Launch (Zenit), USA (Delta IV), Japan (H-II), China (LM-3), India (GSLV-II)

NGTO

- Dominance of converted Russian ICBMs (Dnepr, Rockot) > Over
- Successful penetration of **SpaceX**

- Competitors: Russia (ex ICBMs), U.S. (Falcon 9), Europe (Vega), India (PSLV),
- Limited presence: China (LM-2), U.S. (Pegasus, Minotaur, Antares), Japan (Epsilon)

The Current Landscape: Overview

- Access to space becoming **more responsive** to **cost** and **price** pressures, following decades in which performance and reliability were the main drivers for launchers development.
    - Launchers commoditisation? Price as main differentiator?

- **Price targets** in the short term remain in the **same order of magnitude** as today's prices, yet:
    - Innovative approaches in development, production, and commercialisation
    - Increased flexibility through vehicle modularity and common elements
    - Pursuit of disruptive technological innovation

- Dynamism in supply is taking place in a market whose **overall demand** in the GTO segment expected remain **stable** over the next years. In LEO, a growing demand for small satellites.
    - Stiffer competition in the coming years? **What kind of landscape in the future?**

The Future Landscape

Unfolding Technological Trends in Demand and Supply

- (The return of) **Mega-constellations** & **Small satellites**
- Increasing interest of commercial satellite operators for LEO (e.g. proposed 1000+ internet broadband constellations, but also EO), so far an almost-exclusive domain of institutional payloads.
- Arianespace-OneWeb, ~700 broadband satellites, €1.3 B (largest commercial launch contract ever).
- Exponential rise of small satellites, urging for **small**, **flexible** and **cheap** launch solutions (not to mention robust STM/debris regulations).

Unfolding Technological Trends in Demand and Supply

- All-electric satellites. Use of **electric propulsion** not only for station-keeping, but also for orbit-raising. Industry estimates: 25% of all satellites will be electric-propelled by 2022.

- Impact on satellite manufacturers: **huge mass savings** (e.g. 40%), open up two scenarios:

More payload per satellite

Lighter satellites

- Possible impact on launch service providers:

Increased number of satellites per vehicle, giving rockets with **dual/multiple-launch capabilities** and advanced orbit injection a strategic advantage

Increased use of **small launch vehicles**

Unfolding Technological Trends in Demand and Supply

- As at April 2016, **first-stage rocket landing is a fact** for orbital vehicles (SpaceX), and the reuse is proven for suborbital ones (Blue Origin).
- Yet, the business case still has to be closed. The unknowns in the technology feasibility have shifted to **unknowns in the economic viability** of this model (e.g. refurbishment costs, reliability considerations for typically risk-averse satellite operators…).
- Different concepts: Falcon 9R (SpaceX), Adeline (Airbus), SMART (ULA) …
- **Non-vertical launch?** Lynx Mark III, Pegasus II, SOAR, Launcher One, Stratolaunch …
- **Spaceplanes?** Skylon (UK Reaction Engines), X-37B (Boeing/NASA/USAF), AVATAR (ISRO) …

Unfolding Technological Trends in Demand and Supply

- Additive manufacturing: a **revolution** in industrial processes for the decades to come.
- Huge potential for launchers: 3D-printed rocket components can be **lighter**, **cheaper**, and open up entirely **new design possibilities** (more complex geometries and shapes).
- Europe is very well positioned in this emerging sector.

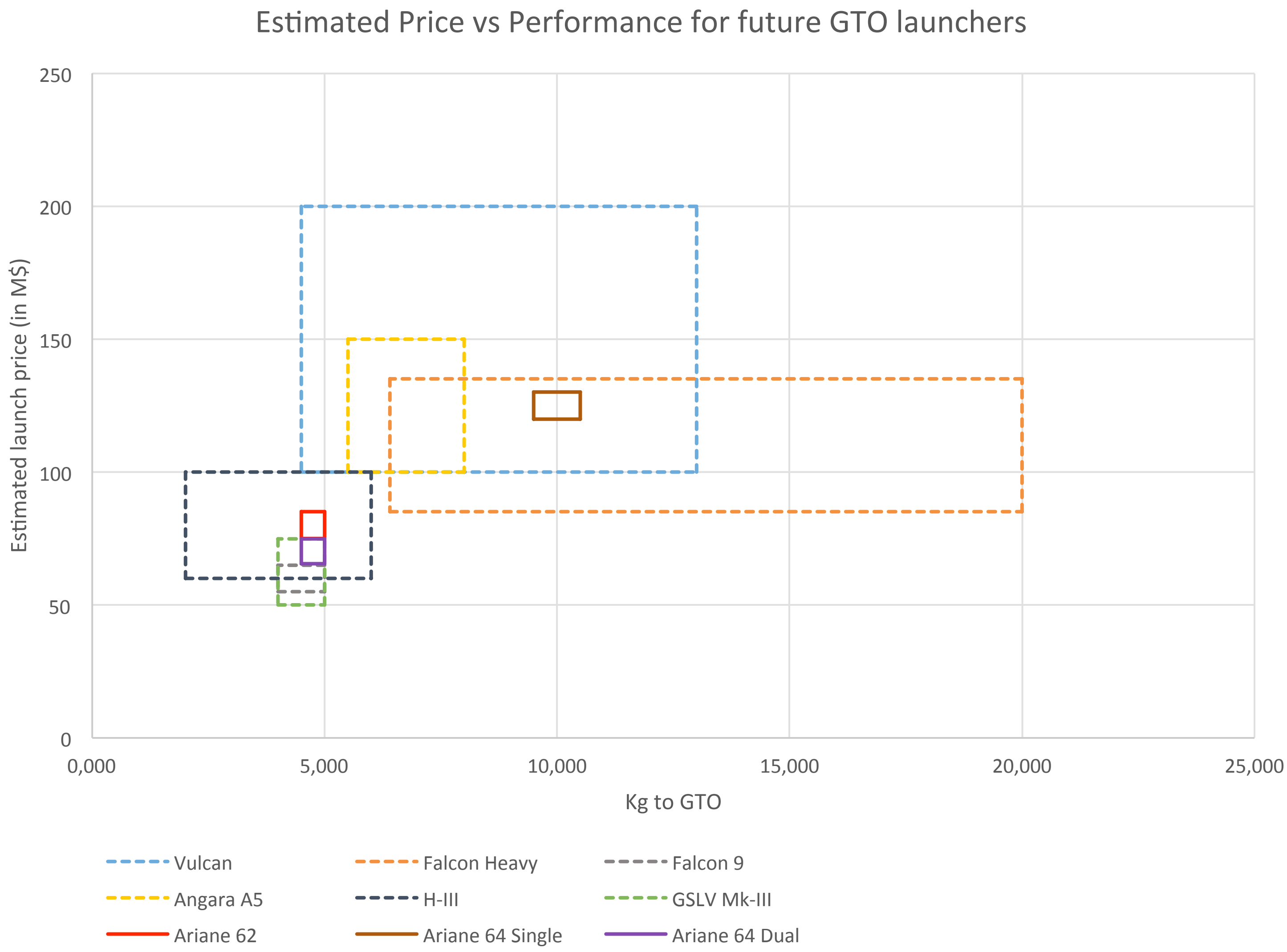
The Future Landscape: a snapshot of the 2020s

GTO

- Competitors: A6, Falcon 9R/Heavy, Angara 5. Also Vulcan, H-III, LM5/7, GSLV Mk-III.
- **Potential overcapacity** (GTO demand stable, but increased willingness by actors to compete on commercial market). Price war?
- Substantial decrease in launch prices could occur as a result of some **major technological breakthrough**.
- In this scenario, the way will be paved for an even larger increase in demand for launch services and the current structure of the commercial **launch market** will be substantially **disrupted**.

NGTO

- Competitors: Vega-C, Angara 1.2, PSLV, LM6/7, Falcon 9, Antares, Epsilon (+more).
- Still mostly institutional-oriented, but with **growing commercial interest**.
- Larger demand for small commercial satellites could be intercepted by an **increased offer of small launchers**.


Estimated Price vs Performance for future GTO launchers
Estimated launch price (in M$)
250
200
150
100
50
0
0,000
5,000
10,000
15,000
20,000
25,000
Kg to GTO
Vulcan
Falcon Heavy
Falcon 9
Angara A5
H-III
GSLV Mk-III
Ariane 62
Ariane 64 Single
Ariane 64 Dual

What Prospects for European Launchers?
An Assessment

Europe's Strategy on Access to Space: an Assessment

- ESA CM/14 Resolution on Access to Space: a politically **well-balanced compromise** between ESA MS, which was noticeably taken as late as 18 years after the qualification flight of Ariane 5.

- Multi-pronged strategy aimed at **maintaining robust launch competencies** while **increasing flexibility** and **reducing costs** through a number of levers:
  - utilisation of heritage hardware
  - streamlining of industrial organisation
  - maximisation of common elements, creation of synergies between different market segments
  - guarantee of five institutional launches per year

- Driver: to decrease launch costs and to generate economies of scale so as to **ensure competitive pricing** for Ariane 6 and Vega-C **without the need for public support** payments during exploitation.

Europe's Strategy on Access to Space: an Assessment

- The projected way forward remains to a large extent **conservative rather than trend setting**, at least for the new heavy-lift vehicle. The Resolution sanctions a *revolution* in terms of processes, but a mere *evolution* in terms of products
- The success of this new launcher strategy will rely on the guarantee of an **institutional launch business base**, which might be difficult to ensure absent a formal commitment by all European stakeholders (but still NOT a "buy European" clause).
- The integration of Arianespace into ASL would entail a **significant market consolidation** since one of its shareholders (Airbus D&S) is also a leading satellite manufacturer. Interesting inverse parallelism with the U.S. ex-monopoly of ULA?
- The issue of shareholding structure and **ownership of AVIO** has not been yet sorted out.

Europe’s Strategy on Access to Space: an Assessment

- There are **limited margins of profit** for Ariane 6. Crucially, this reduced margin allows little room for manoeuvre in case of a price war. Higher margins can be expected for Vega-C, provided that the difference between production costs and launch price can be maintained.

- Furthermore, **potential oversupply** (market demand expected stable in GTO, and increased launch offer), or changed market conditions, could lead to more aggressive competition on the commercial market by national actors in the 2020s.

- The roadmap for Vega appears to be more **robust**. However, while the forecast evolution into what will de facto be a medium-lift launcher (Vega-E) will permit to cover (with Ariane 62) the “middle ground” left by the phase-out of Soyuz, it leaves open the question of how to best meet the ever-growing demand for small/micro/nano satellites.

- Ariane 6 has a strong commercial focus. Noticeably, it is **not designed to be human-rated**. Consequently, Europe will not be able to conduct autonomous human spaceflight missions in the foreseeable future.

Europe's Strategy on Access to Space: an Assessment

- The decision to replace Soyuz-ST, one of the reasons being that it does not sustain European industrial activities, down-prioritises the fact that the presence of Soyuz-ST at the GSC represented a **significant geopolitical signal**. This leaves open the issue of finding an analogous valuable mechanism for European-Russian cooperation in space.

- Europe seems to have no comprehensive plans for how to respond to the new policy reality of countries offering complete "launch packages", which might have potentially disruptive effects in the launch market, as well as their increased intention to use **launchers as a geopolitical tool** to support foreign policy objectives.

- Several countries are putting a strong emphasis on expanding their launch infrastructure. Europe will continue to rely on the Kourou site. While located in one of the most advantageous locations in the world, the GSC will remain the **only spaceport** for Ariane and Vega in the foreseeable future, with **inherent risks**.

Europe’s Way Forward

Europe’s Way Forward: Reflections on How to…

- **Enhance the commercial competitiveness of Ariane 6, Vega-C**
- **Promote Disruptive Technological Innovation in Europe**
- **Boost and geopolitically leverage launchers’ strategic value**
- **Support Europe’s future role in human spaceflight**
- **Secure Europe’s gateways to space**

NB: Open points of reflections to be assessed with considerations of:

- ➢ Political feasibility
- ➢ Financial affordability
- ➢ Effectiveness

Enhancing Europe's Commercial Competitiveness

- **Ensuring and expanding the launch business base**
  - Enforcement European preference clause? >> Legal and Political hurdles
  - Provision of ODAs to build up institutional demand
- **Expanding the mass performance at both sides of the spectrum**
  - An Ariane 66 / A "mini Vega"?
  - Holistic Roadmap for future launchers
- **Reinforce the role of ECAs**
  - Creation of a pan-European ECA / European Investment Bank
- **Achieving international consensus upon trading rules**
  - More stringent regime for commercial launches >> cooperation problem
  - *Lex mercatoria* for environmental requirements?
- **Target disruptive, leap-frogging innovation**

Promoting Disruptive Technological Innovation

- Increasing dynamism of international launch industry dictate a **constant investment** in leap-frogging innovation

- **Is Europe a conservative force** in R&D?
  - Silicon Valley mind-set typically American phenomenon BUT
  - Key role of the public sector agencies, particularly the DoD

- **No DoD-equivalent in Europe** and little military involvement
  - R&D efforts driven by ESA
  - EU Framework Programmes for RTD

- **EU interests in pursuing disruptive innovation**
  - EU more risk-tolerant actor
  - EU several tools (industrial policy, research and innovation schemes)

- **Seed funding within H2020** to target launcher innovation (e.g. reusability)

- **Europe must find its own path!!** (e.g. Skylon space-plane, Non-rocket launch)

Boosting Launchers' Strategic Value

- **Europe's current launcher strategy is geopolitically deficient**
  - Launchers not leveraged as potential diplomatic tools
  - Launchers overlooked in their strategic significance!!
- **Structural political constraints and ESA lack of political clout**
- **Involvement of a *super partes* institution (EU) in order to:**
  - Strengthen Europe's political profile and *actorness*
  - Support EU's foreign policy objectives (e.g. through alliance building)
- **Space launchers as a geopolitical toolkit for the EU?**
  - Provision of ODAs to build up institutional demand
  - Discarded technology transfer to target countries
- **Who does it?**
  - European External Action Service
  - ASL with support functions to European foreign policy?

Supporting Europe's role in human spaceflight

- ESA forced to promote HSF through a “cooperation and interdependence” paradigm
- **Autonomy** versus / and **cooperation** considerations
- What options?
    - A new Flagship programme by the EC?
    - Spurring private companies involvement in HSF?

Securing Europe´s Gateways to Space

- GSC: optimal launch site *but* “all eggs in one basket”!
- Some options
    - A new launch site for Ariane 6? Unlikely
    - Extending launch backup agreements (Japan, Russia)
    - Europeanisation of the GSC?
    - Spaceports for small launchers (e.g. Andoya, Kiruna)

Thank you for your attention!

Questions?

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	Vehicle Name	First Flight	Timeline 2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
EUR	Ariane 62	2020										
	Ariane 64	2020										
	Vega-C	2018										
USA	SLS Block I	2018										
	SLS Block II	> 2021										
	Falcon Heavy	2016										
	Vulcan Step 1	2019										
	Vulcan Step 2	2023										
	Athena III	TBD										
RUS	Angara A3	> 2020										
	Angara A5	> 2016										
	Angara A7	> 2028										
CHN	Long March 5	2016										
	Long March 7	2016										
	Long March 9	> 2023										
JAP	H-III	> 2020										
	Epsilon phase 2	> 2017										
IND	GSLV Mk-III	> 2016										
KOR	KSLV-II	2020										
BRA	VLS Alfa/Beta	2020										
ARG	Tronador III	TBD										