ESA Space Transportation Proposal for CM-22

BELSPO Info Day

S. Bianchi - ESA/STS

30 September 2022

Space Transportation CM-22 preparation

European transportation model built on

- Access to > **new capabilities**
- Transport in & return from space > **demonstrated**
- **More** transportation **services**

Stabilise market introduction of Ariane 6 and Vega C

Prepare an innovative, competitive and scalable European space transportation sector

Space Transportation - Forward strategy

Aim: build a European Space Transportation model at a horizon 2030 and beyond serving efficiently Europe's ambition in space, based on 4 principles:

1/ **sovereignty for Europe:** continuous and resilient European gateway to space, a prerequisite for any space power;

2/ **flexibility to match Europe's ambition:** robust and scalable access to space for reliable deployment & refurbishment of space infrastructure.

3/ **environmental sustainability**: reduce by 50% the carbon footprint by 2030 over the whole value chain of launch vehicles, CSG and test facilities.

4/ **cost efficiency**: competitive procurements & simplification of the architecture at system level are key drivers.

> Availability of scalable European capabilities at the 2030 horizon require decisions at CM22!

> New European model to be decided by Member States once both Vega C and Ariane 6 operational.

Draft STS long-term roadmap – *Work in progress!*

...	2020	2021	2022	2023	2024	2025	...

CM-19 **CM-22** **CM-25**

Astris Kickstage

A6 Enhancements

Vega C Maiden Flight

A6 Maiden Flight

Space Rider Maiden Flight

Rapid in-flight demonstration

Technology Maturation

Space Exploration Inspirator
Human Space Transportation

Vega-E maiden flight

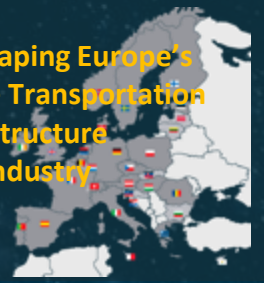
Themis Demonstrator

Prometheus Engine

M10 Engine

Future Proofing Europe's Spaceport

Re-shaping Europe's Space Transportation Infrastructure and Industry



European Next Generation Launcher

CM-22 Proposals
- Ariane 6, Vega C/E
- Future Preparation
- Space Rider
- Infrastructure

CM-25 Proposals (indicative)
- Next Generation Launcher
- Human Space Transportation

ESA Space Transportation CM-22
The 4 pillars of CM-22 proposal

BELSPO Info Day

Overview of Financial Proposal to CM22: 3231 M€

Pillar I. Ariane and Vega

- Ariane 6 405 M€
- P120C+ 202 M€
- Vega 505 M€
- Transition 195 M€
- Exploitation 493 M€
  - *Ariane: 302 M€*
  - *Vega: 91 M€*

Total 1700 M€

Pillar II. Future preparation

- Boost! 140 M€
- FLPP 668 M€
- *Technology disruptors &space logistics 116 M€*
- *Prometheus 230 M€*
- *Themis reusability 212 M€*
- *Reusable upper stage 80 M€*
- *Human Space Transport 30 M€*

Total 828 M€

Pillar III. Space Rider

- Completion & Services Improvements 100 M€
- Evolution 10 M€

Total 110 M€

Pillar IV. Infrastructure

- CSG 2023-2027 593 M€
  - *Reference MCO 485 M€*
  - *Flexible, digital, sustainable 69 M€*
  - *Core Launch Range Renewal (CLRR) 39 M€*

Total 593 M€

Freedom of action

Growth & Competitiveness

ESA Space Transportation CM-22
Pillar I – Ariane & Vega

BELSPO Info Day

I. Ariane 6 and Vega

Programme Proposal Elements

- ❑ Ariane 6 Element
  - Ariane 6 product adaptation
  - Ariane 6 transition
  - Ariane 6 exploitation
- ❑ P120C+ Element
  - P120C+ product adaptation
  - P120C+ transition
- ❑ Vega Element
  - Vega C product adaptation
  - Vega C exploitation
  - Vega E development completion

Implementation Approach

- ❑ Ariane 6 and P120Cplus Element
  - Continue existing prime & governance scheme
  - Evolution of the governance based on lessons learned of programmes implemented since CM14 when Ariane 6 was decided
- ❑ Vega Element
  - Continuity of existing contracts and dedicated work orders
  - All improvements planned for Vega C shall be ready for the first flight of Vega C+.

Programme Proposal on Ariane and Vega Product Adaptations transition and Exploitation - ESA/PB-STS(2022)14 & revisions

I. Ariane 6 product adaptation and exploitation

- **Ariane 6 Product adaptation**
  - ASTRIS: Valves (Safran Aero Booster)
  - VINCI 200kN: Valves (Safran Aero Booster), includes test campaign at engine level
  - ULPM TVAS: verification/ potential upgrade
    - TVAS subsystem level (SABCA)
    - TVAS ECPU (TAS-B)
  - STVAS: P120C+ static firing tests (including STVAS hardware procurement)

- **P120C Product adaptation**
  - Verification of TVAS compatibility with P120C+ environments (SABCA)

- **Ariane 6 & P120C Exploitation**
  - MQO (SABCA, TAS-B)
  - KASSAV (TAS-B)
  - NSO

I. Infrastructures

Objectives

- Maintain in good operational conditions the Liège Cryogenic Test Site
- Develop an Hydrogen ecosystem at CSG with the HYGUANE (HYdrogène GUyanais A Neutralité Environnementale) project ► Increase the launch system resilience to carbon taxes / Enhance the know-how on fuel cell design and use

Scope of Activities

- Proposed industrial activities to be performed by Be.Blue, in Liège and in French Guiana, over 2023-2025
- Perform ordinary and extraordinary maintenance activities at the Liège Cryogenic Test Site
- Introduction of two fuel cells at CSG for energy storage and clean & efficient power generation

I. Ariane 6 product adaptation and exploitation

- **Ariane 6 & P120C Transition**

Objectives

- Support the industry facing a further degradation of the ramp-up, through the coverage of audited costs
- Prepare the Ariane 6 exploitation thanks to process improvement activities and assets modernisation (Good Working Order) ► Competitiveness improvement & Greening

Scope of Activities

- Activities by SABCA and Safran Aero Boosters over 2023-2025
- **SABCA**: Ramp-up effect / Digitalisation of processes / Assembly tool automation / Flexible line
- **Safran Aero Boosters**: Higher automation / Workshop digitalisation / Helium recovery

Belgium (M€ 2022 e.c. - incl. ESA costs)	
Ariane 6	
Ariane 6 product adaptation	[3.00 - 5.00]
Ariane transition	[9.50 - 11.50]
Ariane exploitation	[13.00 - 15.50]
Total Ariane 6	**[25.5 - 32.0]**

Note

Axima *GWO activities in French Guiana (Regulus & Europropulsion facilities) assumed funded through remaining Ariane 5 LEAP budget in Belgium ► Energy savings & Carbon footprint reduction*

I. Vega-C product adaptation and exploitation

- **Vega-C Product adaptation**

  Adaptation for P120C+

  - Interstage 0-1 upgrade (SABCA)
  - TVC: verification (SABCA)

- **Vega-C Exploitation**
  - Launch system MQO (SABCA, SpaceBel)
  - Vega-C Launch complex & launch range maintenance
  - Additional Launch service contribution

Belgium (M€ 2022 e.c. - incl. ESA costs)	
Vega	
Vega C product adaptation	[1.80 - 2.20]
Vega C exploitation	[4.30 - 5.30]
Total Vega	**[6.1 - 7.5]**

I. Vega-E development

M10 Development

Engine valves – Safran Aero Boosters

- **Oxygen Main and Discharge Valve**
  - Delivery of first HW by Q1 2023; to be integrated in M10-DM2 ; hot firing tests in Q3-2023
  - Phase D/E covers all the necessary qualification analysis, testing and 5 items to be integrated in M10: 3 valves for QMs, 1 for Flight, 1 Spare
- ***Methane Discharge Valve***
  - First HW delivery by Q3 2023; delays are under discussion for planning recovery
  - Phase D/E covers all the necessary qualification analysis, testing and 5 items to be integrated in M10 : 3 valves for QMs, 1 for Flight, 1 Spare

Vega Upper Stage Phase D/E

Isolation Valve – Safran Aero Booster

- Present Phase covers the development up to VUS CDR
- Phase D/E cover the qualification and maiden flight; estimated HW : 6 valves (qualification, LPM UC-fire, MF, Spare)

Electro Valve Package – Safran Aero Booster

- Present phase covers delta development up to VUS-CDR
- Phase D/E, covers the qualification of the box, LPM UC-Fire, MF

Avionics

TVC – SABCA

- Synergies with VEGA-CIP but dedicated VUS TVC development is most probably necessary

Belgium (M€ 2022 e.c. - incl. ESA costs)	
Vega	
Vega E development	[23.2 - 28.2]
Total Vega	**[23.2 - 28.2]**

I. Pilar I - summary

Belgium (M€ 2022 e.c. - incl. ESA costs)				
Ariane 6			**Vega**	
Ariane 6 product adaptation	[3.00 - 5.00]		Vega C product adaptation	[1.80 - 2.20]
Ariane transition	[9.50 - 11.50]		Vega E development	[23.20 - 28.20]
Ariane exploitation	[25.00 - 32.00]		Vega C exploitation	[4.30 - 5.30]
Total Ariane 6	**[37.5 - 48.5]**		**Total Vega**	**[29.3 - 35.7]**
			P120C+	
			P120C+	[0 - 0]
			Total P120C+	**[-]**
Grand total: [66.8 - 84.2]				

ESA Space Transportation CM-22
Pillar II – Future Preparation

BELSPO Info Day

S. Bianchi - ESA/STS
30 September 2022

II. Future Preparation (1/4)

flpp

Programme Proposal Elements

- ❑ FLPP
  - Technology disruptors
  - Space logistics
- ❑ BOOST
  - Commercial Space Transportation Services - development & demonstration
  - Procurement of services - flight ticket & flightworthiness validation/maturity check
  - Support to Member States
- ❑ Human Space Transportation

Implementation Approach

- ❑ Preparation of new European commercial and privately-led space transportation services,
- ❑ De-risking and closure of European capability gaps
- ❑ De-risking of space transportation solutions through accelerated building blocks and technology developments

Programme Proposals on Future Preparation

Boost! - ESA/PB-STS(2022)38 & revisions - FLPP - ESA/PB-STS(2022)38 & revisions – HST – ESA/PB-STS(2022)73

II. Boost! – Commercial Space Transportation

Created in 2019 at Space19+

Commercial Space Transportation Services

WHY – ESA supporting European Economic Operators developing new services to:

- ✓ Encourage new entrants, entrepreneurialism & service approach
- ✓ Stimulate competitiveness and commercial business opportunities
- ✓ Adapt to dynamic market changes, a growing number of space activities and actors, and accelerated technology innovation

HOW – Open Call for Proposals

- ✓ Privately-proposed and privately-led service developments
- ✓ Relative technical and financial maturity
- ✓ To space, In Space of From Space
- ✓ Not driven by institutional needs, no guaranteed institutional market

Support to Member States national objectives

Spaceports, testing facilities and associated services

ESA assistance

Existing Agreements with Norway, Portugal, United Kingdom

- ✓ Andøya Spaceport project, Norway
- ✓ Azores International Satellite Launch Programme, Portugal
- ✓ Support to UK Spaceflight Regulator

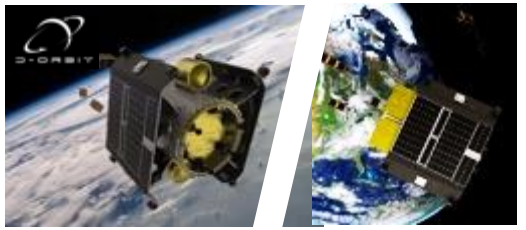
II. Boost! – Support to Commercial Space Transportation

New service–level approach, with ESA:

- acting as partner, and not as customer
- full project authority and full responsibility with service providers
- providing know-how and expertise in space transportation
- enabling access to test facilities
- making available co-funding
- facilitating private funding streams
- Interacting, networking, and more

Presently under Boost! contract: 8 commercial service projects

New industrial consortia being created – 8 primes; 19 sub-contractors



Boost! 5-fold leverage on private investments

Private investment injected in Boost! supported service projects:

ca. 200 M€ (since Boost! engagement)

Support to Member States

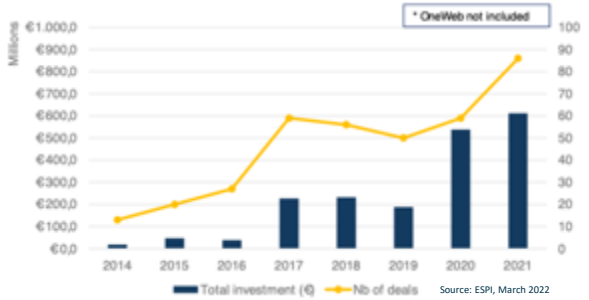
ESA support related to national spaceports & associated services

II. Boost! 2.0 – Drivers for C-M22

Boost! Objectives for CM22:

- **Expand the reach of Boost!** Commercial Space Transportation Services Element through **increased subscriptions** and **additional ESA Member States participation**
- **Adapt Programme Element** to comply with **evolving economic operators' needs** for service consolidation and industrialisation
- **Enlarge the Programme's scope to cover competitive launch service procurement** for demonstration or qualification of technologies or sub-systems in orbit
- **Maintain ESA's assistance to Member States** in implementing national space transportation objectives and capabilities

Europe's level of space ambition



European space start-ups
Transactions & investments

Service Primes

isaraerospace technologies
RFA Rocket Factory
D-ORBIT
PLDSPACE
EXO LAUNCH
ORBEX
VENTURE ORBITAL SYSTEMS
SPACE FORGE
HyImpulse
SKYRORA
The Exploration Company
LUNASA
exotrail
UARX space solutions

+ consortium partners
… and many more

New European service providers

II. Boost! 2.0 – Outlook for CM-22

Scope and Perimeter of Boost! 2.0 – Elements of the Programme

Boost! 1

enlarged scope

Commercial Space Transportation Services (development & demonstration)

Access to Space – launch service development; consolidation; industrialisation; incl. service improvements; extended capabilities (e.g. reuse); self-standing support services

In-Orbit Transport – last-mile & orbital transfer and servicing development & consolidation

Return from Space – re-entry platform and return service capabilities development & consolidation

Boost! 3

new scope

Space Transportation Services Procurement

Public sector co-funding of commercial space transportation services (i.e. from Arianespace & new European launch service providers)

Implementation of European **Flight Ticket Initiative** [with European Union]**:** Procurement of space transportation services for IOD/IOV missions

In **Boost!**: Flight ticket **competitive procurement** among 'proven' launch systems for IOD/IOV missions (ESA co-funding [⅓] service price)

ESA flightworthiness validation process for new European launch services

Boost! 2

same scope

Support to Member States

Assistance in implementing national space transportation objectives and capabilities

II. Boost! 2.0 – Opportunities in Belgium

Boost! 1

ESA support contracts are concluded with commercial service **prime companies**

ESA is presently not tracking any commercial space transportation service prime in BE

Von Karman Institute for Fluid Dynamics is already involved in a Boost! project

Potential other BE companies for consortia:

- Aerospacelab (aggregator)
- Rhea Group (e.g. ground segment)
- SABCA (TVC and structures)
- Safran Aero Booster (propulsion)
- Space Applications Services (in-space services)
- Spacebel (ground and flight software)
- Thales Alenia Belgium (avionics)

Boost! 2

No support activities expected

Boost! 3

Space transportation service procurement for IOD/IOV missions to be made on competitive basis, incl. **Ariane 6** & **Vega C** launch services

Geographical return proposed on basis of industrial return in exploitation

Boost!	
Boost!	[2.0 - 3.0]
Total Boost!	**[2.0 - 3.0]**

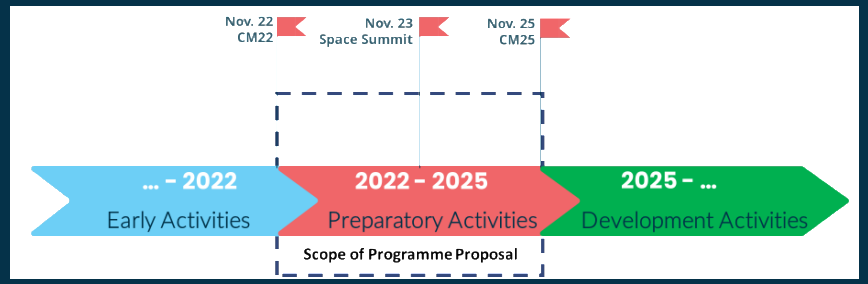
II. Human Space Transportation

Following the recommendation of the High Level Advisory Group on "Accelerating the Use of Space in Europe" to "*further investigate the technical, political, programmatic, and economic relevance of developing a Europe-made human-rated space transportation solution*". A joint STS/HRE team has studied the socio-economic impacts of a European Human space transportation; assessing the startegic, economic and technologic aspects

Strategic	**#1: Barters: Strengthening of European position in negotiations**
	#2: European independence and autonomy
	#3: European Leadership
Economic	**#4: Commercial Exploration services enabled**
	#5: Increased competitiveness of the European Industry
Technological	**#6: Identification of critical technologies for HST**
	#7: Improved technical capacity of the European industry
	#8: Research capabilities developed and maintained

Ways forwards have been identified and are the backbone of the HST preparatory activities described in the programme proposal:
Aiming at the

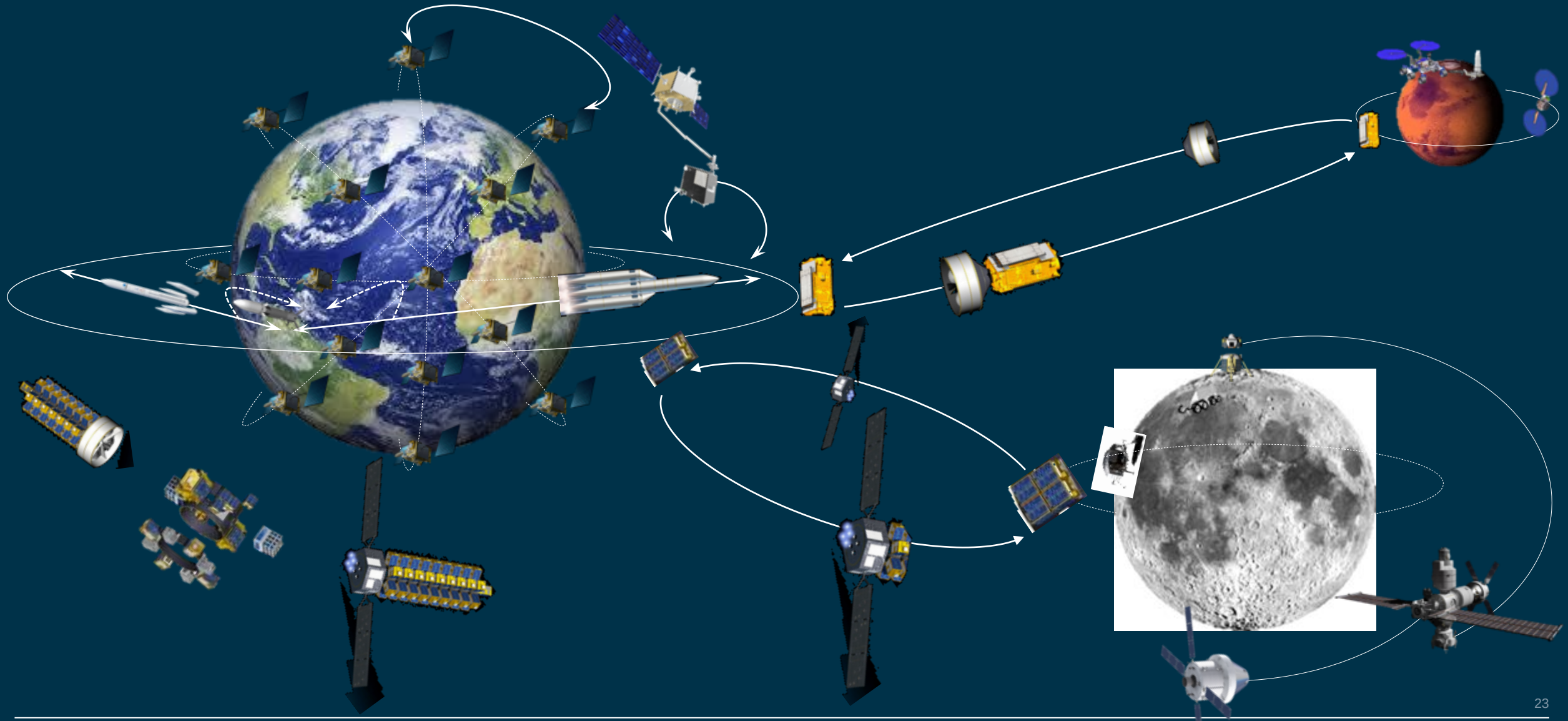
- **End-to-end Mission and System Requirements Identification**
- **Critical and Enabling Technologies Maturation Preparation**
- **Public-Private Risk Sharing Assumptions Consolidation**



Belgium (M€ 2022 e.c. - incl. ESA costs)	
Human Space Transportation	
Human Space Transportation	[2.0 - 3.0]
Total Human Space Transportation	**[2.0 - 3.0]**

Programme Proposal on Preparatory Activities for Human Space Transportation - ESA/PB-STS(2022)73

II. FLPP Towards a Space Transportation ecosystem…



II. FLPP in a nutshell …











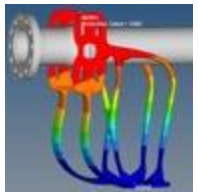













Competitiveness
Versatility
Diversification

II. FLPP at CM-22: Overarching objectives

Leveraging the on-going transformation of the European space transportation, FLPP will further evolve along:

An alignment with the overarching strategy, to shift from an access to space towards a space transportation, and progressively **towards a European Space Logistics**

Selected de-risking of major **building blocks** and promotion of enabling **technology portfolio**, decreasing the entry ticket price to the space transportation sector

Support to start-ups and newcomers to **enable scaling-up** towards end-to-end services, in synergy with the C-STS Programme.

Over the 2023-25 and 2025-28 periods, FLPP will be instrumental in the space transportation R&D **transformation** towards **more private sector** empowerment and growth.

II. FLPP at CM-22: Five Elements and ten business ventures

ESA Unclassified – For E… Use Only

ESA/PB-STS(2022)40
Paris, 22 April 2022
(Original: English)

EUROPEAN SPACE AGENCY

SPACE TRANSPORTATION PROGRAMME BOARD

Programme Proposal

Future Launchers Preparatory Programme (FLPP)

Summary

Taking into account on-going space transportation programmes and activities and ESA Agenda 2025 (ESA/C(2021)51), discussions on proposals to be submitted for decision at the ESA Council meeting at ministerial level to be held in November 2022 (CM-22) were initiated with Member States at the occasion of the workshop with PB-STS Delegations held on 24 September 2021. First elements of all programme proposals related to Space Transportation proposed were presented at the occasion of the November 2021 PB-STS in document ESA/PB-STS(2021)52

These elements are structured along the following four programmatic pillars:

1) Ariane and Vega product adaptations and exploitation
2) Space Rider development completion and evolution preparation
3) Future Preparation, and
4) Infrastructure

With respect to each of the space transportation programmatic pillars above, programme proposals further detailing the rationale, objectives, programmatic and budgetary elements and implementation approach were submitted to the February PB-STS (documents ESA/PB-STS(2022)14, 15, 16 & 17).
Within the space transportation "Future Preparation" programmatic pillar, this document further details the related rationale, objectives and programmatic approach, as well as the proposed content, budgetary and implementation details within the Future Launchers Preparatory Programme (FLPP) frame.

Required action

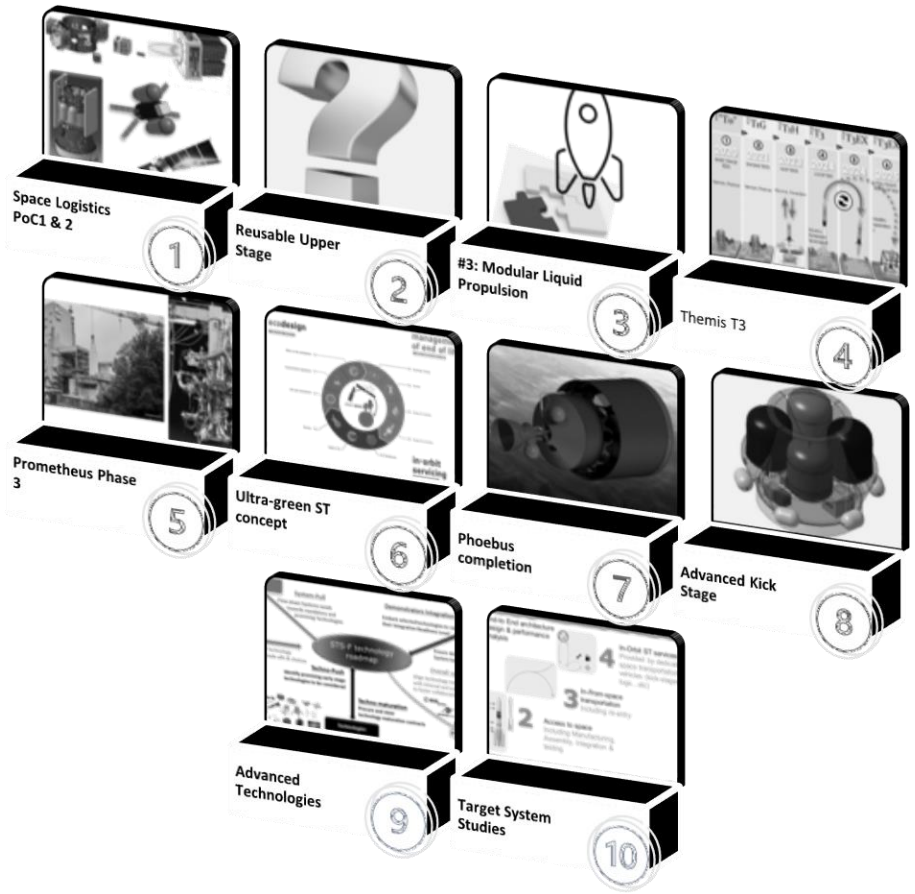
Delegations are invited to take note of and comment the proposal

5 Elements

1. **Technology Disruptors** and **Space Logisti…** Element, incorporating:
   - Space logistics and system studies
   - Proof of Concept Missions for Space Logistics (ITT)
   - New technology Disruptors

   (incorp. former Space19+ Studies, Demonstrator and Advanced Technology Core Element)
2. **Themis/Reusability** Element
3. **Prometheus** Element
4. **Reusable Upper Stage Demo** Element
5. Human Space Flight Element

10 Business Ventures



II. in the Business Ventures: first assessment

FLPP Ventures | ✓ Space19+ BE achievements – *status at CM22* | CM22 priorities

1. Space Logistics PoCs

tbd **PoC 1 Contest** & Phase 0/A1

tbd **Consortium partner for PoC-1**

tbd **Cryogenics systems for PoC-2**

2. Reusable upper-stage

HEARTED Phase A

HEARTED re-entry capsule + ejection // TPS, thermo, flight instrum.

Application of Flight termination tech

3. Modular liquid propulsion

Application of electro-valves & elec. control tech

4. Themis T3

✓ **Successful Themis Initial Phase:**

Procurement of **Low-Cost Actuation System**

✓ **and Conclusive Themis Bridging Phase**

MAIT of Themis Multi-Engines Bay

Integration of **all building blocks into a flightworthy T1H**

Hop-tests in Kiruna in collaboration with Horizon Europe

T3 Actuation System

T3 Grid Fins & Actuation Systems

Autonomous Flight Termination System

T3 Multi-Engines Bay

Themis T3 full-domain flights:

5. Prometheus Phase 3

Prometheus valves

Follow-up on Prometheus valves

6. Ultra-Green ST concept

7. PHOEBUS completion

8. Advanced Kick-Stage

App. of storable valves with green prop.

9. Advanced technologies

Low-Cost Actuation System (I & II)

Grid fins maturation (ArianeWorks)

Grid fins actuation System initiation *(tbc)*

Autonomous Flight Termination System

Ground system engineering tools

Multi-Engines Bay MAIT optimization

Low-cost valves technologies

Electro-valves & electronic control

Decentralised control for actuation funct. chains

Health & Usage Monitoring System

Power sources trade-off then techno maturation

Diagnostics techniques for refurbishment

Propellant mgmt, autogenous pressu, e-pumps…

10. Target System studies

ITT NEP phase 0

Space Nuclear Propulsion maturation

II. Future Preparation proposed contributions for Belgium at CM22

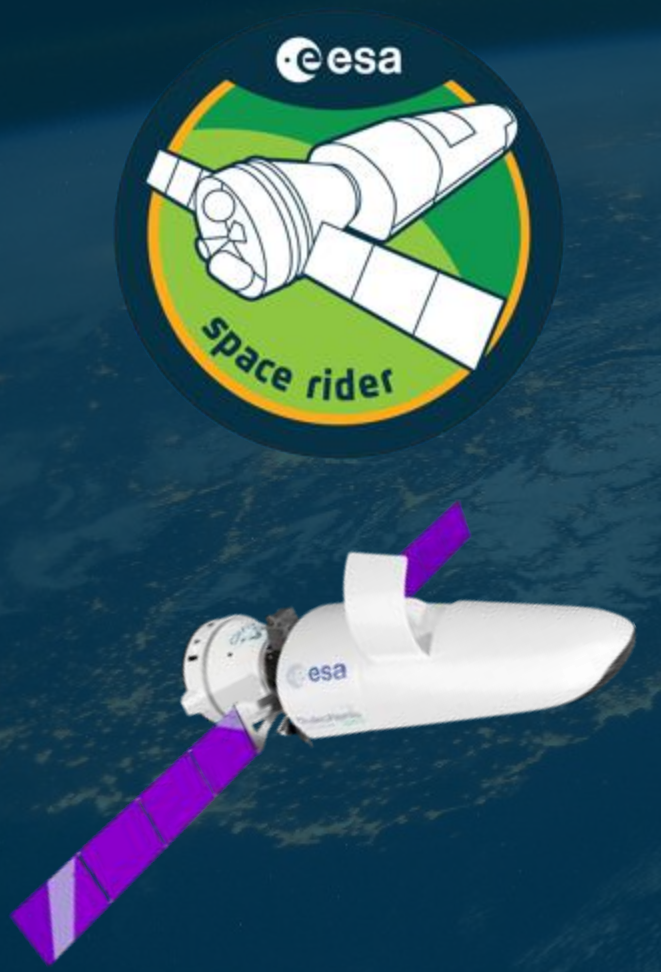
Belgium (MEUR, 2022 e.c. incl. ESA costs)			
FLPP Element	**CM22 Subscription range**	**Element amount**	**Venture**
Techno Disruptors and Space Logistics	10-16	120	1: Space Logistics PoC 6: Ultra-Green ST concept 7: Phoebus completion 8: Advanced Kick Stage 9: Advanced Technologies 10: Target System Studies
Themis and Reusability	8-10	220	4: Themis T3
Prometheus	14-18	238	5: Prometheus Phase 3
New Rapid Demonstrators	3-6	80	2: Reusable Upper Stage 3: Modular Liquid Propulsion
Human ST	2-3	30	
Total FLPP	**37-53**	**688**	
Boost	**2 - 3**	**140**	
Future Preparation Pillar II Total	**39 – 56 M€**	**828**	

ESA Space Transportation CM-22
Pillar III – Space Rider

BELSPO Info Day

S. Bianchi - ESA/STS
30 September 2022

III. Space Rider - Programme Proposal



Programme Proposal Elements

❑Completion & Services Improvement

- Reusability qualification (fully achieved after 5 re/flights)
- Consolidation of commercialisation
- Vehicle improvements and new services development

❑Evolution Preparation

- design preparation of possible future Space Rider-based concepts
- extension of the reusability capabilities
- increase in payloads mass by 30% and recurrent cost reduction by 30%

Implementation Approach

❑New slice named Space Rider **Step 3.1**

Executed and managed by ESA, relying on the Vega & Space Rider Integrated Project Team

❑ "**Completion**" activities with existing industrial team and potential new contributors for specific improvement activities linked to qualification for reusability and new services

❑ "**Evolution**" activities in continuity with existing industrial consortium and benefiting from availability of the ground and flight qualification data. Open competition framework will be set-up for some of the principal subsystems (solar panels, structure, mechanisms, etc..)

Programme Proposal on Space Rider development completion and evolution preparation - ESA/PB-STS(2022)16 & revisions

III. Space Rider - Status

SABCA: Attitude Surface Control System
(& TAEM motors)
SPACEBEL: On-Board Software

Programme Proposal on Space Rider development completion and evolution preparation - ESA/PB-STS(2022)16

III. Space Rider - Programme Proposal

Opportunities:

- "Recurrent" involvement for SRS refurbishment & re-flight activities
  - SABCA: Attitude Surface Control System – ASCS
  - SPACEBEL: On Board Software

- Involvement as well in future evolutions preparatory activities

- *New IPDU introduction for Space Rider*

Notes:

- In the table, IPDU activities not yet included as just very recently identified. But it is important to introduce since this stage of the development (PDR just done) the Space Rider requirements (radiation environment / thermo-mechanical loads / reusability)
- The required support for this important activity would rather move the requested contribution on the upper end of the identified range

Belgium (M€ 2022 e.c. - incl. ESA costs)	
Space Rider	
Completion	[1.5 - 2.0]
Evolution	[0.5 - 1.0]
Total Space Rider	**[2.0 - 3.0]**

ESA Space Transportation
Pillar IV – CSG

BELSPO Info Day

30 September 2022

IV. CSG (1/3)

Programme Proposal Elements

- ❑ Europe's Spaceport

Implementation Approach

- ❑ CSG Launch Range activities

First elements of DG's Proposal for the Agency contribution to the funding of the Guiana Space Centre Activities and associated services beyond 2022 (ESA/C/WG-M(2022)9)

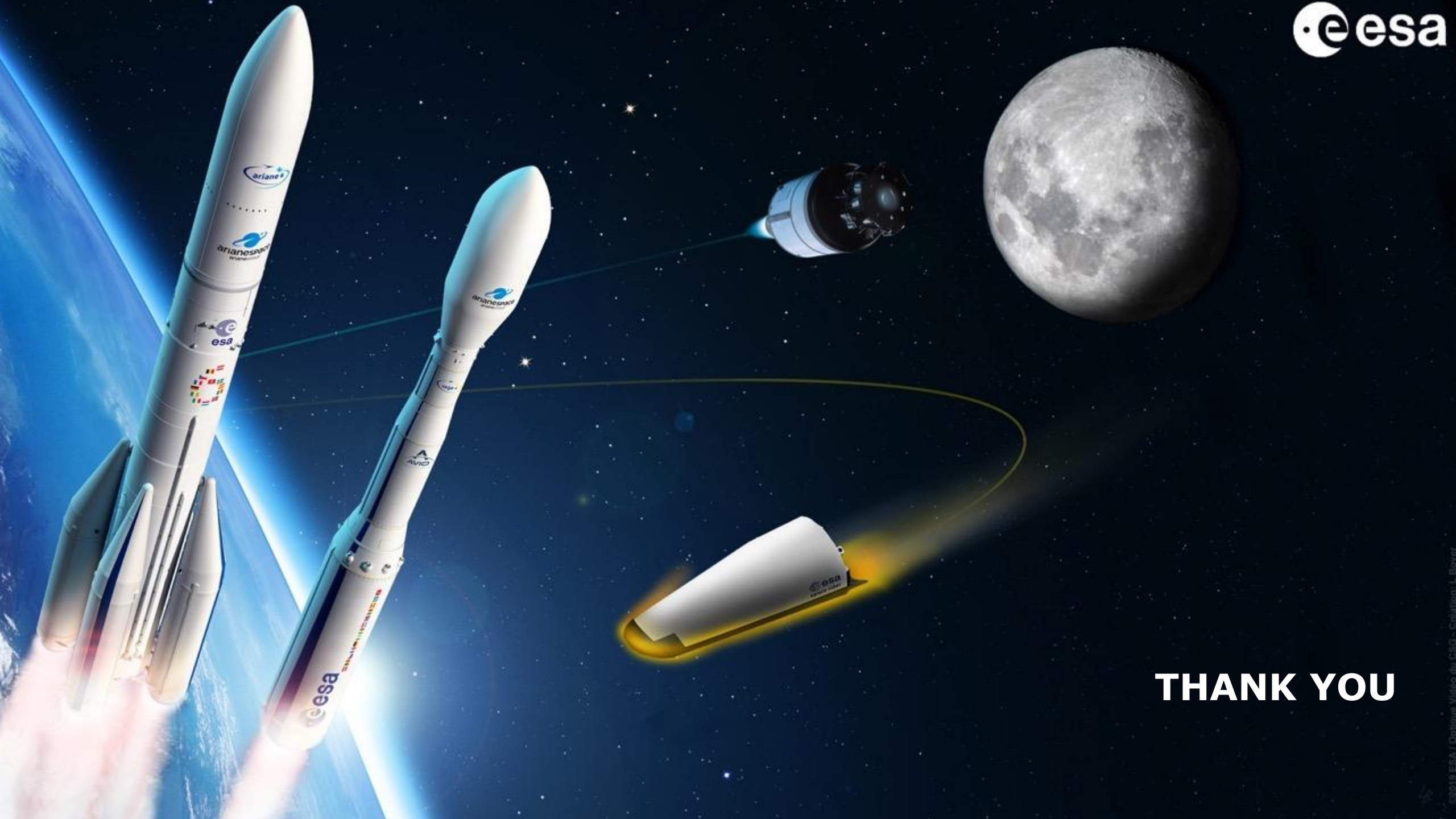
DG proposal for the Agency contribution to the funding of CSG & associated services - ESA/PB-STS(2022)13 & revisions

Overview of Belgium proposed subscription to CM22

Belgium (M€, 2022 e.c. , incl. ESA costs)	
Pillar	**CM22 Subscription range**
Ariane and Vega Product Adaptation and Exploitation	[66.8 – 84.2]
Future Preparation	[39.0 – 56.0]
Space Rider	[2.0 – 3.0]
Infrastructure	[20.]
Overall total CM22	**[128 – 165]**

Freedom of action

Growth & Competitiveness


esa
THANK YOU