



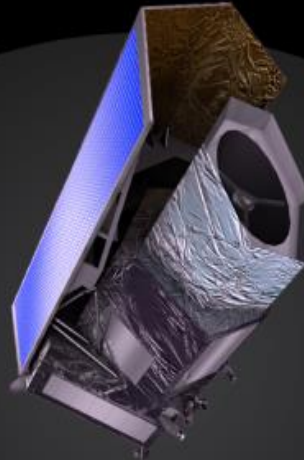
**Technical (R) Evolutions in Launchers**  
**Jean-Marc ASTORG Director of Launchers**  
**CNES, Paris, France**  
**ESPI Autumn Conference, September 2015**

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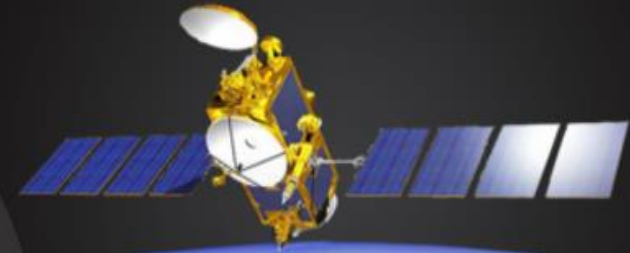
## 5 Fields of activity

**Ariane**

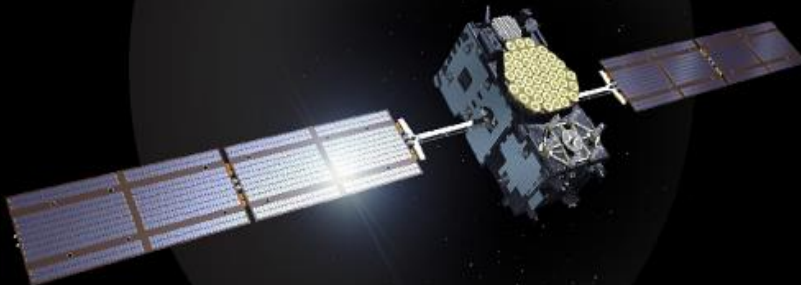


**Science**

**Observation**



**Telecommunications**

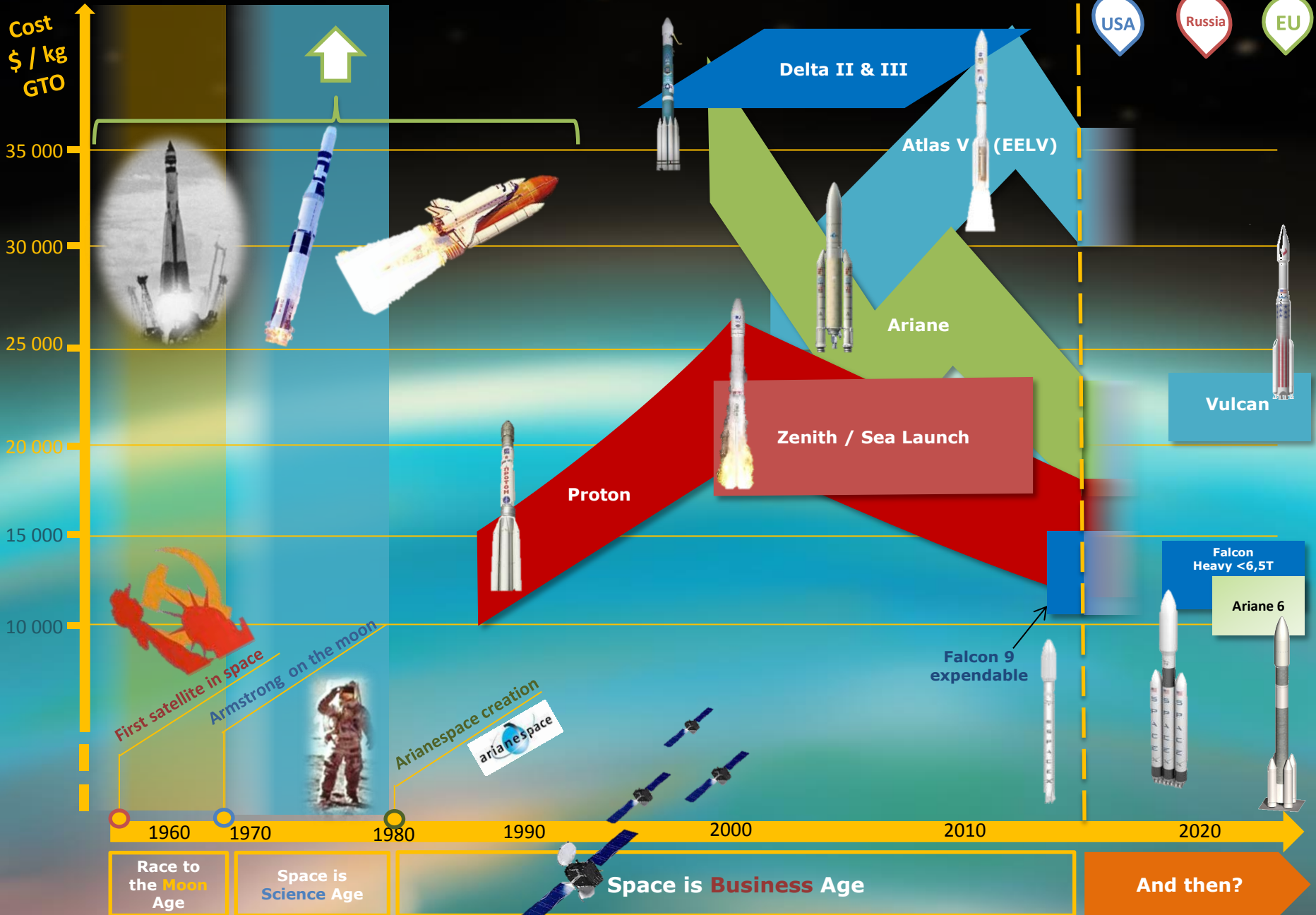


**Defence**



# The cost of access to space over history - GTO

\$ in EC 2015  
kg GTO in [GTO+1500 m/s]



## Europe Launchers Fleet

1.5 t (SSO)



# Vega

3 t (GTO)



# Soyuz

at CSG

10 t (GTO)



# Ariane 5

# ARIANE 5: 67 success in a row

4 systems, 4 missions

## Ariane 5 ES

Launches the ATV to resupply the International Space Station: up to 21t into LEO



## Vega

Launches small satellites up to 2,5t into low or polar orbits



## Soyuz at the CSG

Launches intermediate payloads from 3t into GTO to 4.5t into SSO

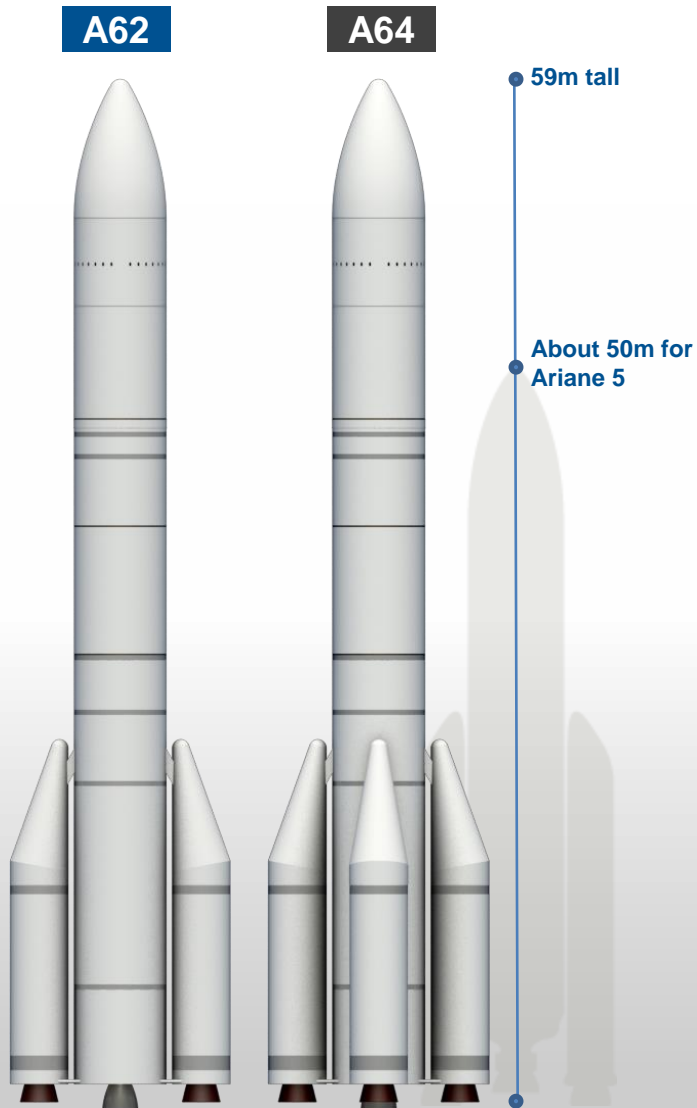


## Ariane 5 ECA

Launches heavy payloads up to 10t into GTO



# ARIANE 6



## Basics

- Decided in December 2014
- A revolution in the manufacturing process
- A new governance

## Performance

	A62		A64
	GTO (Zp=250km)	SSO	GTO (Zp=180km)
HLRs	≥ 5t net	≥4.5t net	≥10.5t

**Maiden launch: 2020**

**Fully operational: 2023**

**Planned launch rate: five A62s and six A64s per year, including five institutional satellites**

# ARIANE 6: THE A62 AND A64 DESIGN CONCEPTS



2 P120s



A62 (5 t into GTO)  
€70 million



4 P120s



A64 (10.5 t into GTO)  
€90-100 million



# HOW TO REDUCE A6 COSTS ?

A5

A5 & VEGA-C use the same SRM



**Launch rate effect:**

A62+A64: 11/yr  
P120 : 35/yr - Vinci & Vulcain :11/yr  
Tank: 11/ yr - etc.

~-20%

**Design and processes**

H150 - SRM - SEL -V2.1 + GOX, etc.

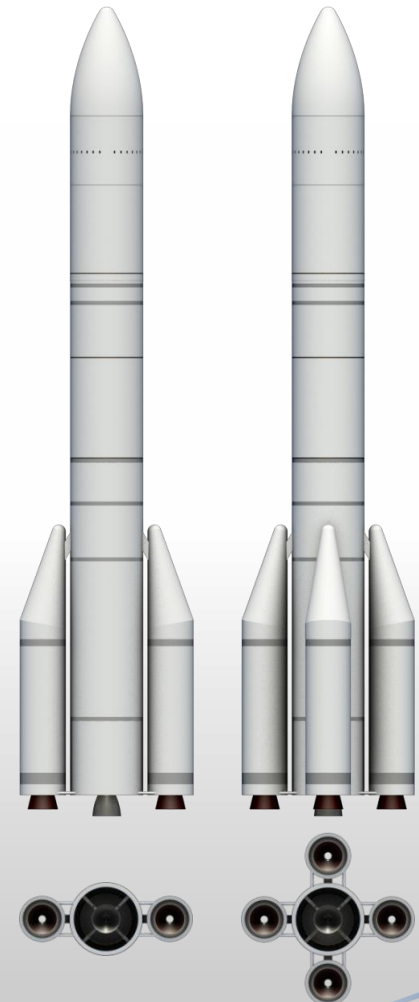
~-20%

**Launch operations**

~-10%

A62

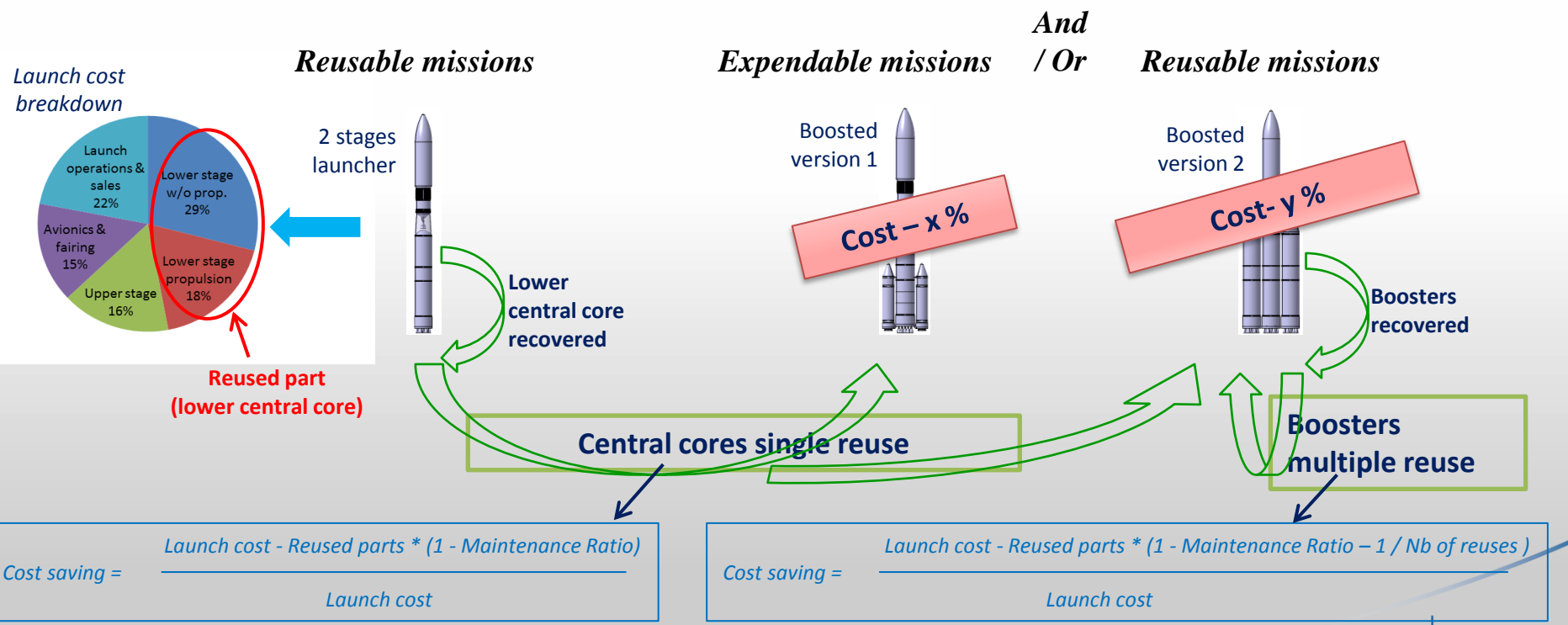
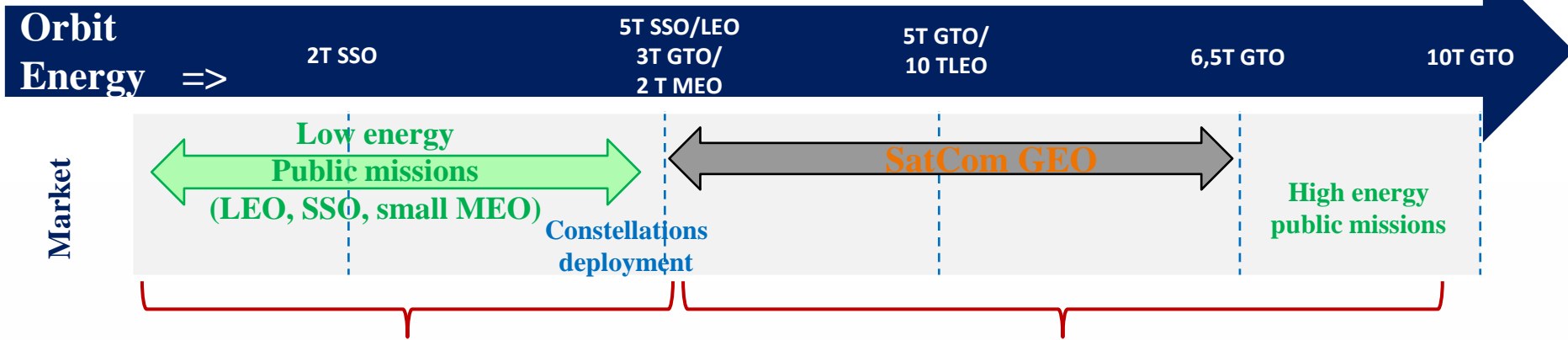
A64



## REUSABLE LAUNCHERS: A WAY TO REDUCE COSTS ?

- Up to now, reusable launchers have been more expensive than expendable
- Reusability is practically limited on the first stage or first stage propulsion module, which represents only a fraction of the total vehicle cost (< 50% for a TSTO)
- Key parameters for cost savings with reusable launchers are:
  - ◆ Operations costs: recovery, refurbishments
  - ◆ Recovery reliability (loss of vehicle)

# A reusability possible scheme ?

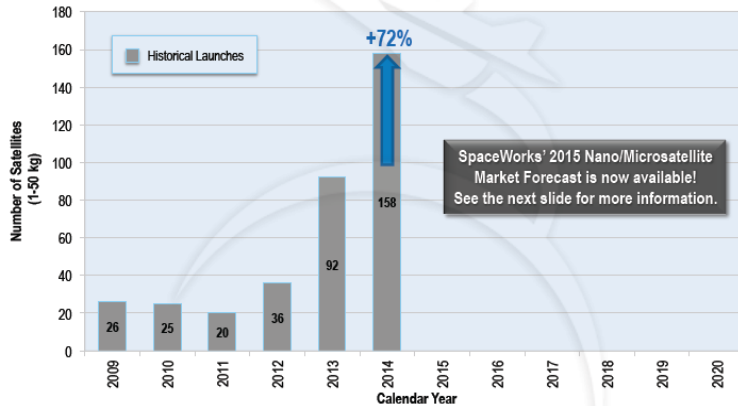


# Exciting smallsat dynamic

## SIZE DOES MATTER

### Nano/Microsatellite Launch History (1 - 50 kg)

The nano/microsatellite industry continues to thrive, with 158 satellites launched last year



Credit: SpaceWorks 2015

Some satellites are multiple-manifested (i.e. more than one satellite co-manifested on a particular launch vehicle).

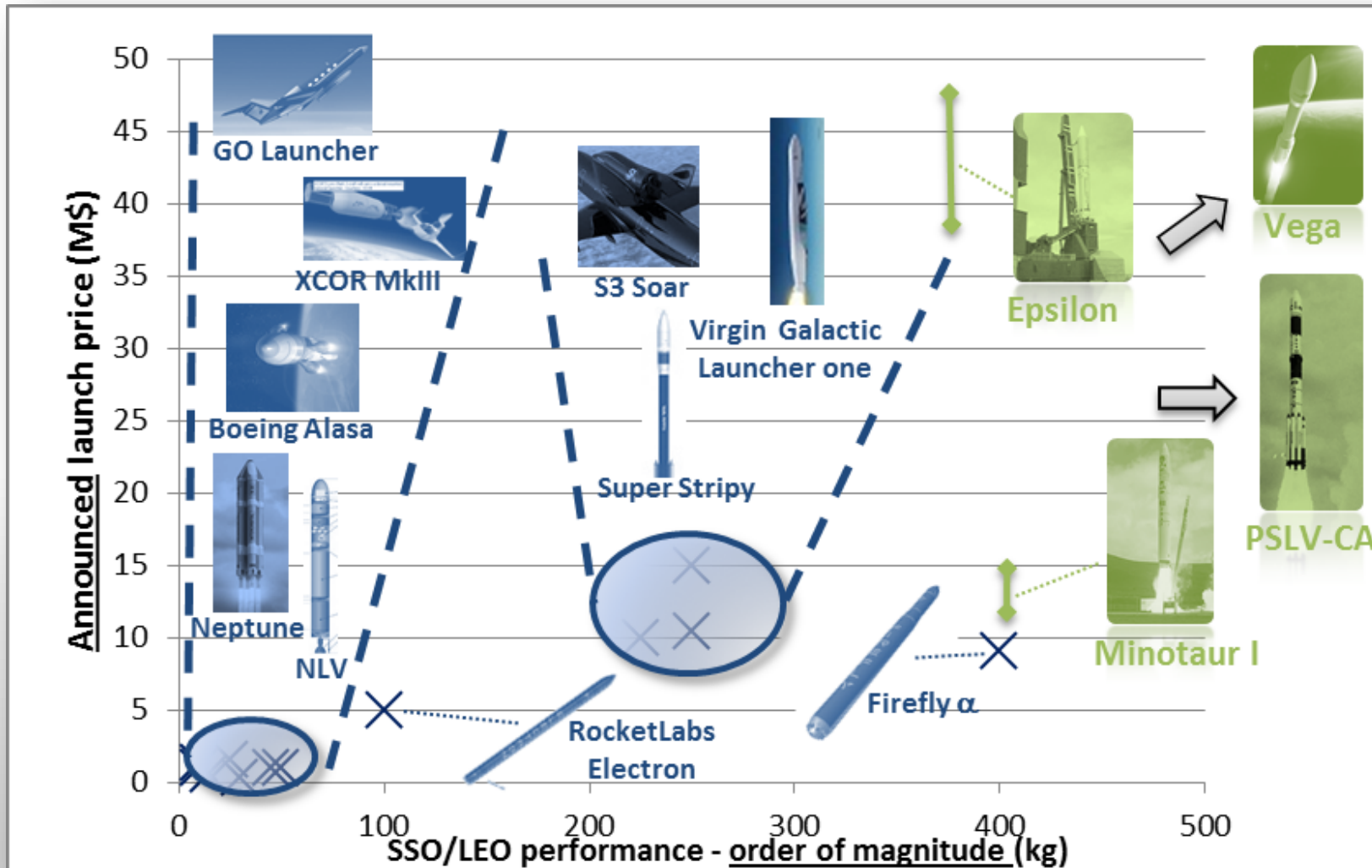
Significant trend supported by emerging commercial applications...

...that remains hampered by the lack of adequate launch solutions & opportunities



# Many contenders (none flying yet)..

## ...AND OPPORTUNITIES FOR EUROPE BY 2020 ?



# CONCLUSIONS

- Ariane 6: a revolution in manufacturing launchers in Europe in order to reach less than 10 k€/kg in GTO in 2020.
- Further cost reduction by:
  - ◆ new engines for all stages (LOX/CH<sub>4</sub> ?)
  - ◆ reusability ?
- Small launchers (hard) requirement: 3 M€ to launch 50 kg on LEO !