



arianeGROUP

SHAPING THE FUTURE OF ACCESS TO SPACE



























#spaceenablers

IC3, Arcachon, 04-06.06.2018

Jean-Luc Macret, R&T Senior Manager

MORE THAN 25 LAUNCH SERVICE OFFERS !!!










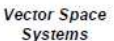




HEAVY LAUNCHERS

												
Ariane 5 ECA	Ariane 64	Falcon 9 (R)	Falcon Heavy (R)	Proton M	Angara A5	Atlas V	Vulcan	CZ 7	H-3	GSLV MK3	New Glenn	NGL
												

SMALL LAUNCHERS

							
Vega	Rocket	Vega- C	PSLV XL	Angara 1.2	Epsilon	KSLV 2	Long March 6
							

MICRO LAUNCHERS

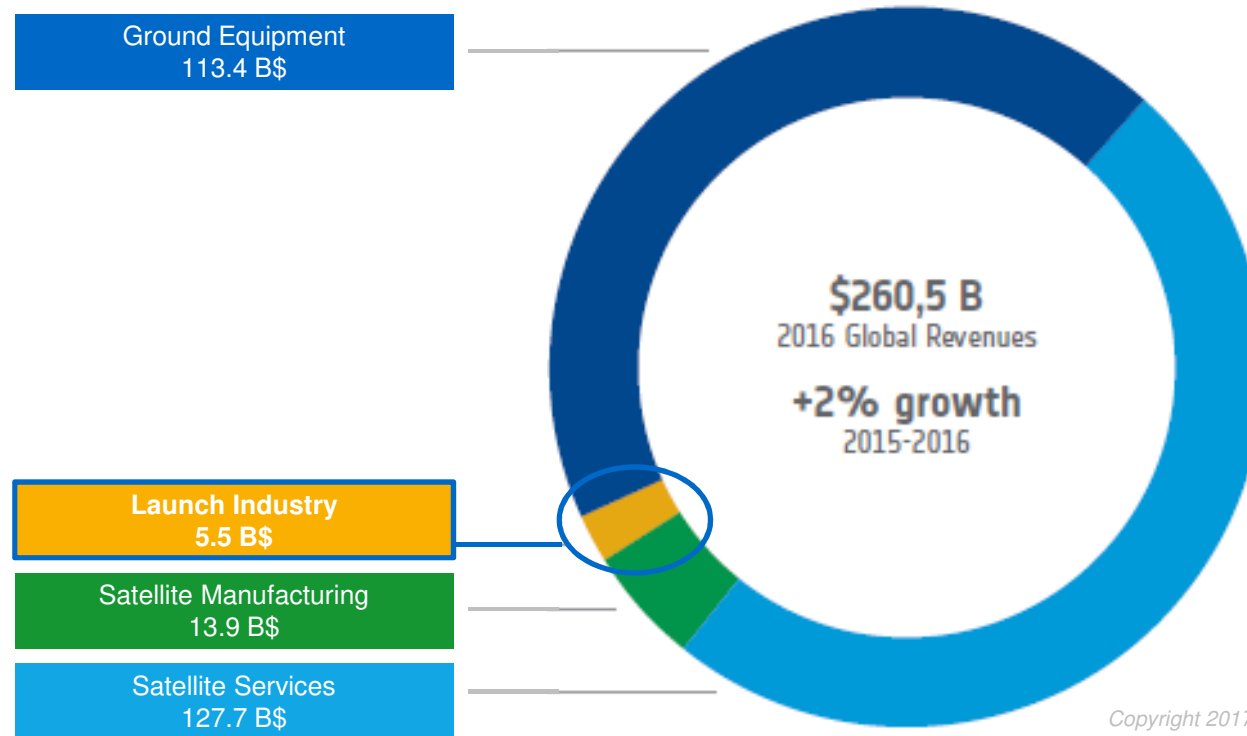
						
Electron	LauncherOne	Vector- H	Kz-1A	Vega-C light	PSLV / Falcon 9 / Soyuz	PSLV / Soyuz / Long March
						



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LAUNCH SERVICES: KEY FOR SATELLITE SERVICE MARKET

But limited part of the required investment



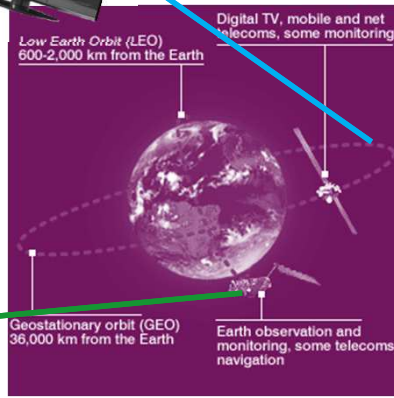
MARKET EVOLUTION: A VERY LIKELY MAJOR CHANGE

GEO market down cycle
 Main operators delaying their satellite orders
 → Annual rhythm of 15 sats per year only

Constellation market boom
 Mainly 2 commercial drivers

- Broadband Internet Access for 5G
- Quick revisit Earth Observation

Projects booming
 133 constellations identified
 27074 satellites still to be launched



MARKET NEEDS:
 GEO SATCOMS
 EUROPEAN INSTITUTIONAL MISSIONS
 SMALLSAT RIDESHARE
 QUICK CONSTELLATION DEPLOYMENT



EUROPEAN SPACE AGENCY OBJECTIVES

⇒ TO GUARANTEE INDEPENDENT, RELIABLE, AVAILABLE AND COMPETITIVE LAUNCH SERVICES FROM EUROPEAN TERRITORY FOR EUROPEAN INSTITUTIONAL MISSIONS

⇒ TO ENHANCE THE COMPETITIVENESS OF A EUROPEAN SPACE TRANSPORTATION SECTOR LEADING THE DELIVERY OF PREMIUM LAUNCH SYSTEMS AND SERVICES

⇒ TO DEVELOP THE TECHNOLOGICAL BUILDING BLOCKS FOR SPACE TRANSPORTATION SYSTEMS AND SERVICES BEYOND 2030.

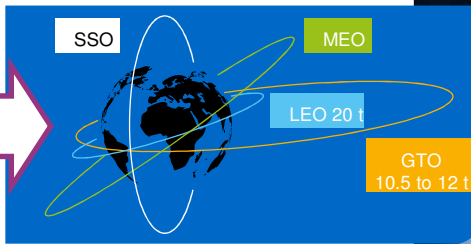
ARIANE, THE EUROPEAN HEAVY LAUNCHER ADAPTATION TO SHORT TERM MARKET NEEDS



ARIANE 5
THE
BENCHMARK

ARIANE 6
MAXIMUM INDUSTRIAL
EFFICIENCY
COMPETITIVE
LAUNCH PRICE

UP TO **10.5 t**
TO
GEOSTATIONARY
TRANSFER ORBIT
(GTO)



UNINTERRUPTED SUCCESS
SINCE
2003

FIRST FLIGHT
2020



© ESA-CNES-ARIANESPACE/Optique Vidéo du CSG

LAUNCHERS ADAPTATION BEYOND 2020

➔ NO CLEAR MARKET TREND

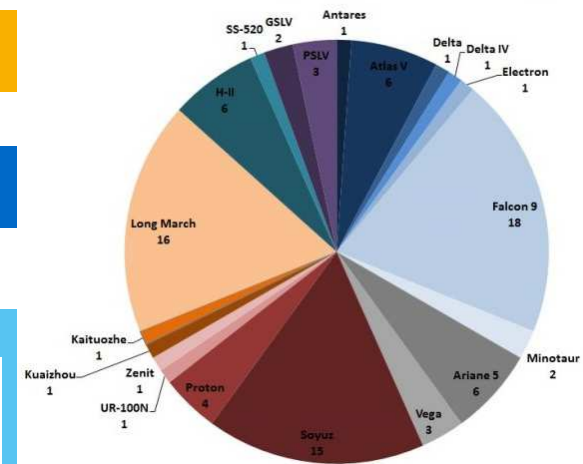
➔ NO MASS PRODUCTION: MAX 50 LAUNCHES/YEAR/LAUNCHER.

➔ MASTERING PRODUCTION OVER LONG PERIODS:
 ARIANE 5: 1996-2020+
 ARIANE 1-4: 1979-1999
 SOYUZ-U: 1973-2017
 PROTON-K: 1967-2012





➔ ADAPTATION TO GLOBAL INDUSTRY TECHNOLOGY STEPS
 COMPOSITE/METALLIC MATERIALS & PROCESSES
 COMPUTERS & ELECTRONICS
 ENVIRONMENTAL REGULATIONS
 ➔ "NOT IN THE DRIVING SEAT"

Launch Attempts by Launcher Family



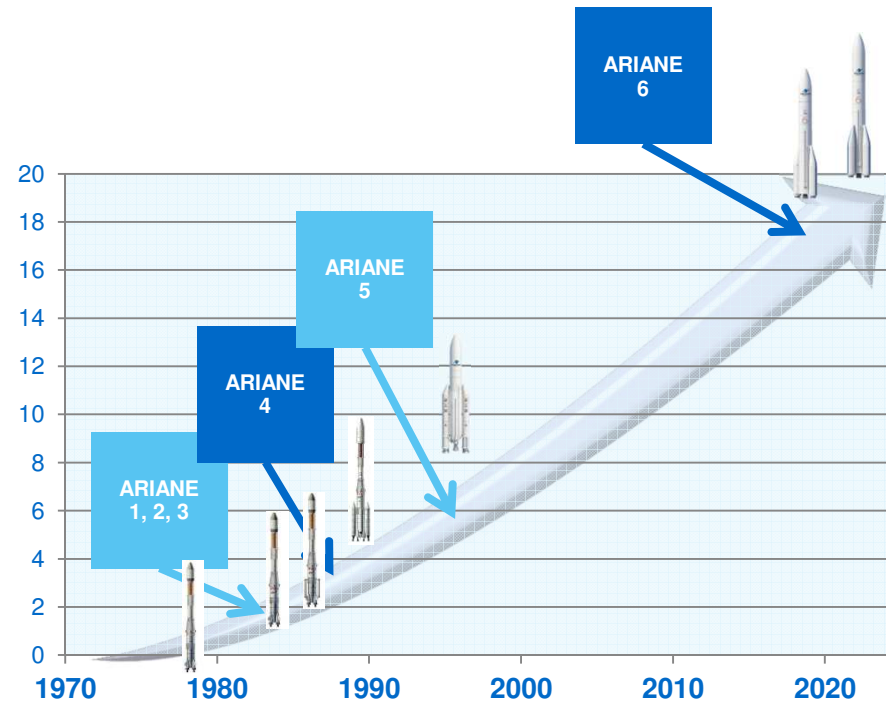
From <http://spaceflight101.com/>

Ariane 1	Ariane 6
	
8080 2MHz 64 kB	ARM V8R 2GHz 2GB

INNOVATIONS IN EVERY DOMAIN: A KEY FOR FUTURE

- ⇒ CONCEPT
- ⇒ PROPULSION
- ⇒ MATERIALS & STRUCTURES
- ⇒ AVIONICS
- ⇒ ASSEMBLY & INTEGRATION
- ⇒ OPERATIONS

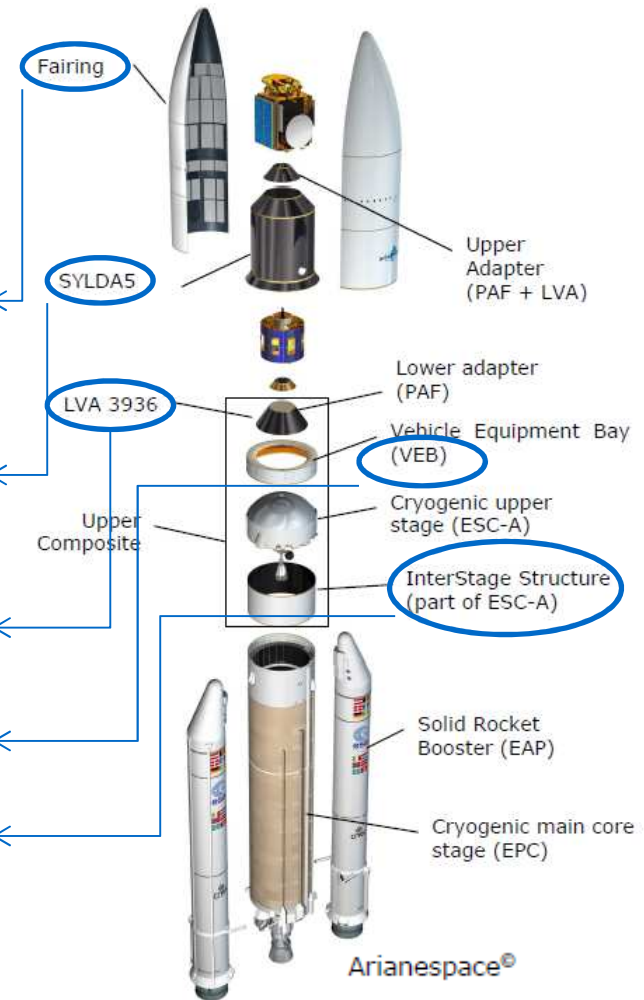
COMPOSITE STRUCTURES IN LAUNCHER HISTORY



ARIANE 5 COMPOSITE STRUCTURES

LAUNCHER PERFORMANCE
UPPER STAGE
EXCHANGE RATIO 1:1

PAYLOAD FAIRING	
Diameter	5.4 m
Height	17 m
Mass	2675 kq
Structure	Two halves - Sandwich CFRP sheets and aluminium honeycomb core
SYLDA5	
Diameter	4.56 m
Height	Total height of standard version: 4.903 m Adjustable cylinder height : +0.3/+0.6/+0.9/+1.2/+1.5/+2.1 m w.r.t. standard
Mass	From 425 to 535 kq, depending on height
Structure	Sandwich CFRP sheets and aluminium honeycomb core
CONE 3936 or LVA 3936	
Height	783 or 1187 mm
Mass	200 or 170 kg
Structure	Monolithic CFRP cone and glass fiber membrane
VEB	
Structure	Sandwich CFRP sheets and aluminium honeycomb core
Avionics	Flight control, flight termination, power distribution and telemetry subsystems
Inter Stage Structure (ISS)	
Structure	Sandwich CFRP sheets and aluminium honeycomb core



ARIANE 6 COMPOSITE STRUCTURES

COST OPTIMIZATION

ADVANCED MANUFACTURING TECHNIQUES

PERFORMANCE AND COST OPTIMIZATION

ADVANCED MANUFACTURING TECHNIQUES

PAYLOAD FAIRING
Out-of-autoclave process

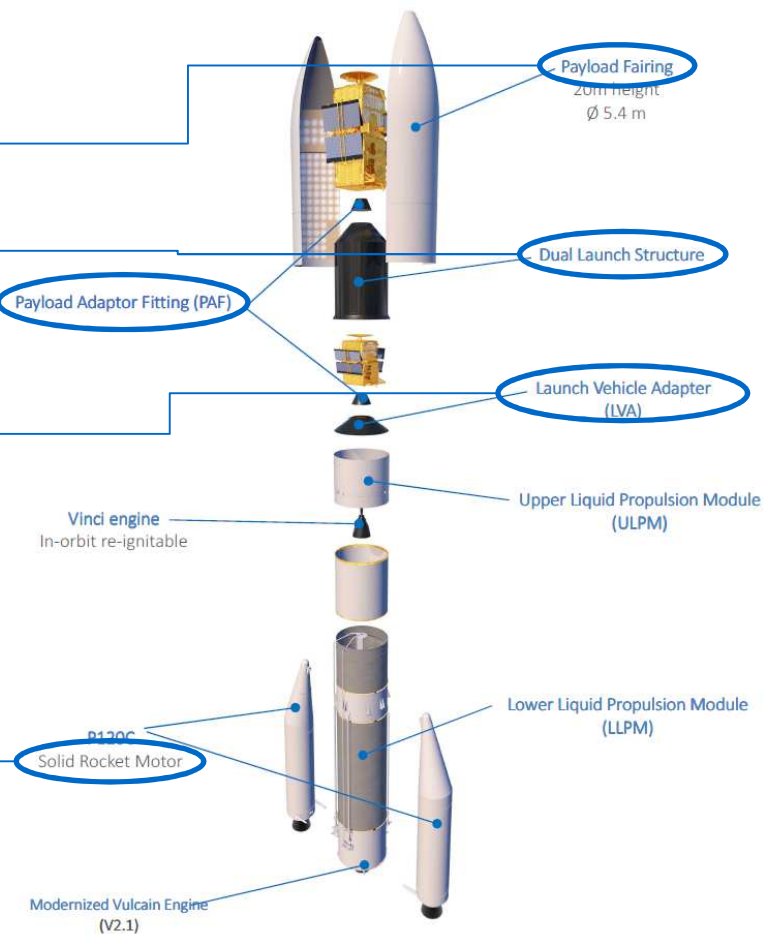
DUAL LAUNCH STRUCTURE
Automated fiber placement process

PAYLOAD ADAPTOR FITTING
Automated fiber placement process

LAUNCH VEHICLE ADAPTER
Automated fiber placement process

NEW

SOLID ROCKET MOTOR
Motor length: 11,7 m
Diameter: 3,4 m
Motor case mass: 8300 kg
Filament winding process



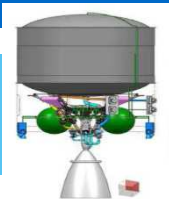
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ARIANE BEYOND 2020: THE WAY FORWARD

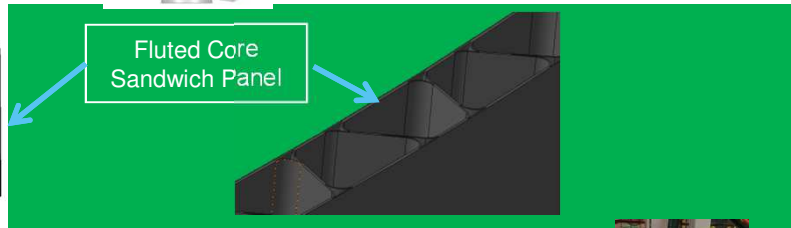
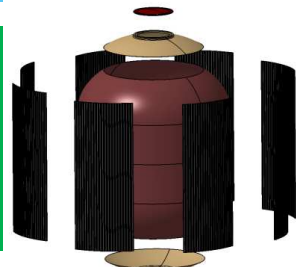
➔ EVOLUTION: ARIANE 6 TO **ARIANE 6 2025:**
COST & PERFORMANCE OPTIMIZATION
TRL>4



➔ CONCEPT
 OPTIMIZED ARCHITECTURE FOR UPPER STAGE



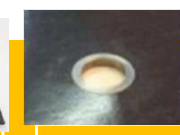
➔ CRYO COMPOSITE TANKS
 MASS SAVINGS > 30 %



➔ INNOVATIVE ASSEMBLY
 COST SAVINGS > 30 %



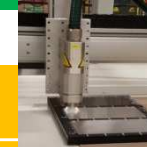
HYPERJOINTS



EXPANDED BONDED BUSHINGS



LASER ABLATION ON COMPOSITE



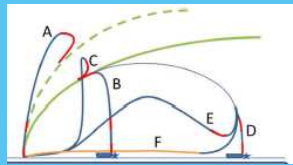
ATMOSPHERIC PRESSURE PLASMA ON COMPOSITE

ARIANE BEYOND 2020: THE WAY FORWARD

➔ **BREAKTHROUGH: ARIANE 6 2025 TO **ARIANE 2030****
TARGET COST -50% VS A6
TECHNOLOGIES TRL>3



➔ **CONCEPT:**
REUSABLE VS EXPENDABLE:
WHAT IS THE RIGHT BUSINESS CASE ?

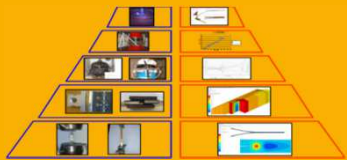
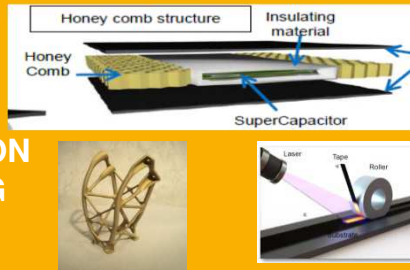


ARIANE BEYOND 2020: THE WAY FORWARD

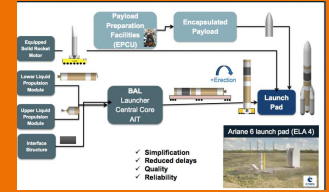
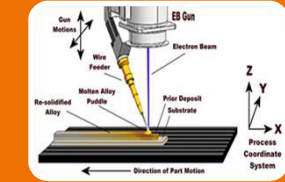
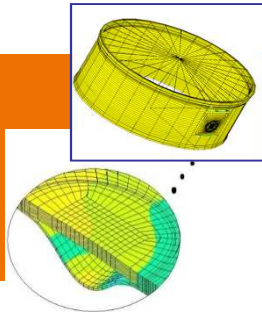
➔ **BREAKTHROUGH: ARIANE 6 2025 TO ARIANE 2030**
TARGET COST -50% VS A6
TRL>3



➔ **STRUCTURES:**
MULTIFUNCTIONS STRUCTURES
IMPROVED STRUCTURAL DESIGN PROCESS
 ➔ **BIO MIMESIS – TOPOLOGY OPTIMIZATION**
 ➔ **MANUFACTURING PROCESS MODELING**
 ➔ **VIRTUAL TESTING**



➔ **DIGITAL FACTORY :**
VIRTUAL MANUFACTURING
REAL TIME PROCESS MONITORING
INTEGRATED TESTING FUNCTIONS
QUICK OPERATIONS



INNOVATIVE TECHNOLOGIES - ARIANE 2030

STRUCTURAL DESIGN
IMPROVED & COST EFFECTIVE METHOD

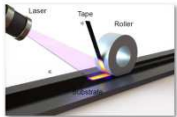
ADVANCED PRE-DESIGN OPTIMIZATION METHODS

IMPROVED FAILURE CRITERIA AND DESIGN ALLOWABLES

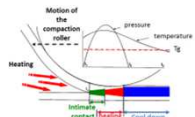
ADVANCED DAMAGE MODELLING AND VIRTUAL TESTING

MANUFACTURING
IMPROVED & COST EFFECTIVE METHOD

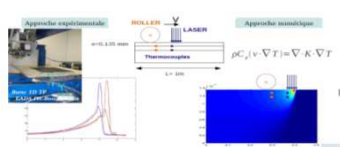
PROCESS SIMULATION



KEY PARAMETERS CYCLE DEFINITION CRITICAL DEFECTS

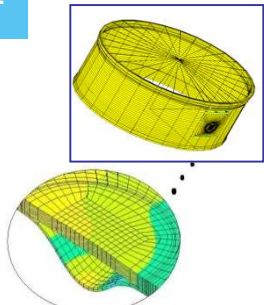


REAL TIME PROCESS MONITORING

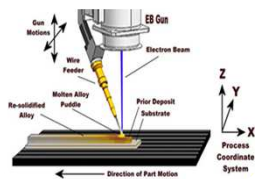


VIRTUAL PLATFORM
INTEGRATED DEVELOPMENT CYCLE

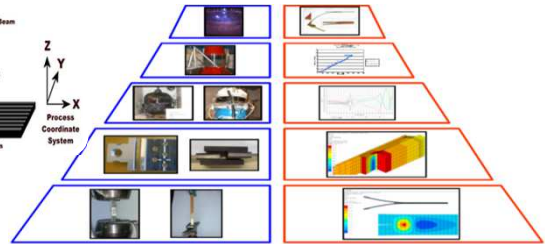
CAD/DMU



VIRTUAL MANUFACTURING

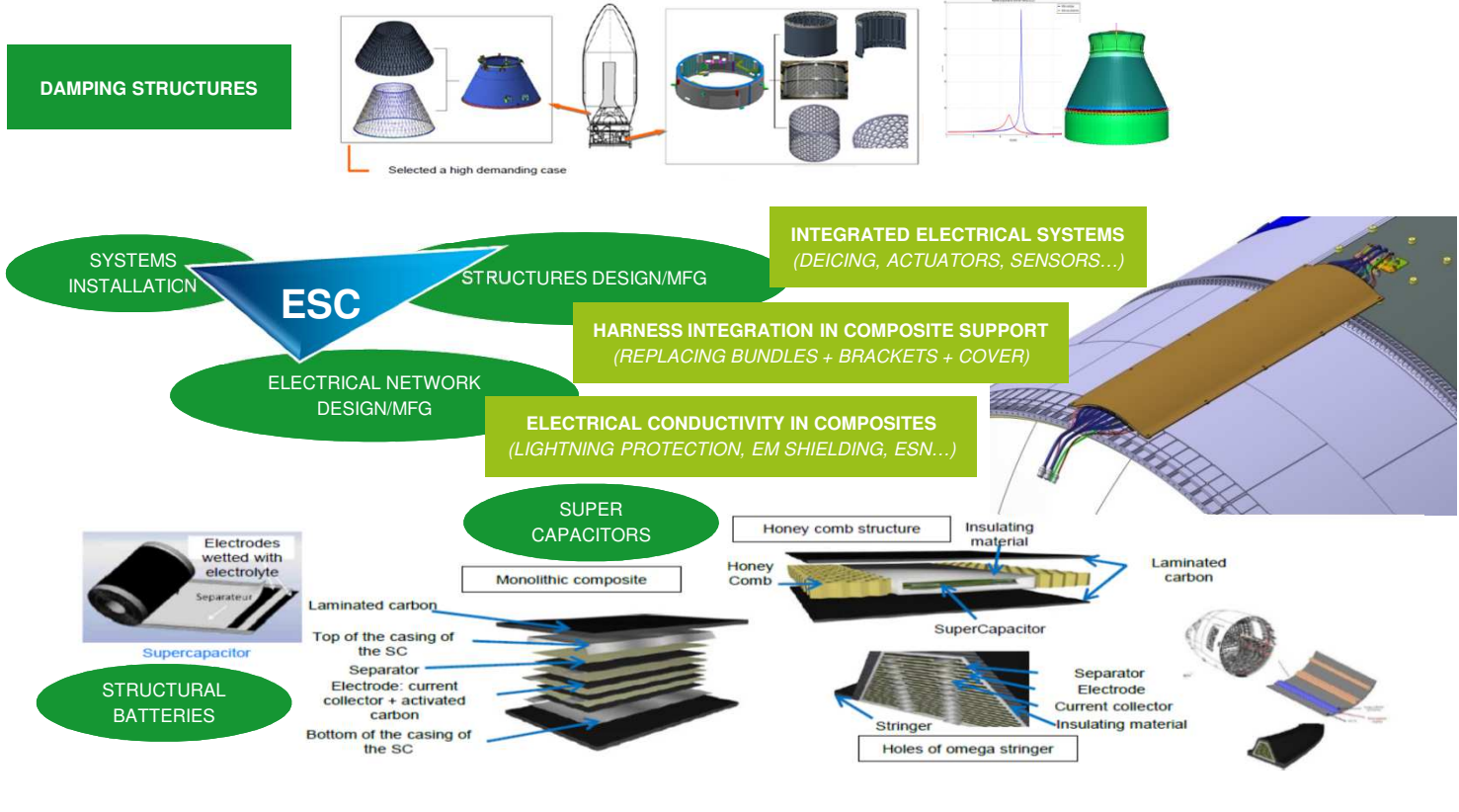


VIRTUAL TESTING



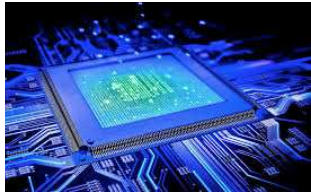
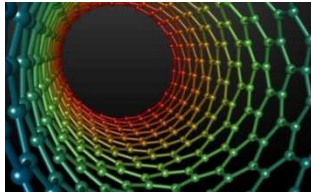
INNOVATIVE TECHNOLOGIES – ARIANE 2030

INNOVATIVE DESIGN
THANKS TO COMPOSITE
CAPABILITIES



FUNCTIONALIZED
STRUCTURES

WE HAVE TO CONSIDER INNOVATIVE TECHNOLOGIES WITHIN THE TECHNOLOGICAL REVOLUTION



NBIC, The alphabet of the technological revolution

N for “Nanotechnologies”

B for “Biotechnologies”

I for “Information technologies”

C for “Cognitive sciences”

AVOIDING THE “NOT INVENTED HERE” SYNDROME

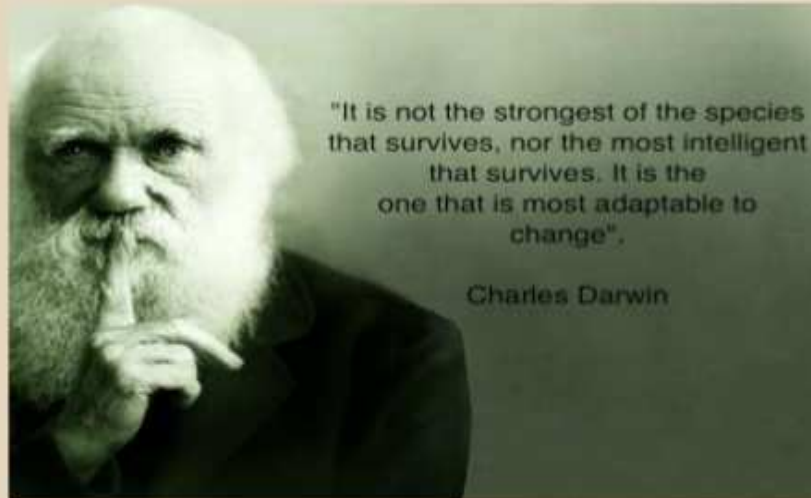
⇒ INNOVATIONS EXPECTED FROM ANYWHERE

⇒ LABS AND RESEARCH ORGANIZATIONS

⇒ SMEs & START-UPS

⇒ INDUSTRIAL PARTNERS

CHARLES DARWIN QUOTE



THANK YOU FOR YOUR ATTENTION !

#spaceenablers