

# **Space Launchers: Competitiveness continuous renewal thru Innovation**

**ArianeGroup Keynote @ CEA LETI Innovation Days**

**H. GILIBERT – Chief Technical Officer**

**04/07/2018**

**#spaceenablers**

# ARIANEGROUP IS A SPACE BUSINESS ENABLER

**“ENABLING EUROPE  
TO ACCESS SPACE,  
FOR THE BENEFIT OF ALL ITS CITIZENS  
IS WHAT WE DO EVERY DAY.”**

## Access to space

- Ariane 5 & Ariane 6
- Marketing and operations of Vega & Soyuz via Arianespace and Rockot via Eurockot
- Space Situational Awareness & Space Traffic Solutions through GEOTracker



**Stability on Earth supported  
by deterrence**

## Propulsion solutions for all missions and all orbits

- Satellite propulsion systems
- Launchers propulsion products and equipment (e.g. ammonium perchlorate, nozzle...)
- Orion-MPCV propulsion system



Moon

## Advanced space products and solutions

- Light and stable composite space structures
- Cutting-edge equipment and sensors for New Space
- Critical deep space solutions

# WORLD LEADER IN ACCESS TO SPACE

**9,000**

EMPLOYEES  
IN FRANCE  
& GERMANY

**11**

SUBSIDIARIES  
& MAIN AFFILIATES

**50/50**

JOINT COMPANY  
BETWEEN  
AIRBUS & SAFRAN

**€3.4 BILLION**

ESTIMATED PRO FORMA  
SALES



## CIVIL LAUNCHERS

- ▶ Ariane 5  
Ariane 6  
Launch services



## DEFENSE

- ▶ M51 program



## EQUIPMENT & SERVICES

- ▶ For satellites, spacecraft  
For launchers  
For defence, security, critical  
infrastructures and industry



**MORE THAN FIGURES ...  
OUR IDCARD IS WHAT MAKES US VIBRATE ...**



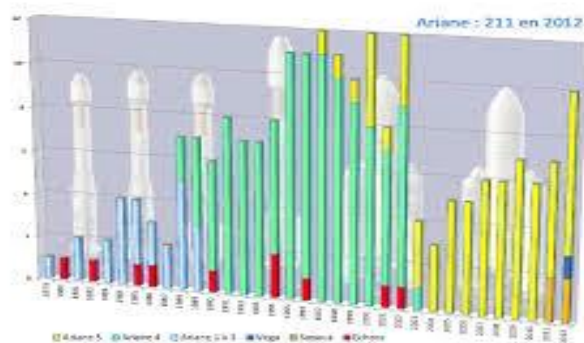
# ACCESS TO SPACE: VIEWS ON LAST DECADES ... ... A FANTASTIC TRAJECTORY

**FROM  
1980**

**Pioneers ...**



**TO  
2010**



**... commercial**



- ▶ Launch attempts
- ▶ Technical exploits
- ▶ Public enthusiasm

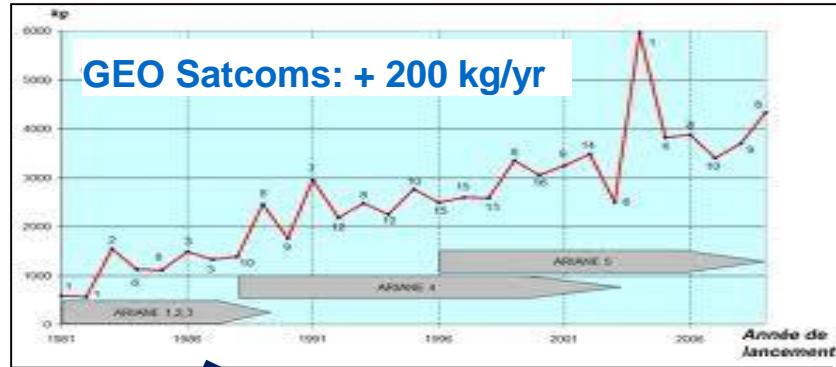
- ▶ Reliability, Availability, Cadence
- ▶ Industrialisation, Low Costs

**Access to Space is Strategic**

# ACCESS TO SPACE: VIEWS ON LAST DECADES ... ... A FANTASTIC TRAJECTORY

1980-2010

Evolution of launchers missions / performance / size



ATV to  
ISS

Dual launch  
(Ariane 5)

Deep  
space

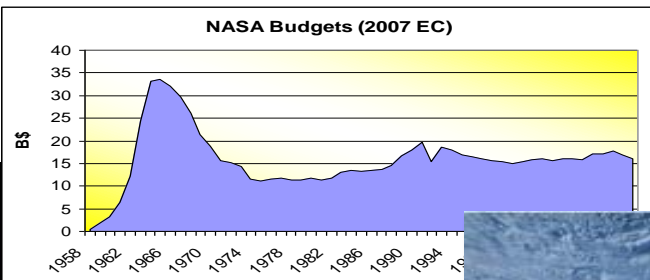


Herschel & Planck

# ACCESS TO SPACE: VIEWS ON LAST DECADES ... ... A FANTASTIC TRAJECTORY

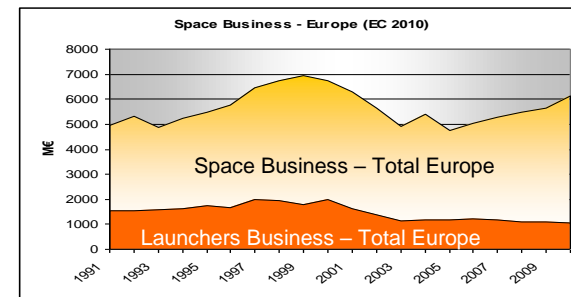
1980-2010

Ambitions for space : ups, downs and ruptures ...



**L517**

Still strategic, but subject to ordinary  
budget and competition constraints

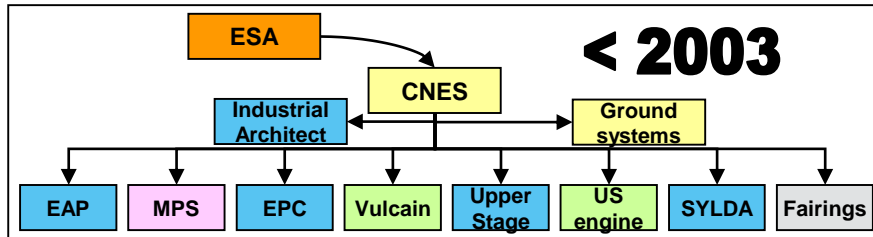




# ACCESS TO SPACE: VIEWS ON LAST DECADES ... ... A FANTASTIC TRAJECTORY

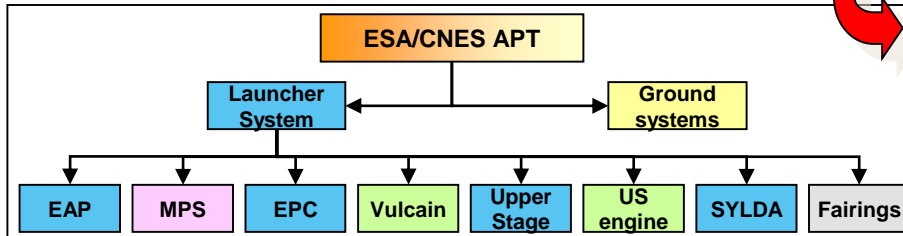
1980-2010

## Programmes management & organisation



ESA = Devt Contracting Authority  
CNES = Prime Contractor,  
Design Authority  
& Qualification Authority

Astrium  
Snecma  
Europropulsion  
RUAG



ESA = Devt Contracting Authority  
ASTRIUM = Prime Contractor

From direct management of industry by Agencies to responsibilized industry  
wrt reliability, availability and competitiveness

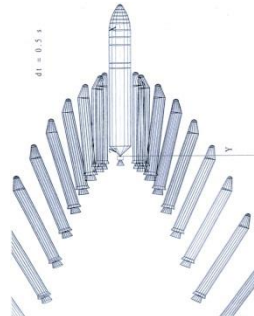
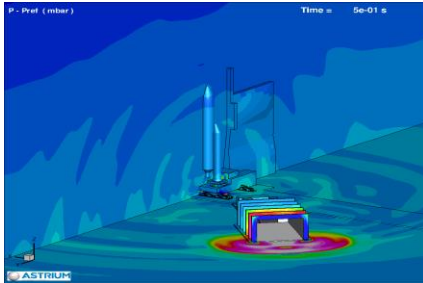


# ACCESS TO SPACE: VIEWS ON LAST DECADES ... ... A FANTASTIC TRAJECTORY

**1980-2010**

**Leading edge engineering & technology ...  
... to be now fully devoted to industrial robustness**

- **Leading edge System Engineering**
  - Multi-disciplinary optimisation (“Architect”)
  - Top-Down approach & concurrent engineering
  - Reliability & Safety
- **Leading edge engineering**
  - Physics modelling in all domains !

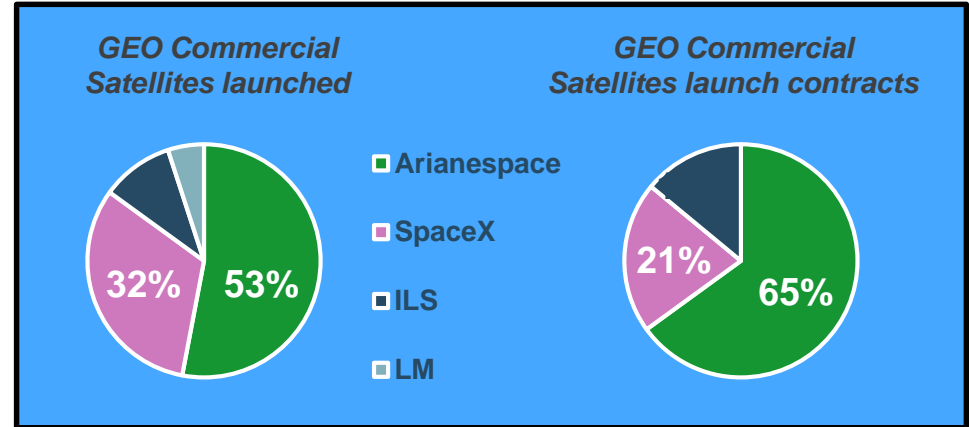
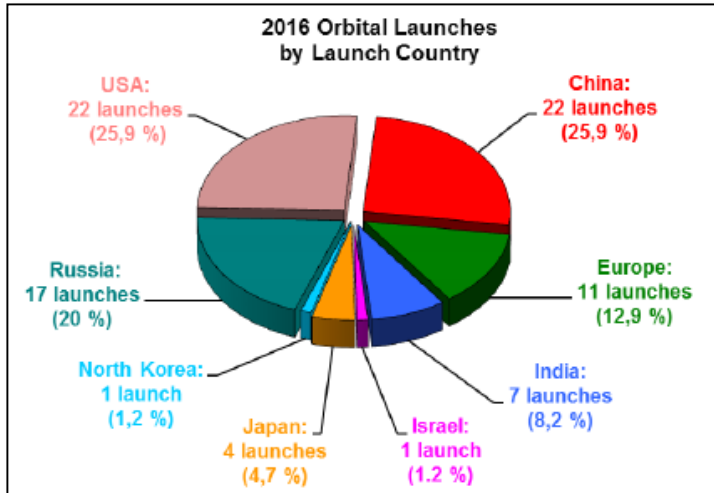


- **Today & tomorrow :**
  - Model Based System Engineering (MBSE)
  - Functional Mock-Up (FMU)
  - Digital Mock-Up (DMU)
  - Functional Digital Mock-Up (FDMU)

# ACCESS TO SPACE : VIEWS ON LAST DECADES ... ... A FANTASTIC TRAJECTORY

1980-2015

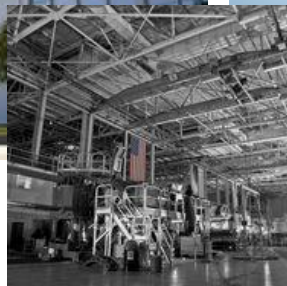
## European Supremacy on Commercial Market



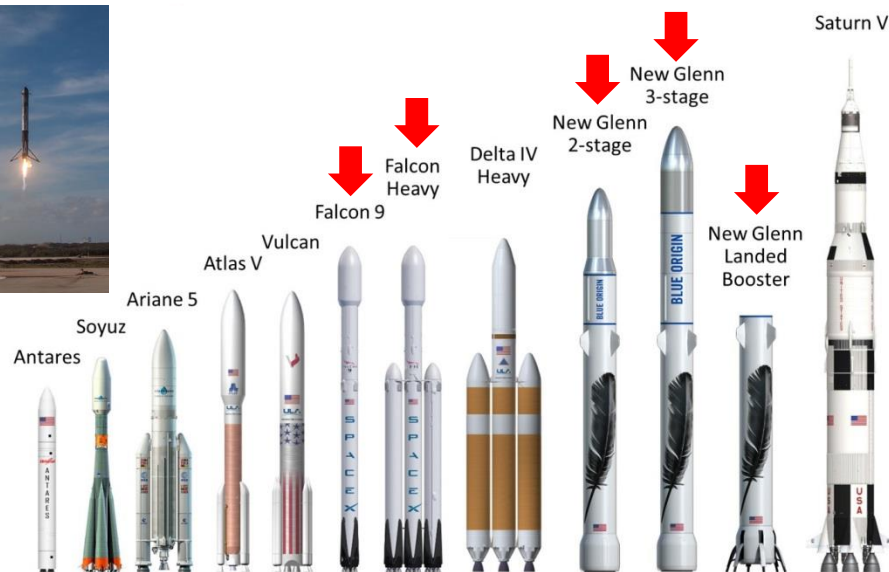
# SPACE TRANSPORTATION TODAY

2010 + ...

Private actors shaking the well established playground ...



Falcon 9



Total disruption on commercial launch service prices (k\$/kg)

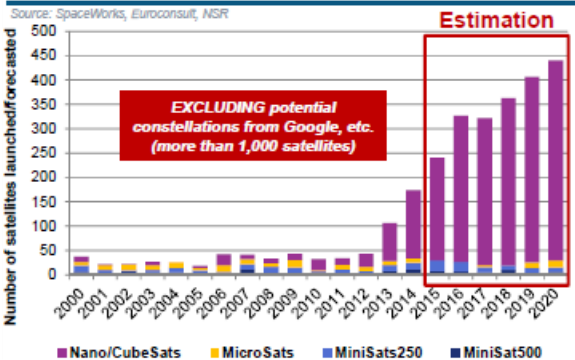
# SPACE TRANSPORTATION TODAY

2010 + ...

## The wave of New Space

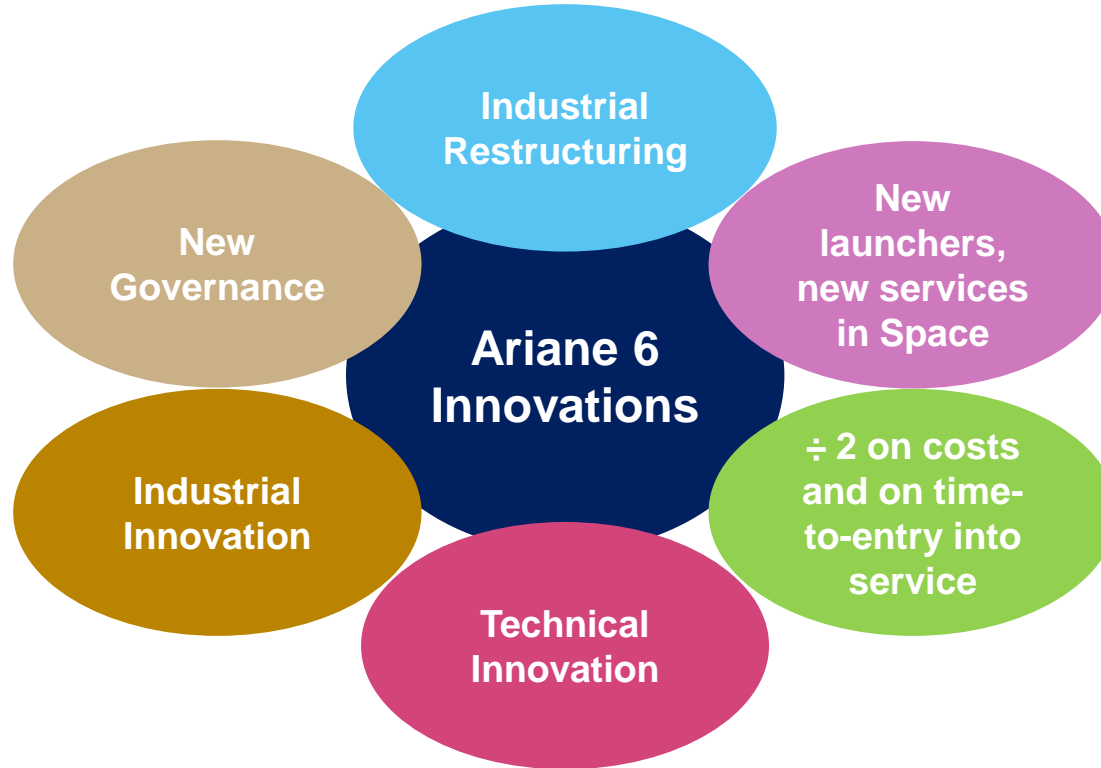


Forecast of satellites to be launched until 2020

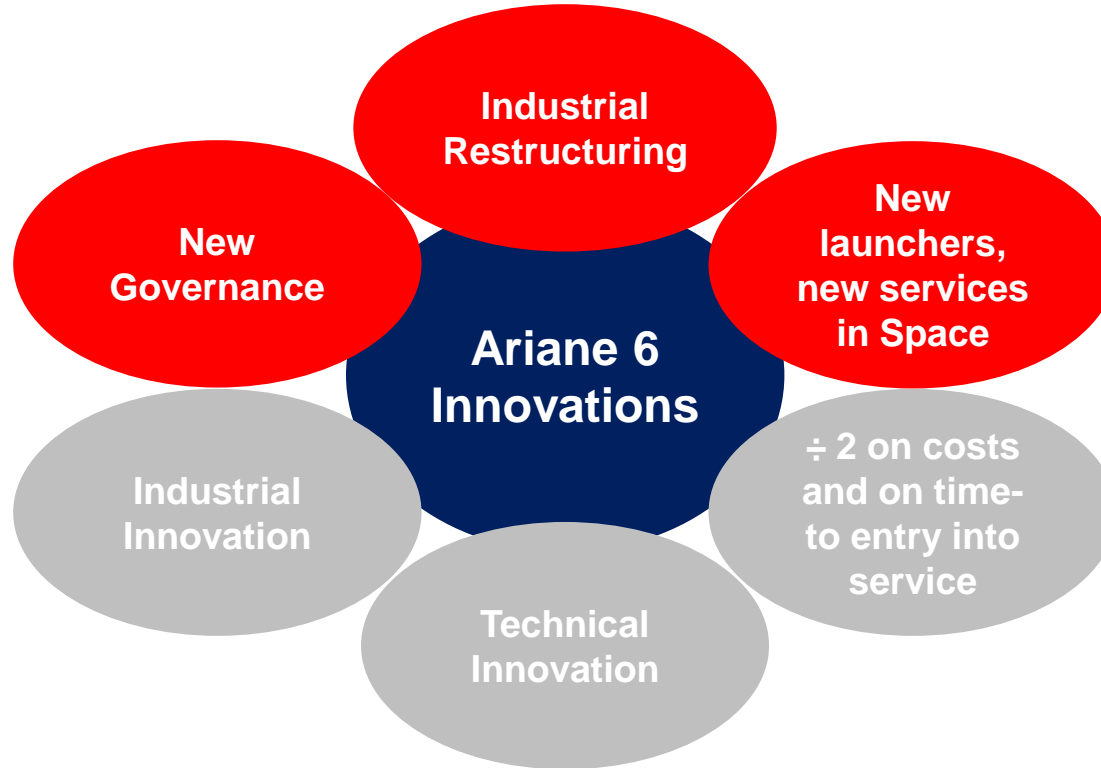




# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020



# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020



# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020

On June 16<sup>th</sup> 2014, Airbus and Safran have proposed a triple initiative to reshape European launcher sector

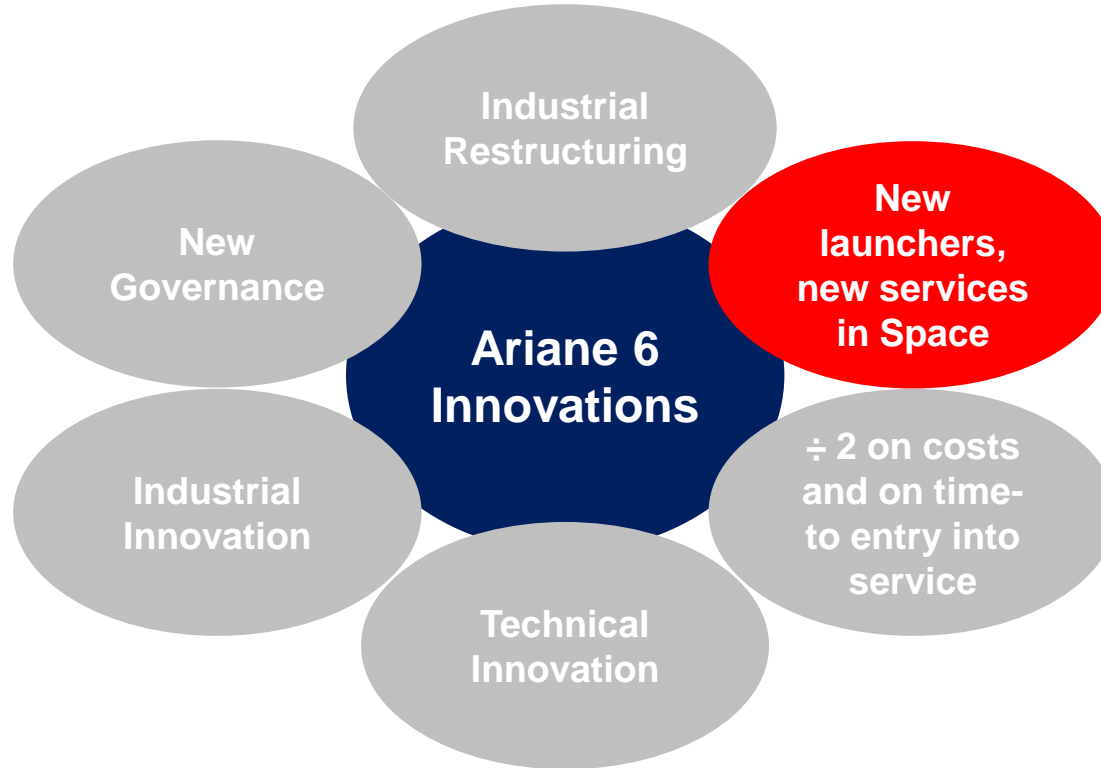


The two main European launcher industrialists decided to join forces to build a new rationalized and lean, Franco-German, industrial organization

Adapting the partnership between Governments/ESA and industry.

Respond to the evolution of market requirements over the next decades with a modular, two-variant offer, and with large built-in evolution and growth potential.

# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020





# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020



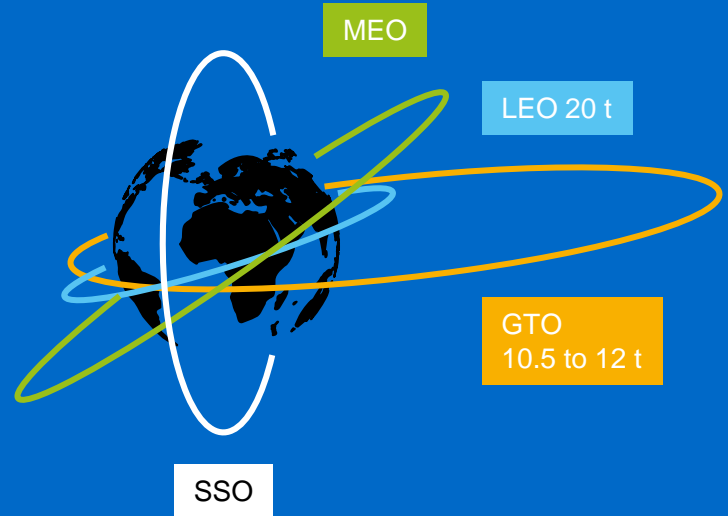
**Vega-C**  
2019  
maiden flight



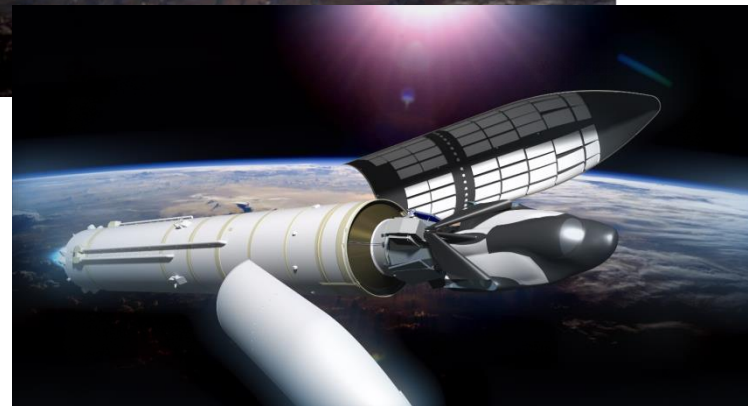
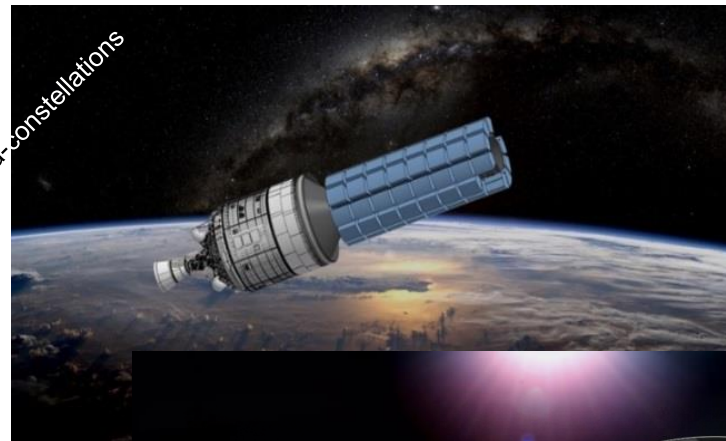
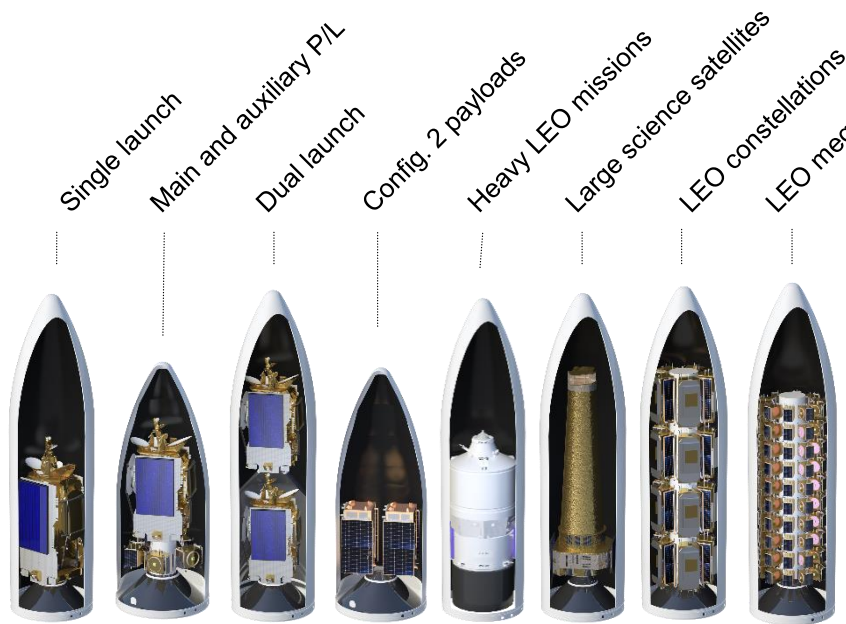
**Ariane 62 & 64**  
2020 maiden flight  
FOC 2023

**High performance and flexibility  
on trajectories**

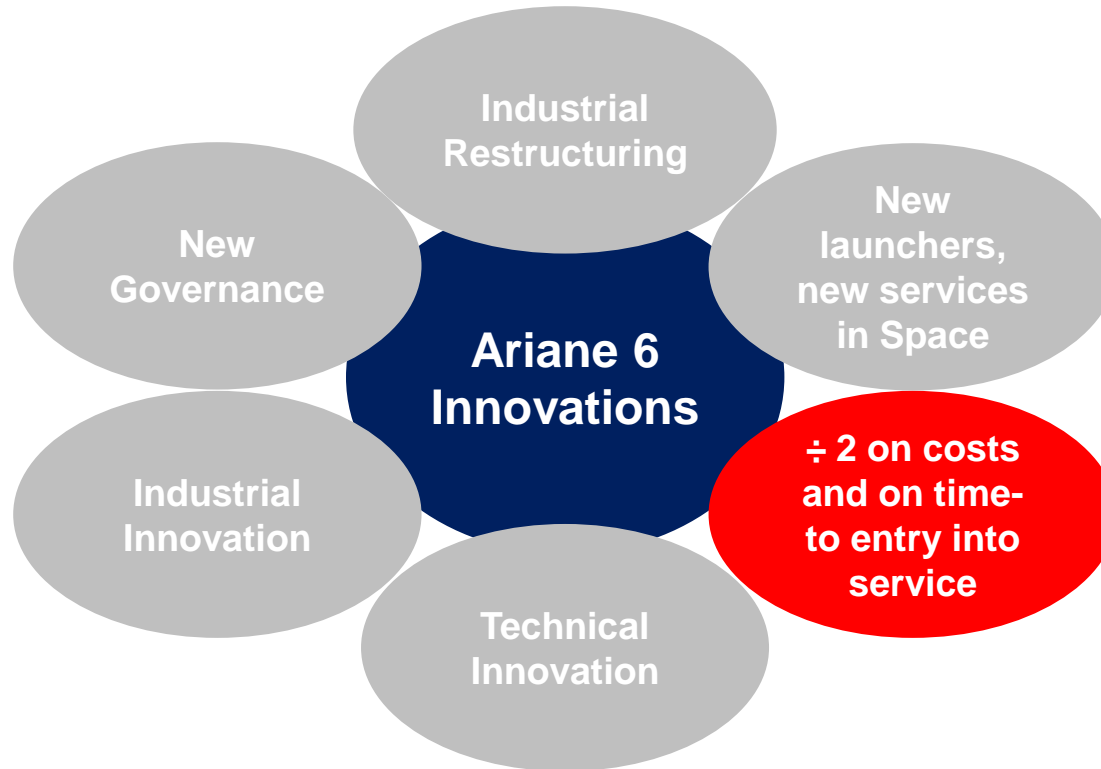
## ARIANE 64 PERFORMANCE



# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020



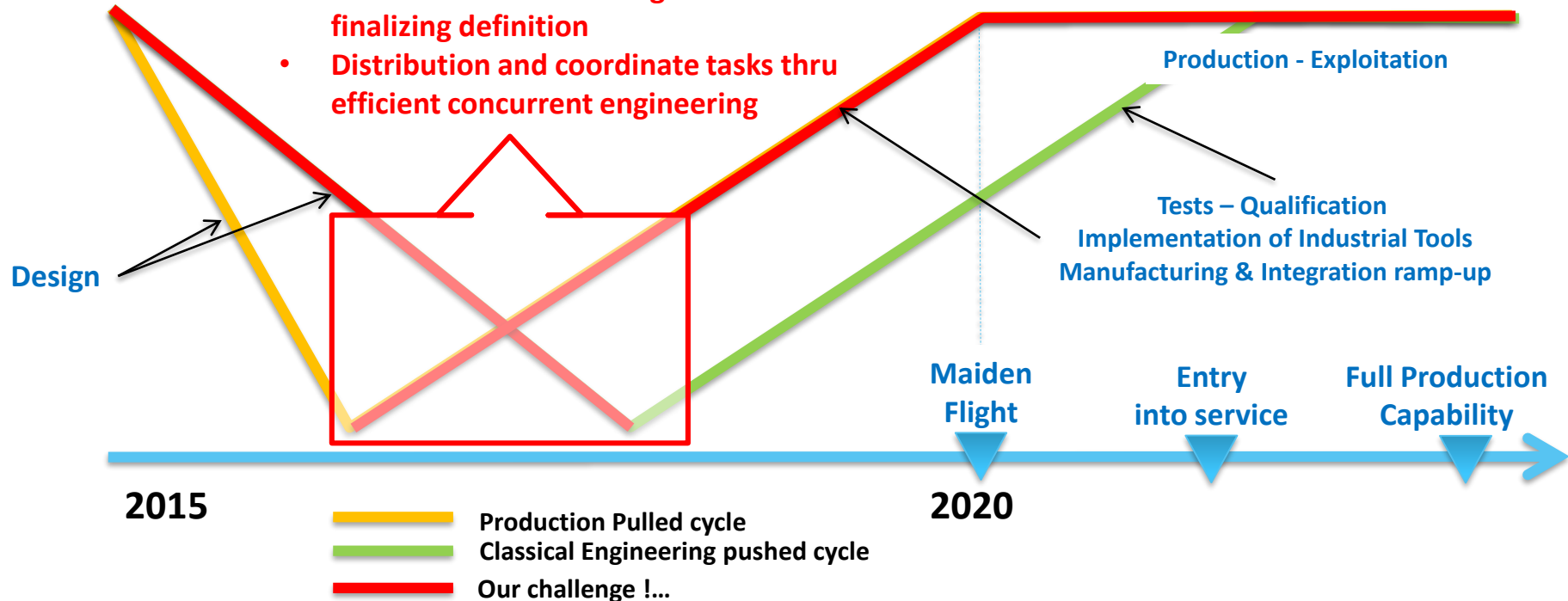
# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020



# ARIANE 6 ENGINEERING: PRODUCTION PULL APPROACH

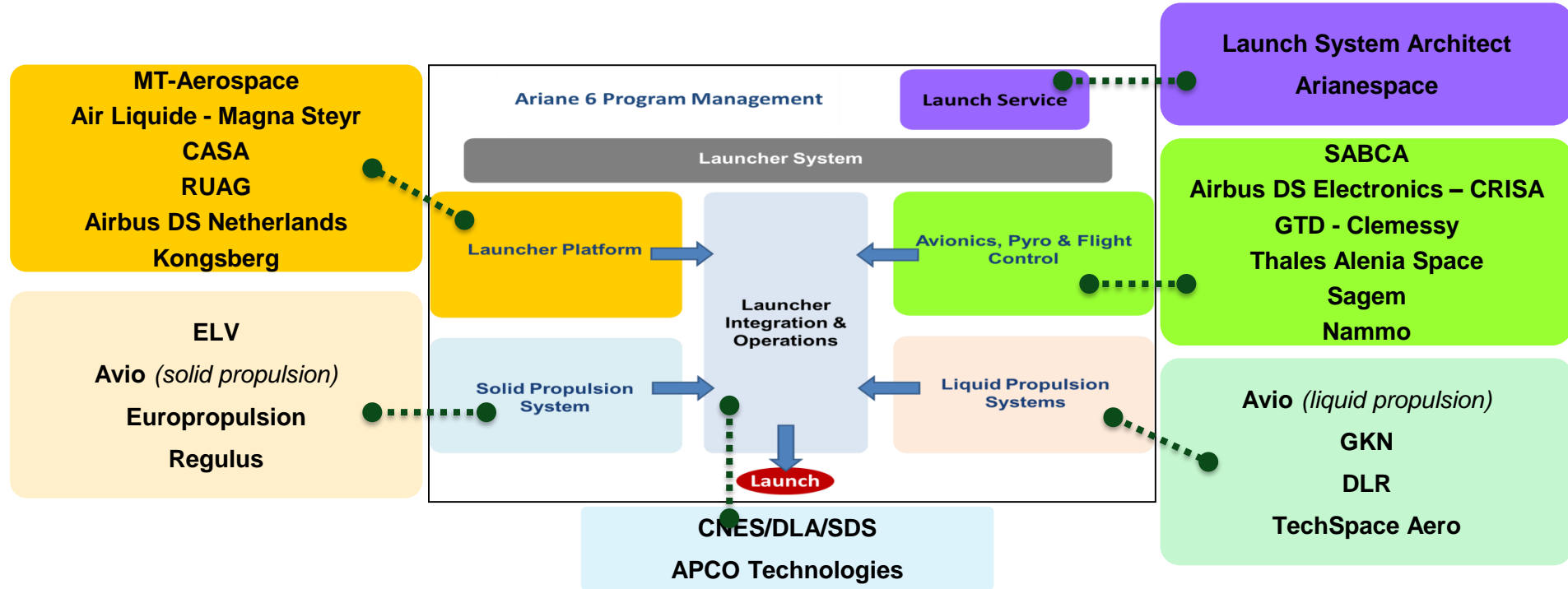
**Gain a factor 2 to 3 on NRC, RC and time to exploitation ...**

- Go fast to Manufacturing before finalizing definition
- Distribution and coordinate tasks thru efficient concurrent engineering



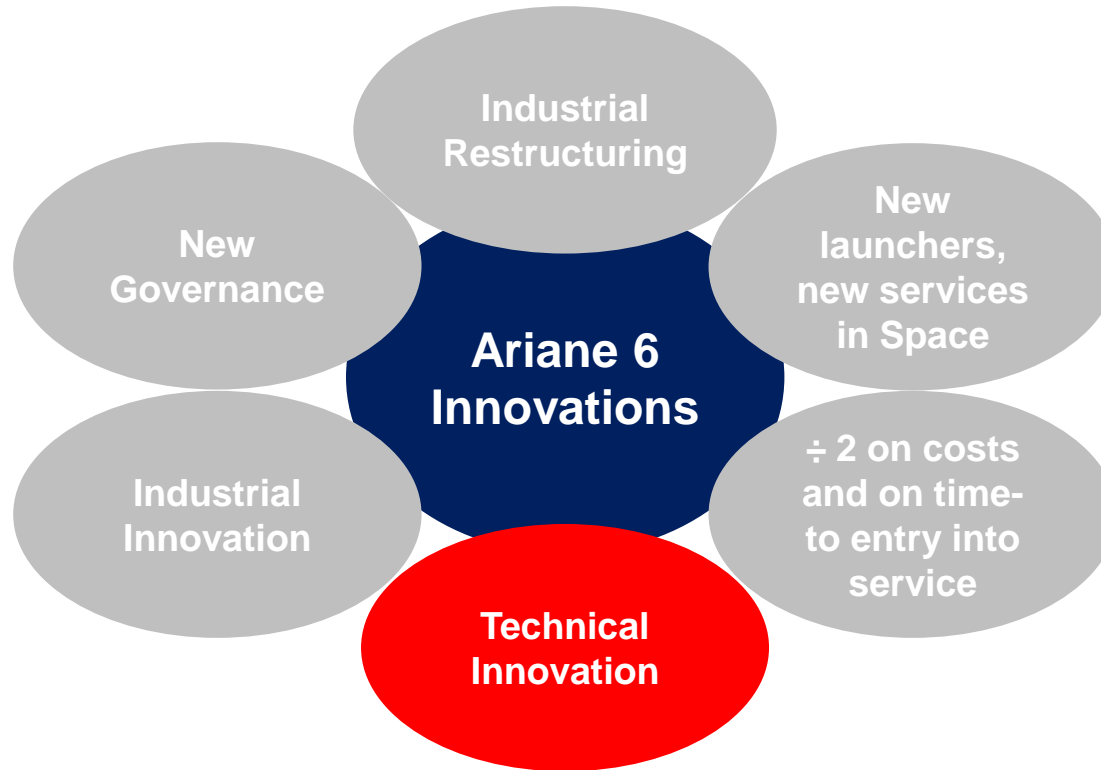


# ARIANE 6 ENGINEERING, HOW WE ARE DOING IT ...



**Each actor of the extended enterprise is involved in one and only one segment**

# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020



# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020

Ariane 6 & VEGA C directly benefit from R&T investments done in the last decade



**P120C**  
-  
World  
largest  
single  
segment  
Solid  
Propellant  
booster

**Simplified  
Nozzle**

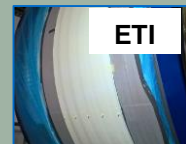
**ALM techno.**



(here on  
Ariane 6 APU)



**Laser Surf.  
Treat.**



**FSW**

**ETI**

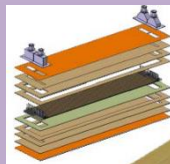
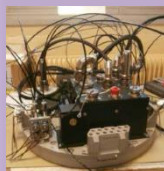
**Vulcain2® engine on P3M**



**Out of Autoclave fairings**

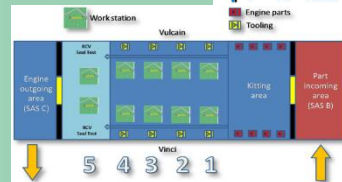


**Opto-pyro**

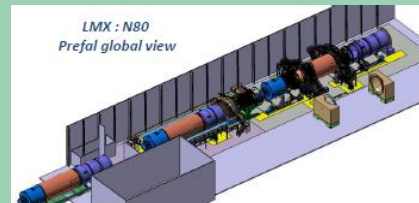


**ESC**

**TTEthernet**



**LMX : N80  
Prefab global view**

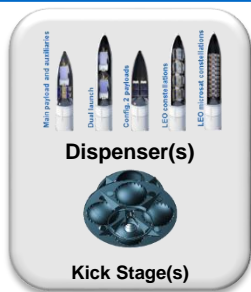


# SPACE TRANSPORTATION TOMORROW ... ... THE EUROPEAN ANSWER IN THE 20'S

A family of innovative dispensers and stages to answer several market needs and improve Ariane 6 market capture

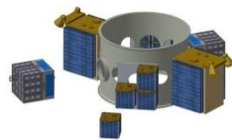
## M/LEO constellation dispatching

- Deploying (big) constellations
- Replenishing in multiple planes
- Galileo 1<sup>st</sup> and 2<sup>nd</sup> generation



## Multi-payload for GTO and GEO

- Dual launch towards GTO
- Transportation of stack of small sats to GEO

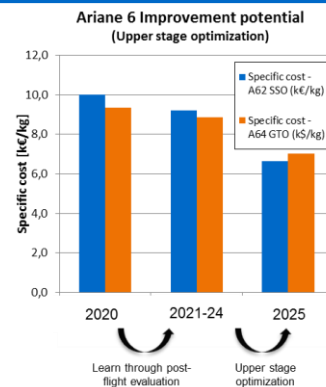


## Enabling complex and long duration missions

- Exploration (lunar and cargo)
- Science missions



Black  
Upper Stage  
on Ariane 6



## PROMETHEUS Engine (for core stage)

- Same thrust level as Vulcain 2
- 10 times cheaper
- Reusable

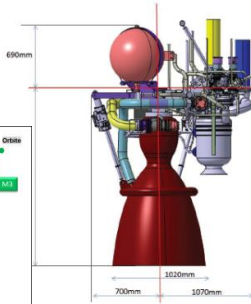
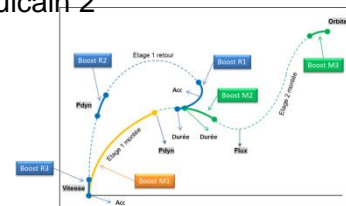
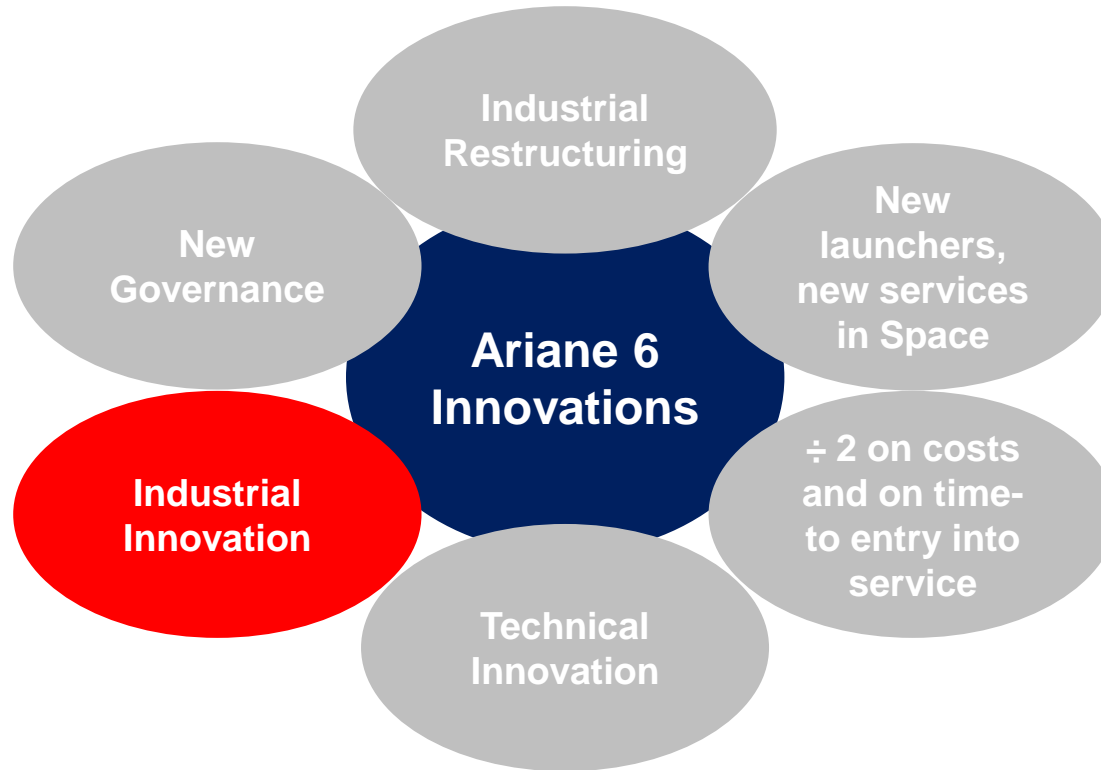


Figure 24 - TARGET engine dimensions

# SPACE TRANSPORTATION TODAY ... ... THE EUROPEAN ANSWER FOR 2020



# BY THE WAY, WHAT ABOUT ELECTRONICS TECHNOLOGIES FOR LAUNCHERS ?

Launchers are not so much demanding for Electronics performance but ...

- **Severe environment**
  - Radiative
  - Mechanical (acceleration, vibrations)
  - Thermal
- **Obsolescences at stake (our cycles are very long ...)**
- **Our objective: decouple design stakes (functional vs environmental) through technology and shorten development and integration duration through full focus on functional aspects (validation on iron birds).**

# AND NOW ... WHAT'S NEXT ?



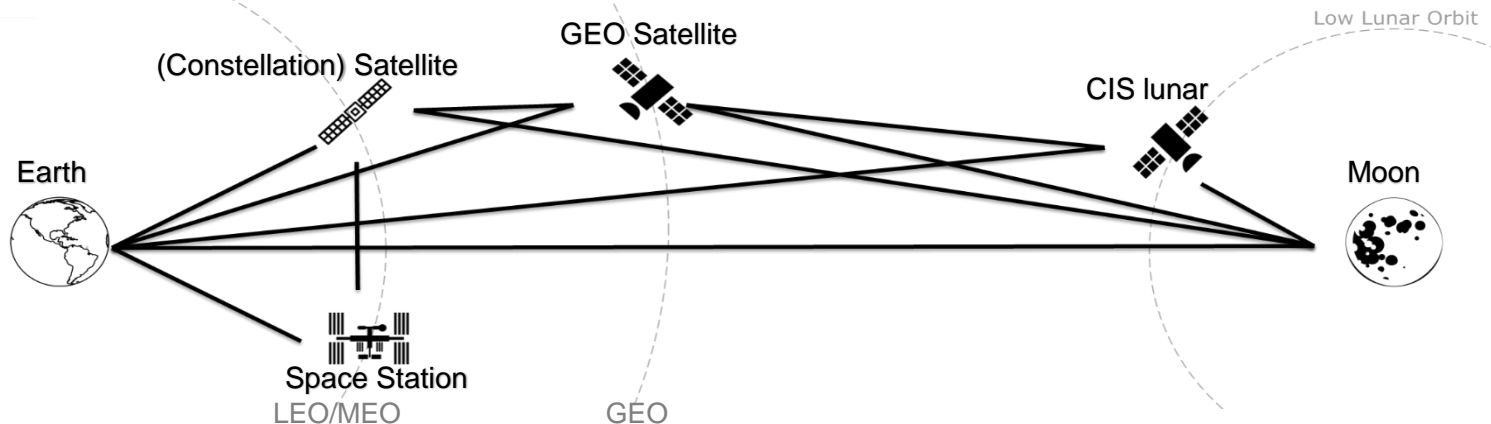
Moon





# OUR PERSPECTIVE: SPACE LOGISTICS CONCEPT & MINDSET

*Address space transportation as a nodes and flows network*



*What main market segments?*

Telecom

Earth Observation

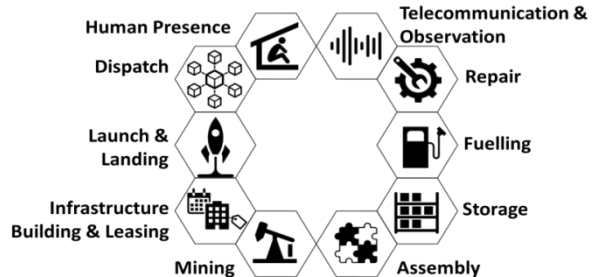
Space Security

Human flight + cargo

Space Production

Mining

*For what activities on the nodes?*



# MARKET EVALUATION USING SCENARIO PLANNING

## GLOBALIZATION “G7 rules”

*At each inflexion point, rich countries (G7) invest in their future and take the ‘best’ decisions. Emerging and poor countries do not implement the necessary changes (structural and institutional).*

## BREAKTHROUGH “Jeff was right”

*Disruption in the cost of access to space, triggering a self-sustaining B2C space economy and dominant level of private investment vs institutional*

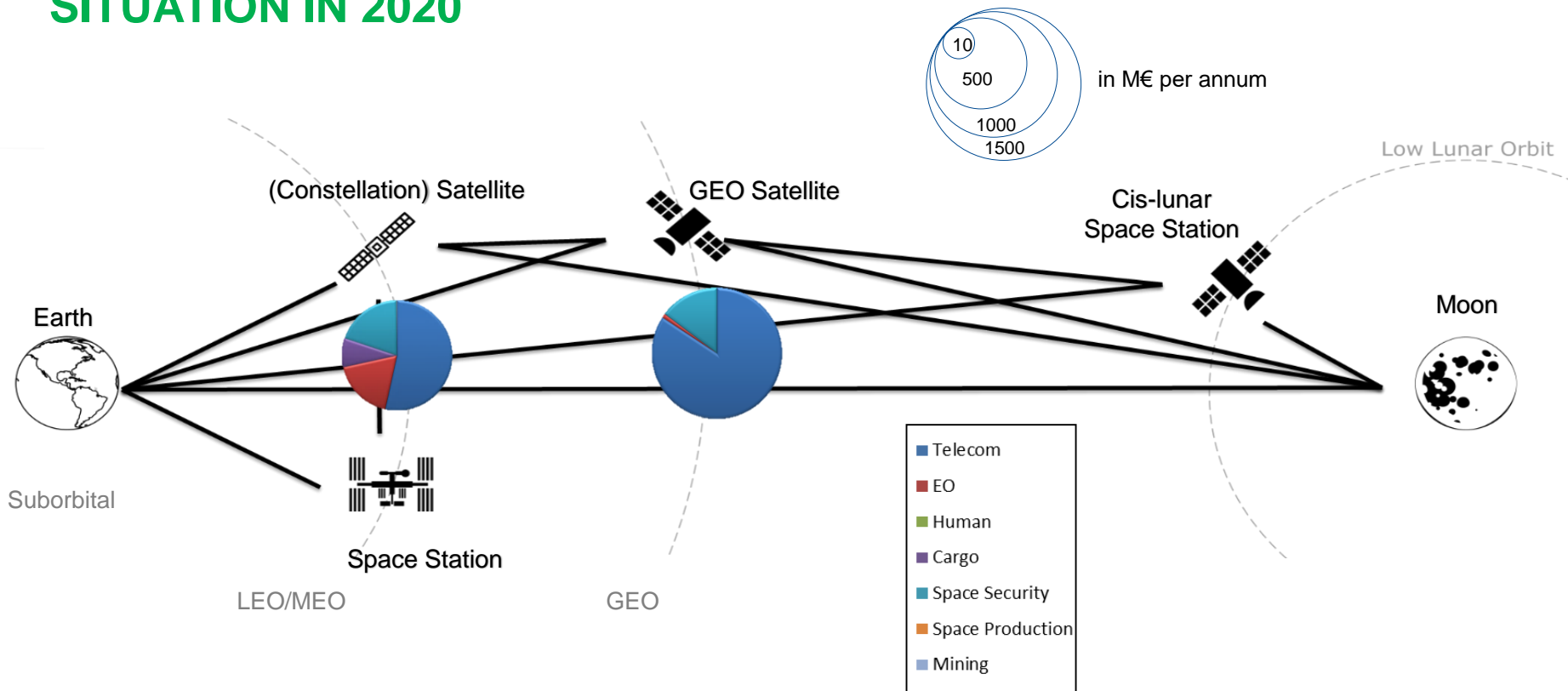
## POWER BLOCKS “Global Neglect”

*At each inflexion point, each country promotes its own interest.*

**Scenarios are a set of ‘extreme’ but coherent futures (2040+), and are quantified with respect to space transportation up to 2035 to support product development robustness assessments**

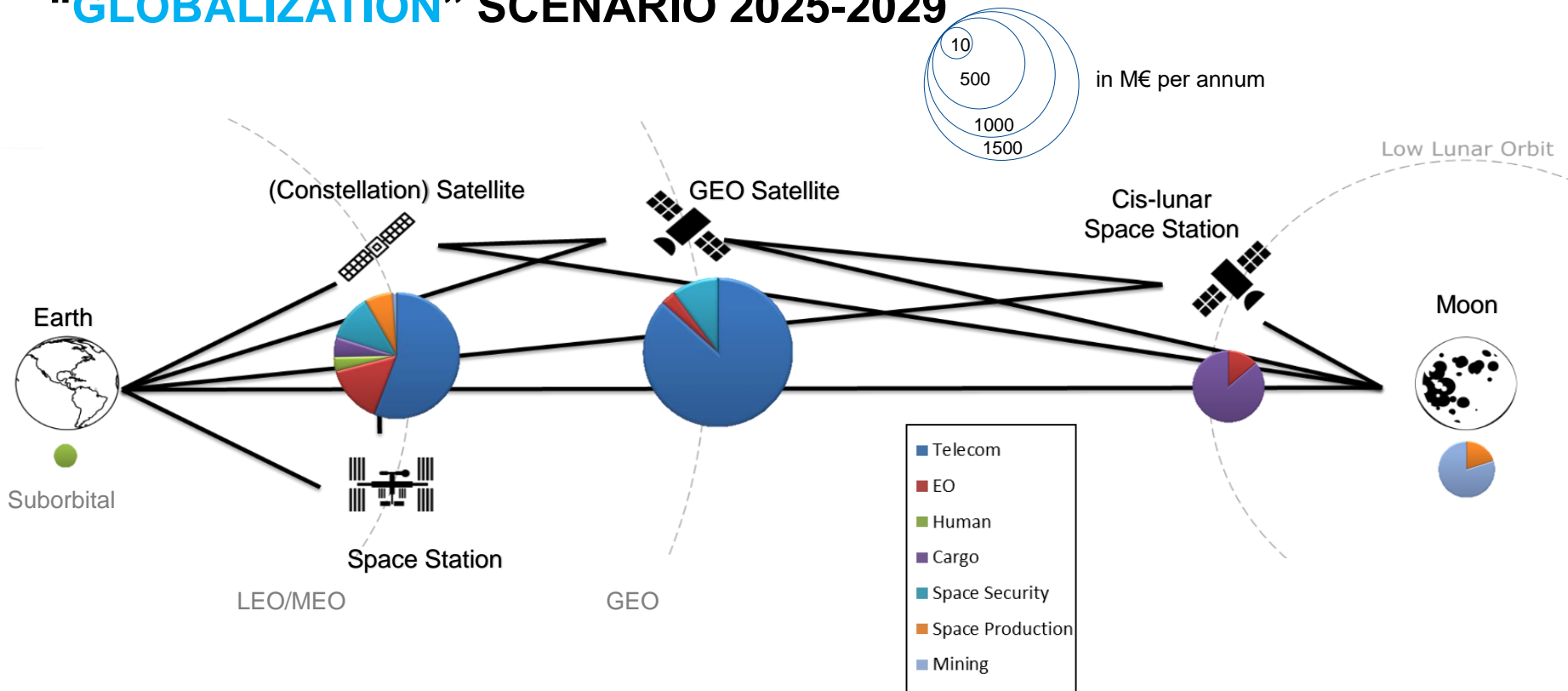
# YEARLY ACCESSIBLE TRANSPORTATION MARKET VALUE

## SITUATION IN 2020



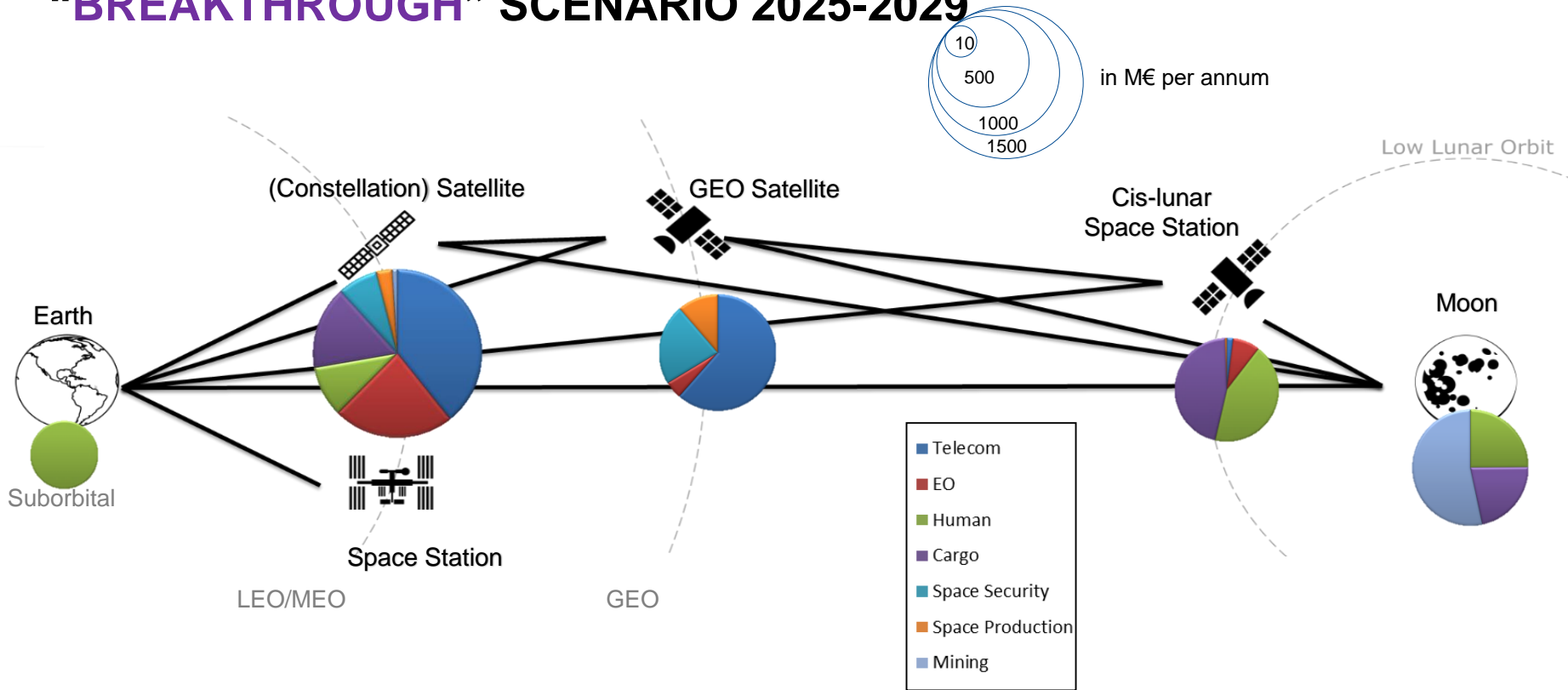
# YEARLY ACCESSIBLE TRANSPORTATION MARKET VALUE

## “GLOBALIZATION” SCENARIO 2025-2029



# YEARLY ACCESSIBLE TRANSPORTATION MARKET VALUE

## “BREAKTHROUGH” SCENARIO 2025-2029



# MAJOR STAKE TO COME ... SPACE SECURITY

2018

~ 1,500  
ACTIVE SATELLITES

~ 23,000  
TRACKED OBJECTS > 10 CM

~ 500,000  
OBJECTS BETWEEN 1 AND 10 CM





# MAJOR STAKE TO COME ... SPACE SECURITY

## 2018



### COLLISION RISKS INCREASE

LOSS OF ASSETS  
GROUND & CITIZEN SECURITY  
DEBRIS INCREASE



# MAJOR STAKE TO COME ... SPACE SECURITY

**X2**  
ACTIVE SATELLITES BY  
**2025**



# OUR PERSPECTIVE ...

« Space, like artificial intelligence or renewable energies, is becoming one of the biggest & most transforming markets of the next 30 years »

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*At each inflexion point, each country promotes its own interest.*

« Space is disrupted and will grow into multi-trillion dollar industry in the next 2 decades »  
Goldman Sachs, March 2017



# HOW WE SEE ARIANEGROUP IN 2025

## ENABLING ACCESS TO SPACE

The versatility of Ariane 6 will provide Access to Space serving any mission to any orbit. ArianeGroup will be part of new exploration programs through high-value Products, Equipment and Services.

ArianeGroup will focus on its customers' needs and expectations, with a global industrial and commercial footprint.

## ENABLING GLOBAL STABILITY ON EARTH

M51 and its evolutions will remain core activities for ArianeGroup, enabling the development of major disruptive technologies.

## PREPARING THE FUTURE

ArianeGroup is preparing the building blocks for next new-generation, reusable and versatile launch vehicles.

## ENABLING SECURITY IN SPACE

The success of the Space Traffic Management system enables Security in Space and Space Business development.



**Thank you  
for your  
attention !**