Product Assurance for Space Reusable Vehicle

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Space Rider

OBJECTIVE

To develop a **reusable orbital customizable/standardized system for multiple commercial and institutional applications** (microgravity, IOV/IOD for Earth observation, science, robotic exploration) able to perform in-orbit payloads operations, de-orbit, re-enter, land on ground and be relaunched after limited refurbishment

HERITAGE

Composed by a stack of 2 upgraded existing modules:

➔ **AVUM Orbital Service Module** derived from the AVUM+ upgraded with a life extension Kit

➔ **Re-entry Module** derived from the IXV re-entry demonstrator, upgraded to **land on ground** and **re-fly,** with a **Multi-Purpose Cargo Bay** dedicated to payloads

Image credit: European Space Agency (ESA)

More than two months in Low Earth Orbit

First European Reusable System

IOV/IOD and Microgravity experiments

CHALLENGES

➔ To develop and qualify the **first European reusable system to perform multiple missions into space,** enabling Europe to gain practical experience on reusability and re-flyability of flown hardware

➔ To **commercialise a novel service** for a variety of commercial and institutional space and non-space applications

THE SPACE RIDER SYSTEM AND MISSION

System Specificities

AVUM+ is VEGA-C 4th stage, with reuse of its main functions (Propulsion, Attitude Control, TLM) with minor adaptions required for thermal control

ALEK is the adaptation kit required for orbital life extension, acting as service module during the orbital phase and providing Power (Solar Panels), GNC & Propulsion

RM is a lifting body which carries the experiments/payloads inside the Multi-Purpose Cargo Bay, and returns to Earth for landing and re-flight

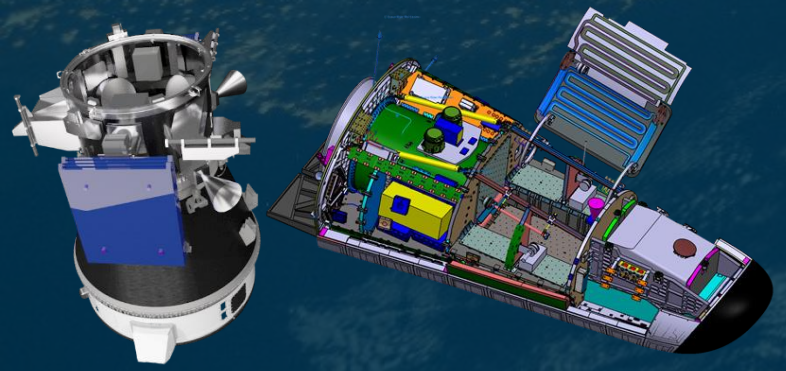


Image credit: European Space Agency (ESA)

Mission sequence

- Launch and Ascent Phase
- LEOP and Commissioning
- Micro-G Operational Mode
- Altitude Control Maneuver
- IOD/IOV Operational Mode
- Deorbiting
- AOM Safe Splash Down
- RM Landing
- Payload Recovery
- RM Refurbish for Re-fly

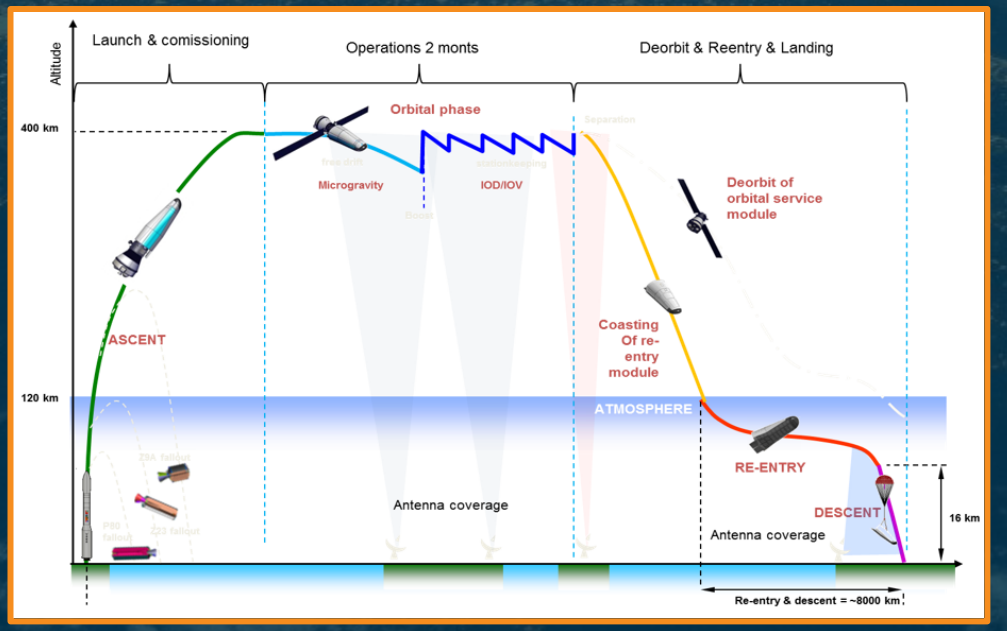


Image credit: European Space Agency (ESA)

Landing Sites

A Kourou (Primary) for Equatorial mission with max P/L capability

B S. Maria Azores (Secondary) for higher inclination missions

Image credit: European Space Agency

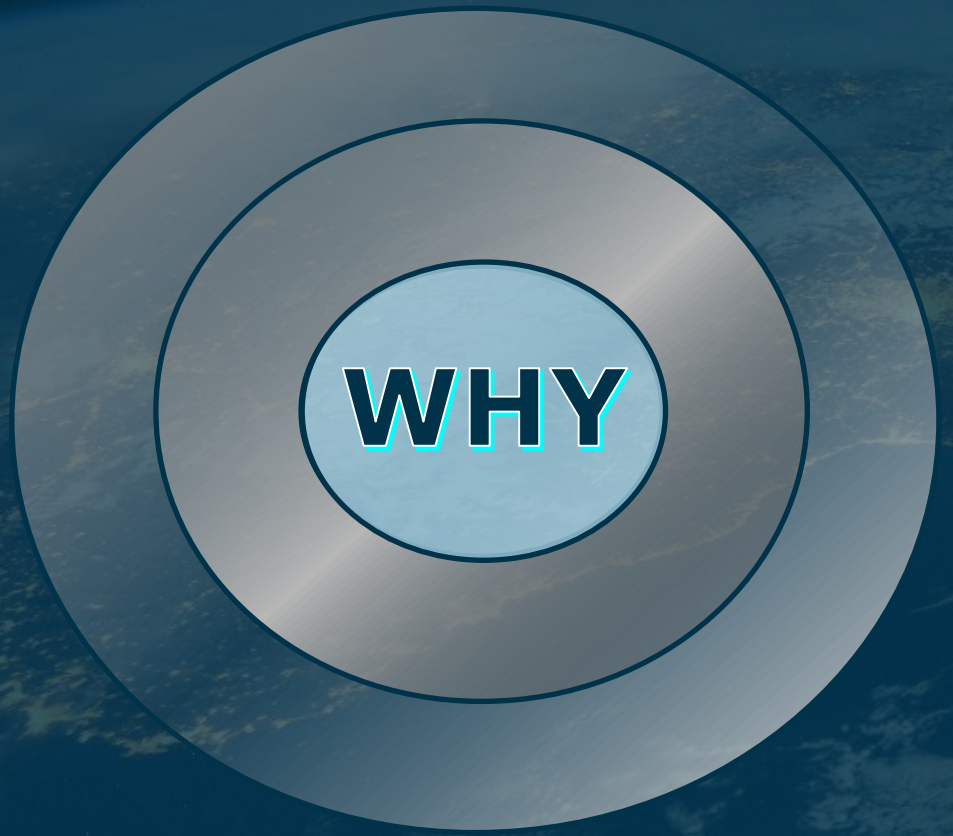
EUROPEAN STANDARDIZATION

European Cooperation for Space Standardization (ECSS)
- supported by several agencies and companies.

Currently, no European Standard for Reusability

..In Space Rider we implemented ad-hoc solutions to survive the lack of normative

REUSABILITY- the Golden circle

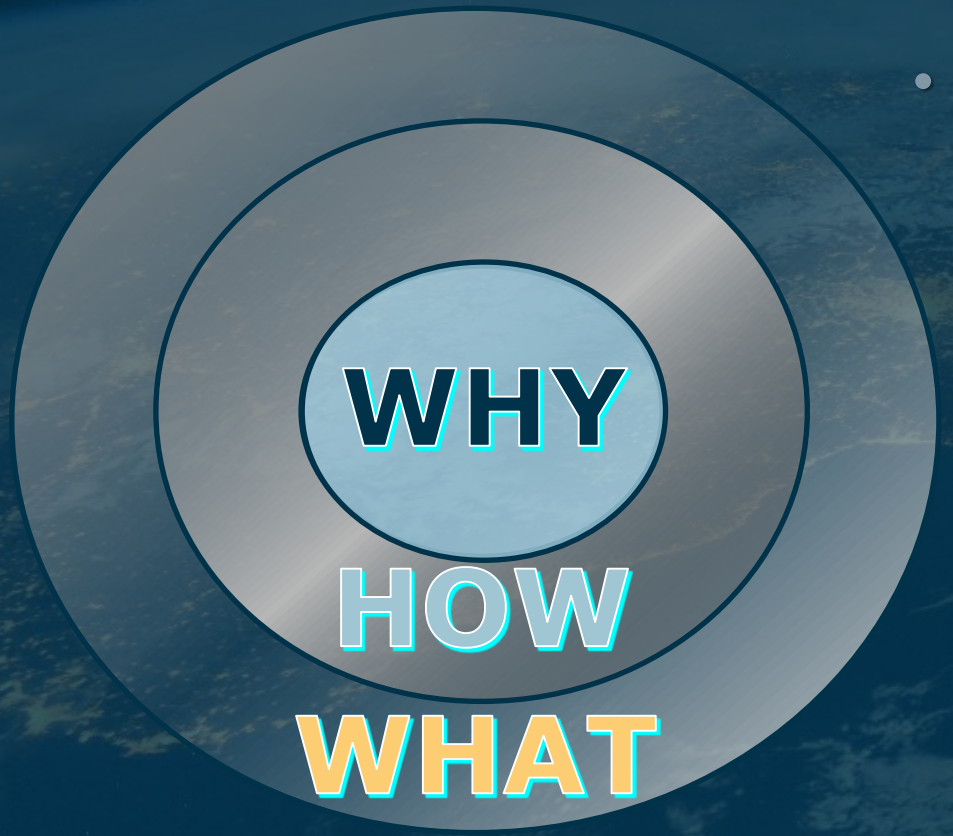


- Environment sustainability
- Cost
- Time
- Enhanced Reliability
- Commercial opportunity

REUSABILITY- the Golden circle

- Reusability by DESIGN
- Qualification
- Post-flight data analysis (mechanical & thermal environment, in-flight failures)
- Post-Flight Testability/Inspectability
- Refurbishment/Maintenance
- RE-FLIGHT worthiness

REUSABILITY- the Golden circle



- Spacecraft
- Space Launch Vehicle or stages

Image credit: Space X

Falcon 9 re-entry

Image credit: ESA

IXV recovery

Image credit: NASA

Crew Dragon recovery

Mission environment – Reusable space vehicle

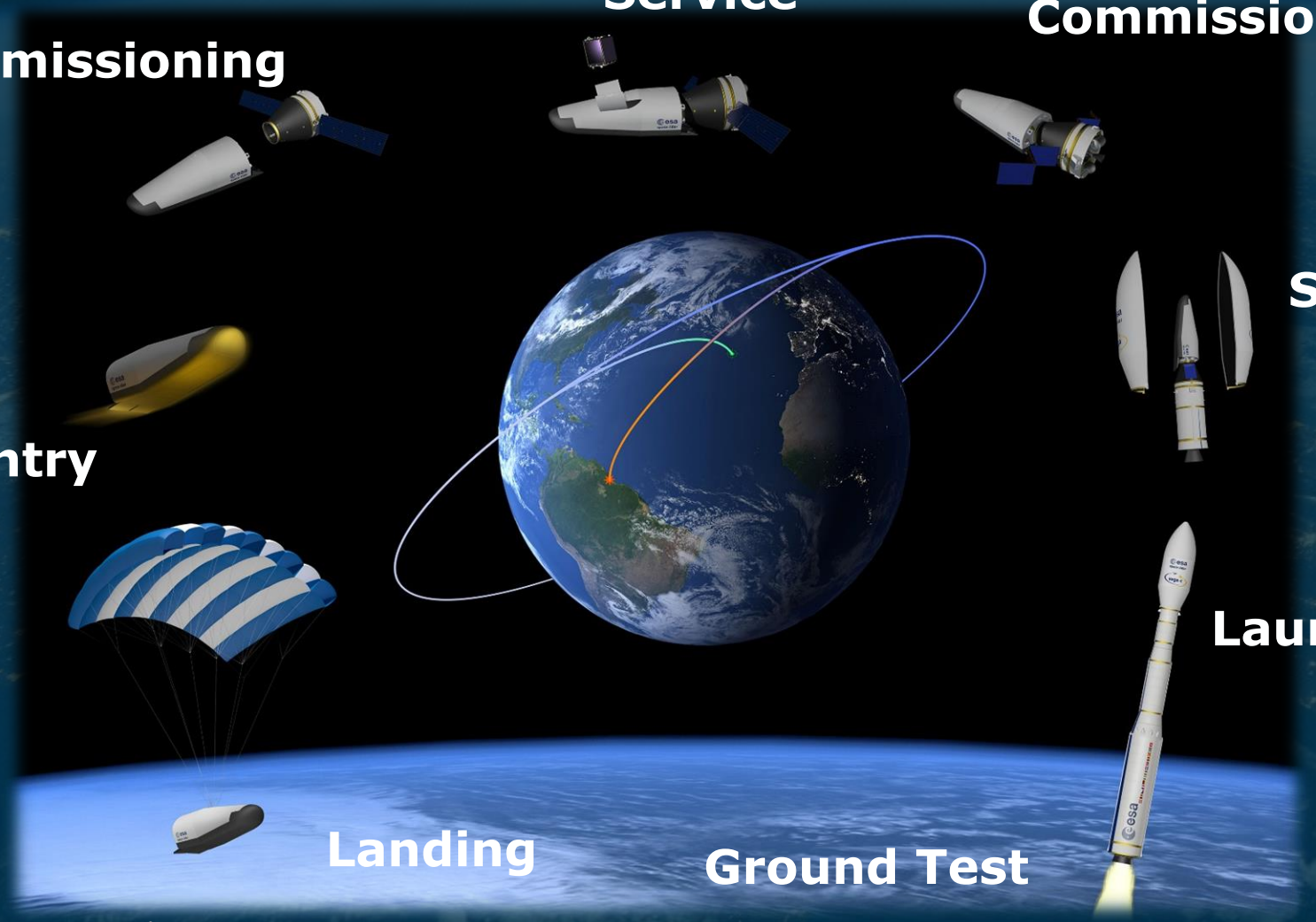


Image credit: European Space Agency (ESA)

Challenges for Reusability – PA focus

- Materials & Processes ➔Mission performances & degradation
- Reliability Analysis (test coverage, hidden failures)
- Quality Control for RE-Flight worthiness ➔ Post-flight Inspections, Inflight data analysis & Non-conformities, lesson learned

➔need for Standards for Reusability to cover:

- Material and processes Qualification guidelines
- Defects catalogue
- Post flight Inspections (NDIs), Tests
- In-flight Quality Control
- Preventive & Corrective Maintenance
- Reliability Modelling
- Spare policy

Space Rider case: Roadmap up to 1st Flight

Design Reviews
(Quality focus)

- Materials& Processes
- Electrical Component & Radiation
- SW Quality
- Reliability

1st STEP:
DEFINE& CONSOLIDATE the Design **FOR REUSABILITY**

Ground Qualification Reviews

SUCCESS?

2nd STEP:
VERIFY the Design **FOR REUSABILITY**

Flight readiness
(including acceptance tests)

SUCCESS?

3rd STEP:
PREPARE for The **FIRST** FLIGHT

1st FLIGHT

Space Rider case: Post-flight focus

...LEARNING!

1. In-flight Lessons Learned
2. In-flight Non-Conformances
3. System Health Monitoring

Post-Flight Data Analysis

Inspections
Tests
Maintenance

Post-Flight Review

Readiness NEXT FLIGHT

Delta Design..??
Delta Qualification..???
Delta Test..??

NEW CONCEPT:

"In-FLIGHT" VALIDATION at spacecraft level With "wider" Lesson Learned

Expectations

Gaps to be filled by the Standard:

- Safety re-entry
- Materials and processes qualification for reusability
- Post-flight Inspection and Testability
- Maintainability, Refurbishment, Repairability
- **Re-flight reviews**

Space Rider case:

- Reusability working group set guidelines
  - finalization and detailing done at project level
- Qualification plans and execution treated via RFA (Request for Approval) process, and RFD (Request for Deviation)

Future and proposals

- ESA is assessing the proposal of writing a handbook/technical note to address these gaps and set “common guidelines” for reusability
- This work will capitalize on the lesson learned from Space Rider and other demonstrator projects

Space Rider will be an important step for ESA towards reusability KNOW-HOW and experience

THANK YOU!
for your attention ☺

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Image credit: European Space Agency (ESA)