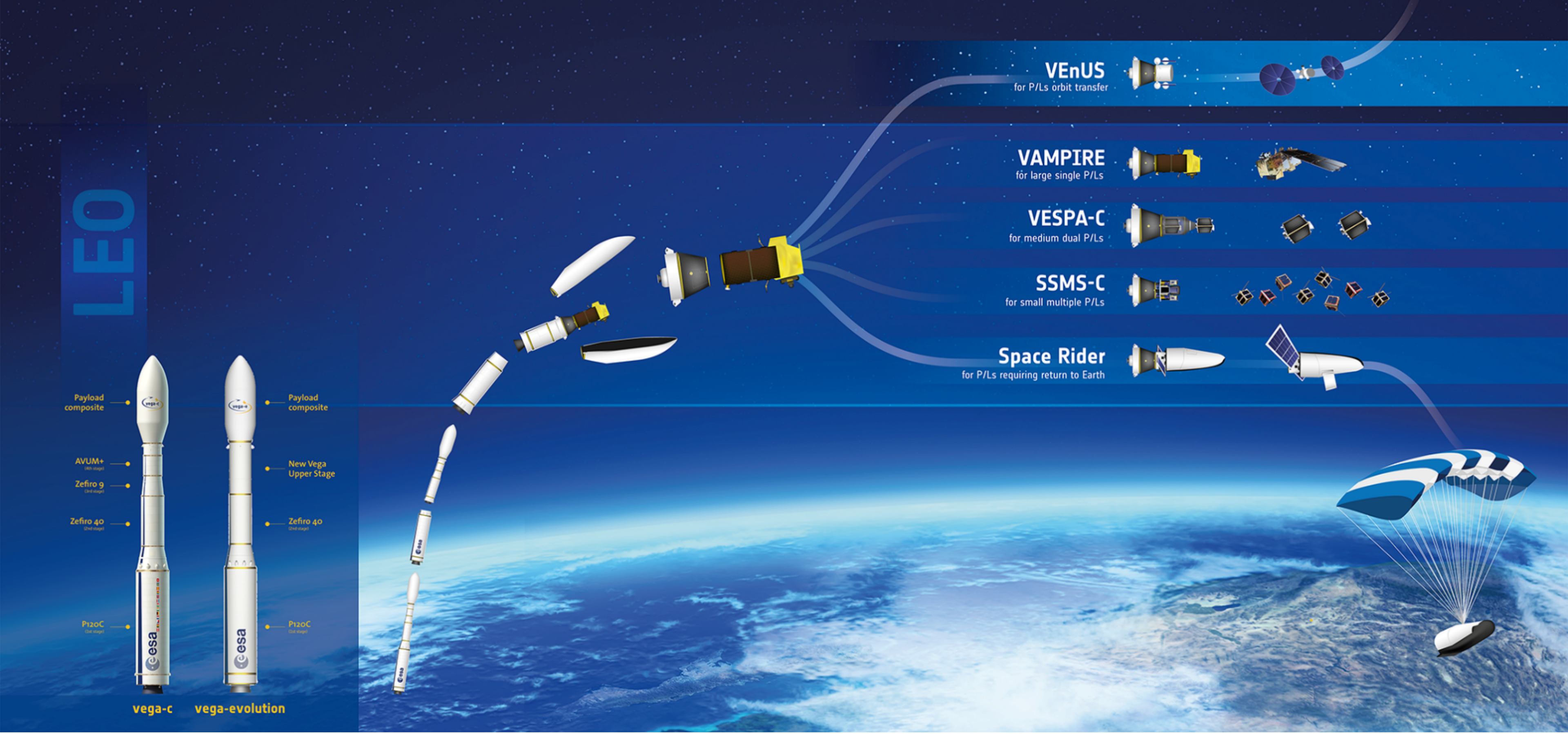
Vega and Space Rider Coping with Regulatory Challenges through New Technologies

ESA - IPT

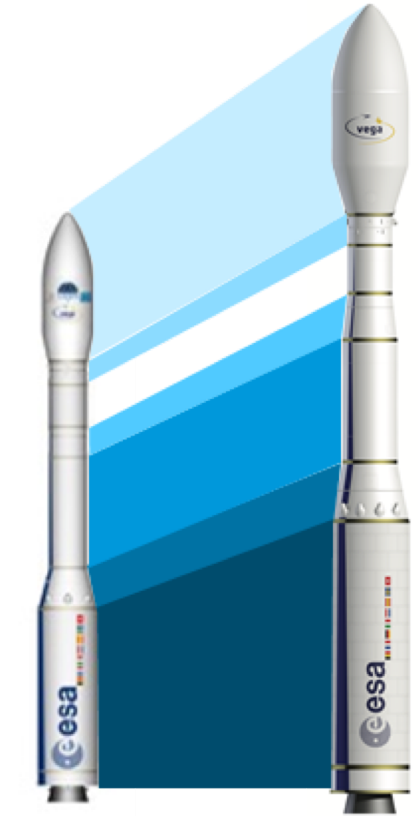
3rd workshop on REACH and its impact on space sector
ESA/HQ, Daumesnil
16/10/2019

Introduction to the Vega Space Transportation System



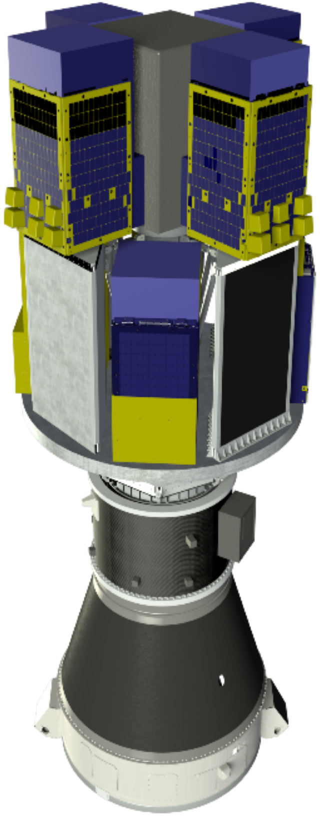
European Space Agency

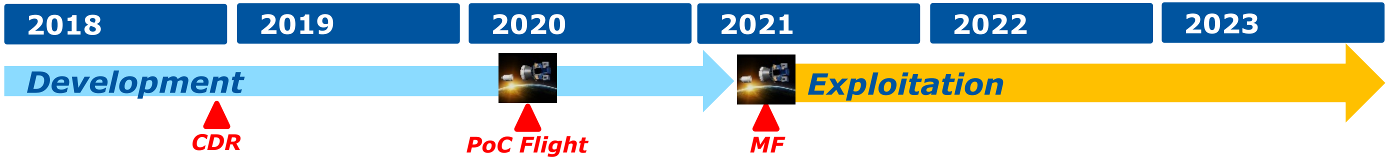
The Vega C Status and Planning



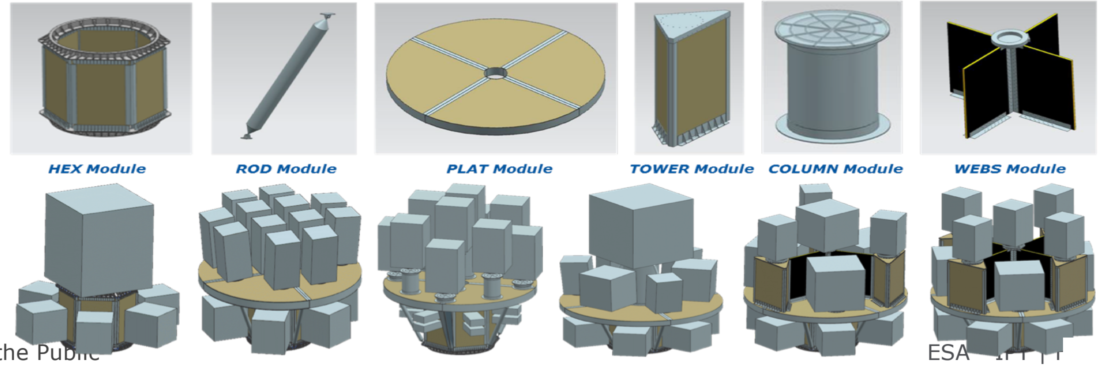
- **Recall of Objective:** Access to Space fulfilling wider market needs with respect to Vega for larger and heavier payloads with mass up to 2350 kg in SSO at 700 km, with Europeanization of key non European components.
- **Status:** The Launch System Critical Design Review was successfully passed beginning 2019, integrating Launch Vehicle and Launch Base aspects, supported by extensive system and subsystem level tests.
- **Planning:** The system and sub-systems level activities are progressing at speed throughout the qualification phase, including the combined test campaign preparation, for a Maiden Flight planned in Q2-2020.

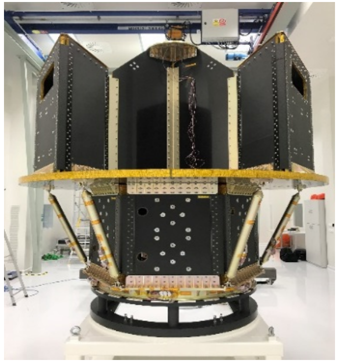
The SSMS C Status and Planning



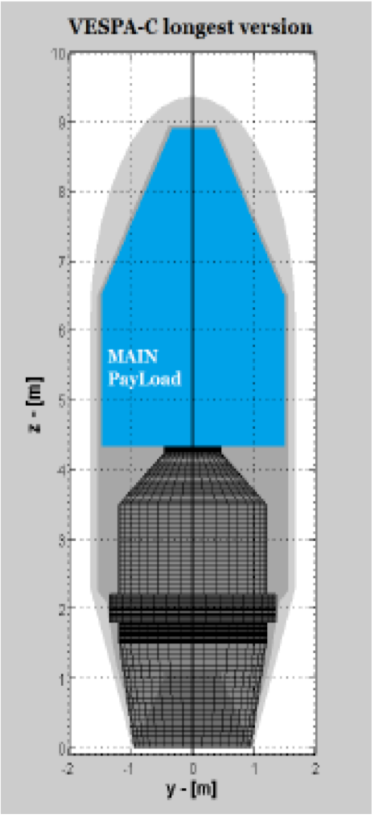


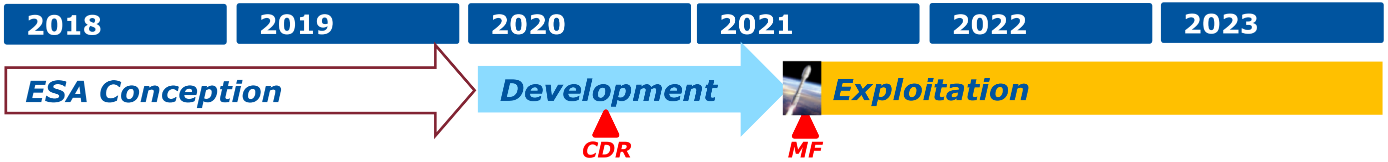
- **Recall of Objective:** Capturing the growing market needs of small satellites, benefiting from the higher Vega-C performance with respect to Vega, relying on the availability of modular dispensers to place multiple aggregates of small satellites with simplified qualification and integration processes.
- **Status:** The Critical Design Review was successfully passed, embedded with the Vega C Launch System CDR, being SSMS C an integral part of the Vega C Launch System.
- **Planning:** The logic implemented was to design, develop, qualify and fly an SSMS version for Vega C, responding to generic payloads aggregates, with an early version for a PoC (Proof of Concept) flight with Vega, currently planned in the first semester of 2020.



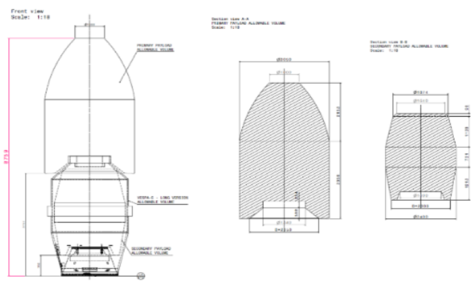


The VESPA C Status and Planning

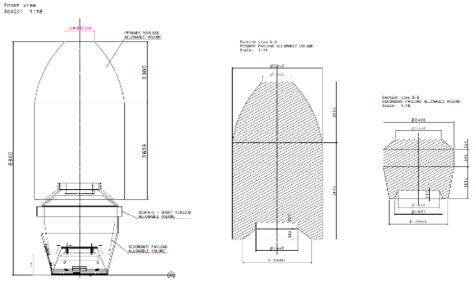




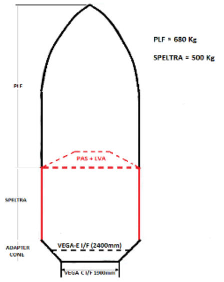
- **Recall of Objective:** Ensuring the dual launch capability for medium size payloads, benefiting from the higher Vega-C performance with respect to Vega.
- **Status:** Analyses have been performed by ESA showing the possible need of two different configurations, with a modular approach based on the qualification of the most demanding version, implementing a flexible production through adaptation of VESPA-C configuration (long versus short) on a case by case basis. In addition, studies are on-going to assess the feasibility of a "SPELTRA-like" configuration, maximizing the allowable volume for main and secondary payloads and fully exploiting the increased VEGA-C performances
- **Planning:** The industrial development activities are planned to start following SPACE19+.



Long Configuration



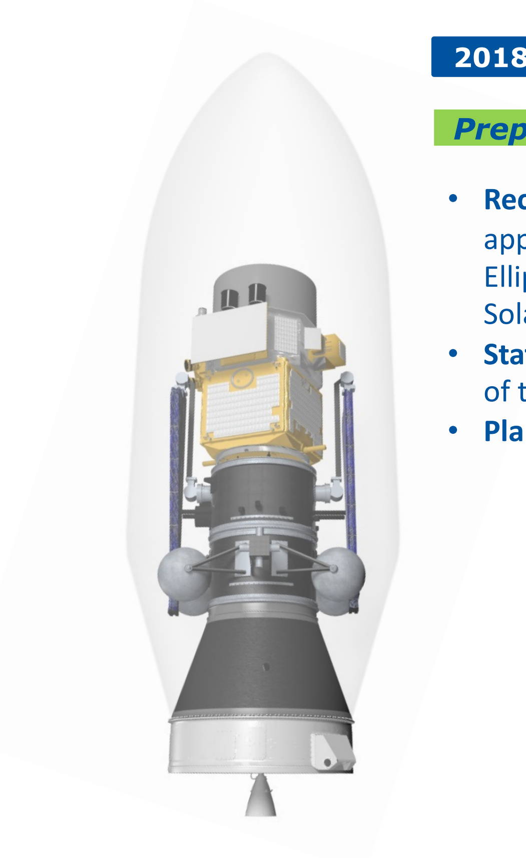
Short Configuration



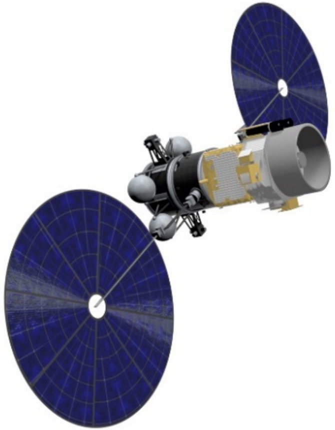
SPELTRA-like concept

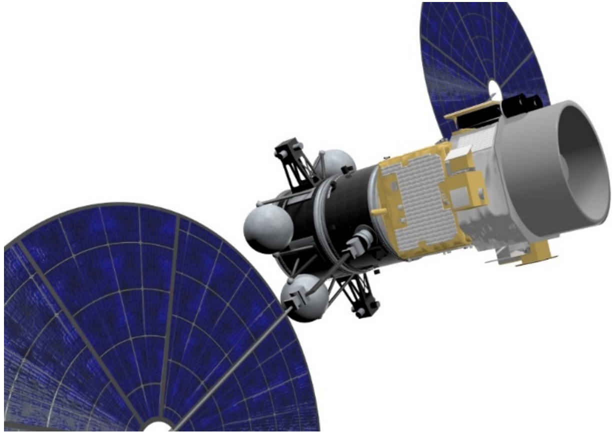
The Venus Status and Planning

2018	2019	2020	2021	2022	2023
Preparation		*Development*			

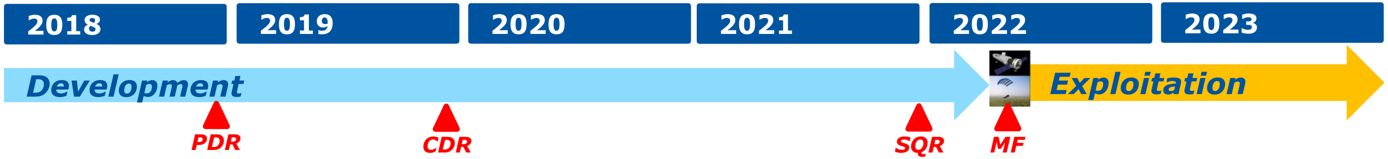


- **Recall of Objective:** Extend the Vega-C market base providing orbit-to-orbit transfer to satellites of approximately 1 ton, up to Medium Earth Orbits (e.g. for constellation replacement services), Highly Elliptic Earth Orbits, Escape Orbits (e.g. for scientific/exploration applications) through the use of a Solar Electric Propulsion Orbital Transfer Module.
- **Status:** Building on the synergies with Space Rider Orbital Service Module based on a modular design of the AVUM Life Extension Kit (so-called ALEK), consolidating the mission critical technologies.
- **Planning:** Consolidation of the mission objectives to encompass the largest variety of applications.

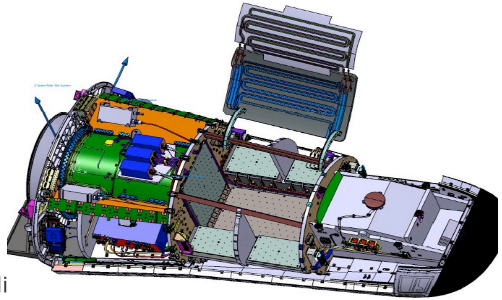


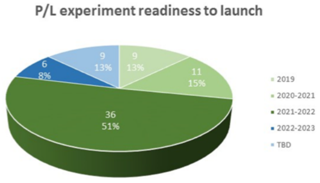


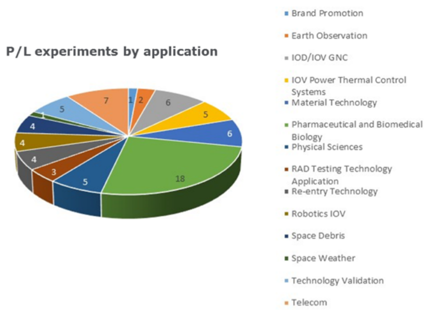
The Space Rider Status and Planning



- **Recall of Objective:** Provide a reusable orbital customisable/standardised space laboratory for multiple applications (microgravity, Earth observation, science, robotic exploration), integrated with Vega-C, able to perform in-orbit payloads operations, de-orbit, re-enter, land on ground, be relaunched after limited refurbishment.
- **Status:** The Preliminary Design Review was successfully passed, for both the Orbital Service Module, a modified version of the AVUM+ to extend the orbital life-time, and for the Re-entry Module, a modified version of the IXV to integrate a multi purpose payloads bay (MPCB) and land on ground.
- **Planning:** The system and sub-systems level activities are progressing at speed throughout the critical design phase, heading towards the Critical Design Review planned in Q4-2019.





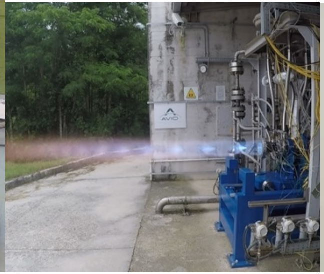


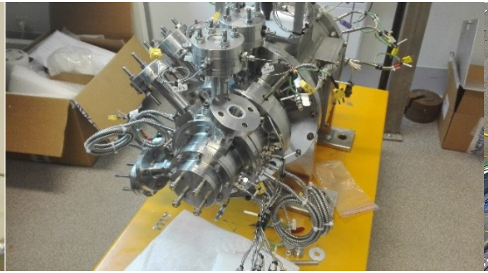
The Vega Evolution Status and Planning

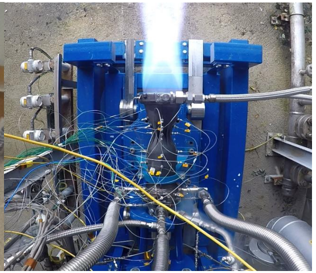
2018	2019	2020	2021	2022	2023

Maturation → **Development** →

- **Recall of Objective:** Continuously improve Vega competitiveness, targeting 20% of System Margins and 20% Cost Reduction with respect to Vega-C, with no overlap with Ariane performance and market.
- **Status:** The project is progressing at speed throughout the Launcher System Preliminary Requirements Review successfully completed in 2018, passing critical Engine and Components level milestones successfully, such as the Engine development model PDR, the Subscale TCA (Thrust Chamber Assembly) with ALM campaign successfully completed with total 20 firing test, the full scale TCA hot firing test campaign upcoming at NASA Marshall.
- **Planning:** Focus on lox-methane propulsion for the upper stage engine, with introduction of additional improvements (e.g. 3D printing for parts reduction, H_2O_2 propulsion for roll and attitude control) increasing Vega-C flexibility.







The VSTS Coverage of Space Services (1/4)

The following market services are currently targeted:

1. **Single Payload Launch:** 2350 kg @ 700 Km, SSO including PLA
2. **Main Payload + Piggy Back Launch:**
   a) Main: 1500 kg
   b) Piggy Back: Class 2, 3, 4
3. **Double Payloads Launch:**
   a) Main: from 1000kg to 1500 kg
   b) Secondary: from Class 0 to 1000 kg
4. **Multi Payloads Launch:** combination of Smallsats from class 1 to class 4
5. **Other Payloads Needs:** orbit permanence, orbit transfer, return from orbit, and more under ESA conception…

The SmallSats are subdivided in classes defined by their mass range as follows:

a) Class 4: 1kg – 25kg
b) Class 3: 25.1kg – 60kg
c) Class 2: 60.1kg – 200kg
d) Class 1: 200.1kg – 400kg
e) Class 0: 400.1kg – 500kg

Note that Class 3 and 4 may correspond to clusters of standard CubeSats (nU).

The VSTS Coverage of Space Services (2/4)

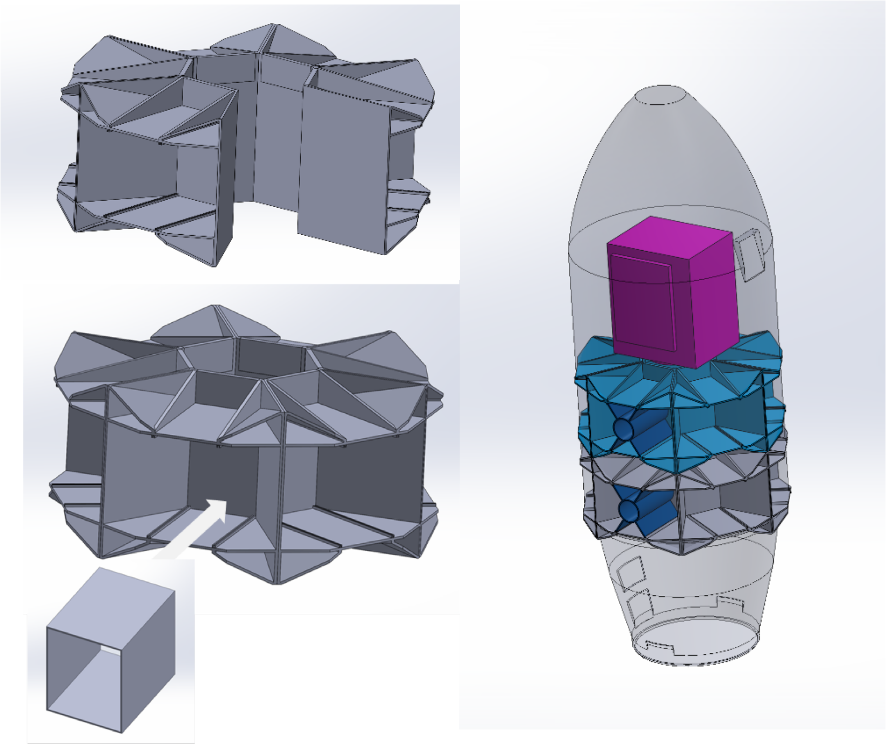
The following additional market services are under ESA conception:

1. The SPC (Standard Payload Container)

Preliminary studies performed by ESA define a concept to standardise the Vega C launch service of SmallSats up to 150kg.

The focus is on different possible concepts with increased levels of standardization, differing in the I/F arrangement between S/C and launcher:

i. **SC I/F is traditional** using standard SSMS lightband (the SC structure is totally independent from the launcher);
ii. **SC I/F is Lightband and two guiding rails** are used to mitigate separation constraints;
iii. **SC structure is specified by the launcher** and qualified together with the launcher cell.

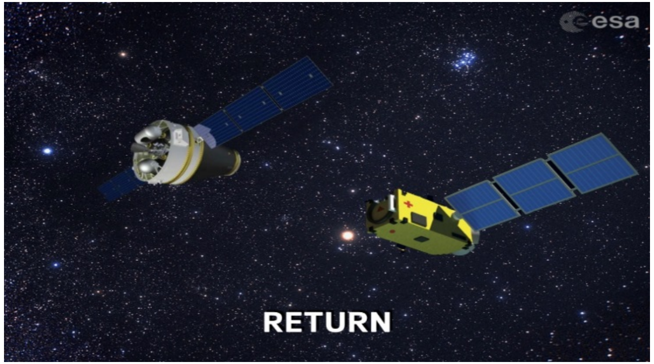


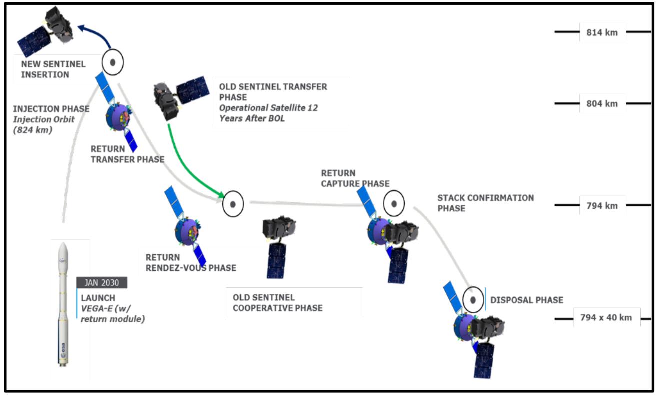
The VSTS Coverage of Space Services (3/4)

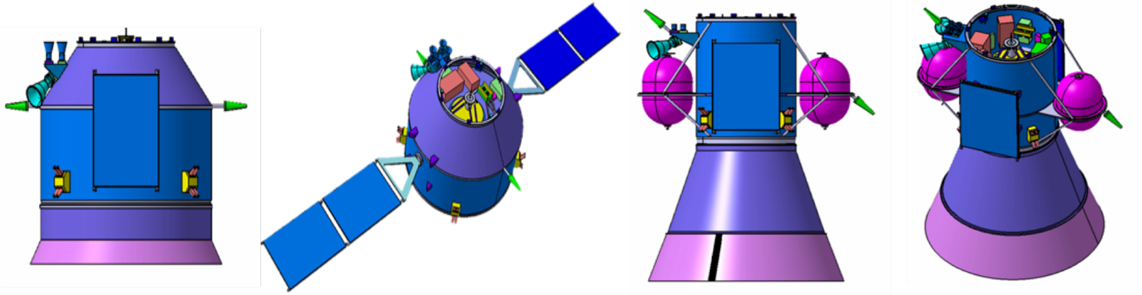
2. The SRM (Spacecraft Replacement Mission)

Preliminary studies performed by ESA define a concept to replace constellation satellites.

The case study was performed on a possible Vega Evo mission for the replacement of future Sentinel spacecrafts (i.e. encompassing in the same mission the release of a future new Sentinel and the return of a future Sentinel to be dismissed), both future Sentinels and Vega Evo with limited adaptations of the respective interfaces.



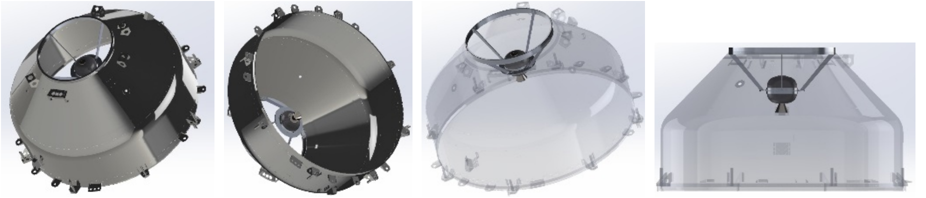




The VSTS Coverage of Space Services (4/4)

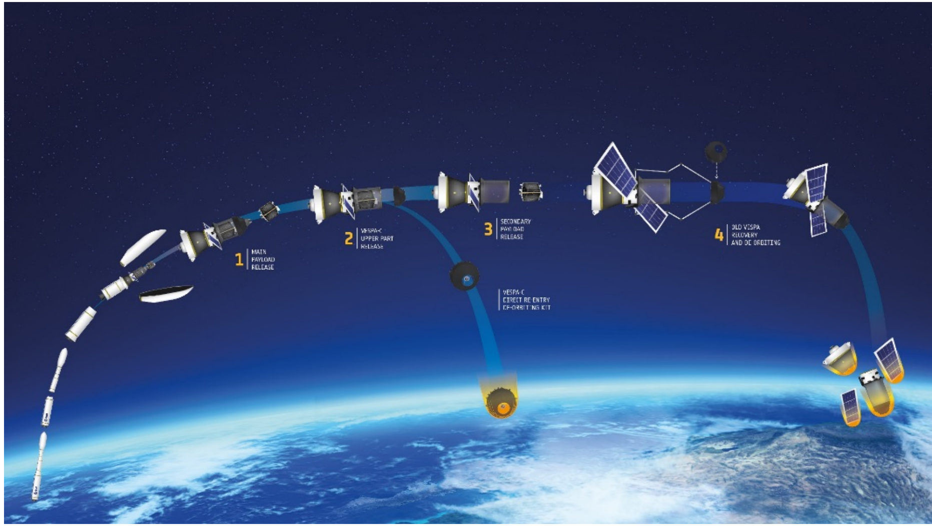
3. The VESPA recovery and direct re-entry mission

Preliminary studies performed by ESA define a concept to include an autonomous de-orbiting kit in the upper part of the VESPA-C (released after main payload separation in dual payloads missions) and a recovery plus direct re-entry of and old VESPA orbiting in LEO, using the ALEK.

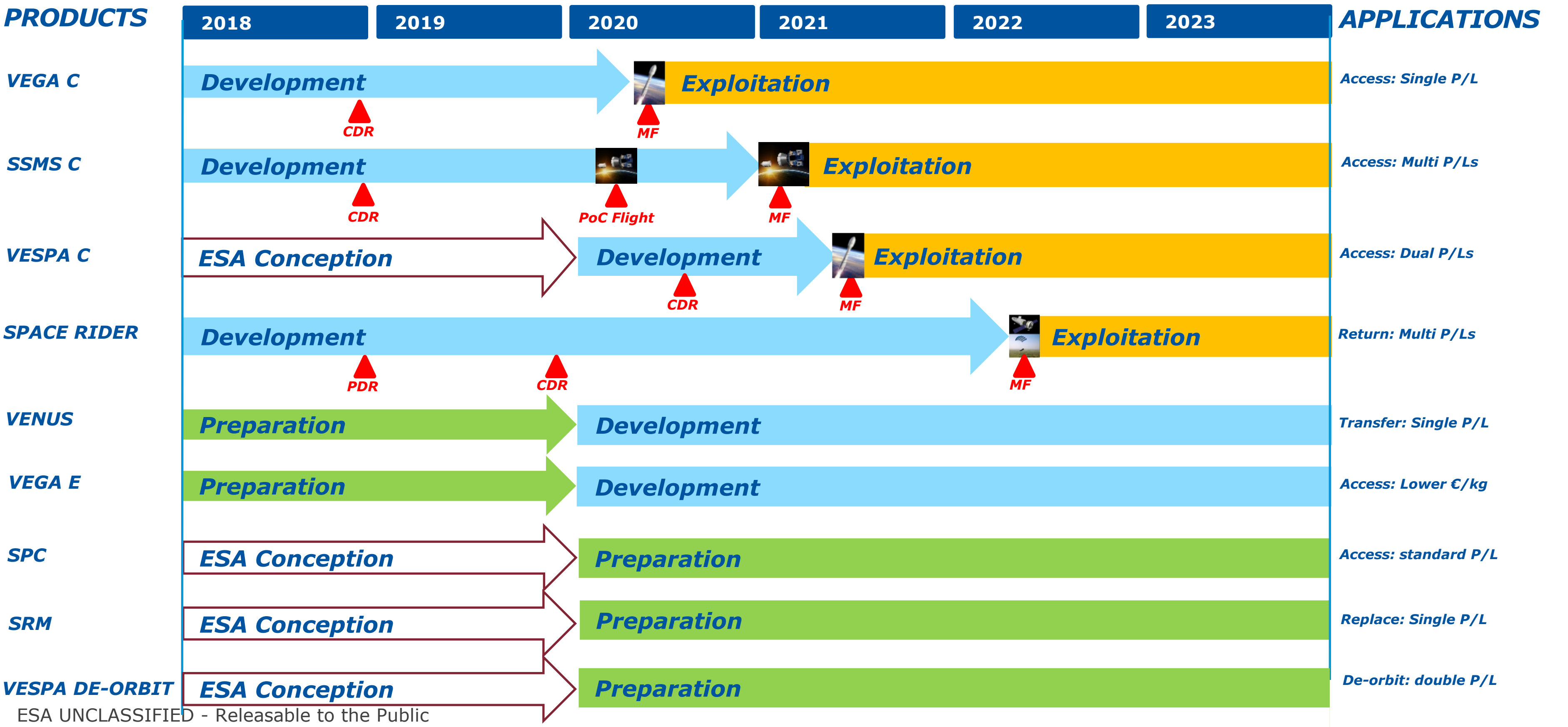


The mission sequence would be as depicted:

1. Release of the main (primary) upper payload
2. Release of the VESPA-C upper part and its direct re-entry thanks to the autonomous de-orbiting kit
3. Release of the secondary lower payload
4. Recovery of an old-VESPA structure and de-orbiting through direct re-entry by means of ALEK



The VSTS Products Synthesis with Master Planning



The VSTS Products Coping with Regulatory Challenges through New Technologies

All the running VEGA and Space Rider development programmes included since the issuing of the agency High Level Requirements the request *to identify and mitigate the risks linked to obsolescence of material or processes at all level of the customer-supplier chain*, with a specific indication of REACH as an example of source for such kind of obsolescence

These requirements are introduced in the PA Requirements of VEGA-C, Vega Evolution and Space Rider and then flowed-down from ESA level, to prime contractors and their subcos

VEGA C Req 1.8
The supplier shall identify and mitigate the risks linked to obsolescence of material or processes at all level of the customer-supplier chain.
NOTE: REACH legislation is an example of source for obsolescence.
VEGA C – End Req 1.8

SR Req 1.8
Obsolescence of materials and processes (e.g. due to REACH legislation etc.) shall be pro-actively managed at all layers of the supply chain. That risk shall be regularly reviewed and reported to the MPCB.
SR End Req 1.8

The VSTS Products Coping with Regulatory Challenges through New Technologies

Three main issues are identified when dealing with REACH:

- The hydrazine issue, relevant to the Roll and Attitude Control System (RACS) for VEGA and for the Space Rider re-entry module

- The Chromium-Trioxide issue, relevant to the anti-corrosion, conductive and protective coating so far used for aluminium alloys (Alodine 1200)

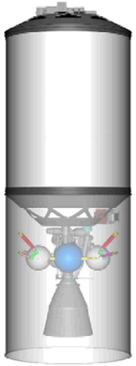
- The lead issue, used commonly for soldering processes throughout a number of applications/subsystems

The VSTS Products Coping with Regulatory Challenges through New Technologies – Hydrazine

For the hydrazine issue, the following actions are under evaluation/implementation:

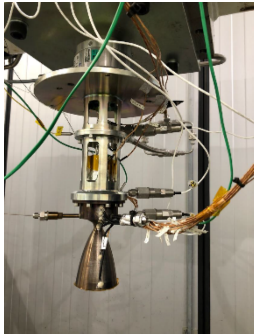
VEGA-EVO Lox-methane Upper Stage (VUS stage)

This activity aims at developing a LOX-Methane M10 engine (already underway) in parallel with the relevant activities at stage level, so to achieve as final objective the replacement of current Z9 solid rocket motor 3rd stage and AVUM 4th stage with a Lox-methane greener upper stage, so-called Vega Upper Stage (VUS)



H2O2 RACS qualification and adaptations for VEGA C++ and VEGA-Evo

This activity targets the completion of the development of the H2O2 RACS already underway, up to the full qualification at equipment (tanks, thrusters, valves) and subsystem levels.



SPACE RIDER Re-entry Module (RM) H2O2 Roll Control System

On Space Rider the baseline RCS system used in the re-entry module is based on hydrazine but it is subject to be replaced by green RCS upon successful qualification with VEGA.

A level 0 feasibility study has been conducted to assess that the available volume and budget mass allow such replacement, providing positive results

The VSTS Products Coping with Regulatory Challenges through New Technologies – Chromium Trioxide and Lead

For the Chromium Trioxide and lead issues, the following actions are under evaluation / implementation:

Alternative Aluminium surface treatment

Although the difficulty in finding a comparable (in terms of performances and durability) alternative to the Alodine 1200 surface treatment, several subco are already active in applying different aluminium alloys coating, like for example Surtec 650 (for flight structures) or PreCoat A32 (for ground structures, e.g. the scaffolding used for fairing integration in EPCU)

Lead-free soldering processes

The objective is to eliminate lead from soldering process and part/components terminations. While on the market several commercial components are already "lead-free", the challenge is in terms of achieving a final unit assembling actually "lead-free". The activity is on-going with promising results and final objective to achieve a "lead-free" process both at components and final assembled unit level

Conclusions

The Vega and Space Rider development programmes objectives provide several unique opportunities for a variety of missions, representing a complete Space Transportation System.

In this context, it is recognized the importance to cope with the upcoming regulatory challenges. While building on successful products, this is aimed to be achieved adding new elements whose technological challenges are kept under control through a stepwise approach with limited risks and associated costs.

In particular, all the main issues posed by REACH (hydrazine, Chromium Trioxide, lead) have been addressed since the early phases of the programmes in terms of top level requirement (obsolescence management) and factually by implementing several lines of activities:

- Hydrazine replacement by H2O2;
- Alodine 1200 replacement by alternative coatings (Surtec 650, PreCoat A32..)
- Lead-free soldering / units assembly process qualification

Thank You!