NASA & ESA
Partnership On The
The Multi-Purpose Crew Vehicle
Service Module

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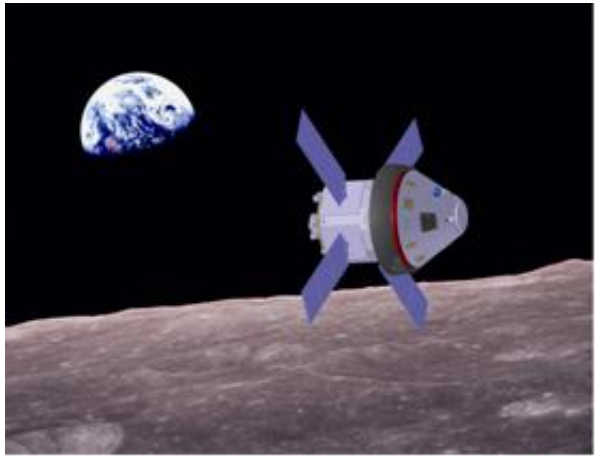
Introduction

- ESA decided in its Council Meeting in March 2011 to partially offset the European ISS obligations after 2015 with different means than ATVs
- The envisioned approach is based on a barter element(s) that would generate cost avoidance on the NASA side
- NASA and ESA considered a number of Barter options, NASA concluded that the provision by ESA of the Service Module for the NASA Multi-Purpose Crew Vehicle (MPCV) was the barter with the most interest.
- A joint ESA - NASA working group was established in May 2011 to assess the feasibility of Europe developing this Module based on ATV heritage
- The working group was supported by European and US industry namely Astrium, TAS-I and Lockheed-Martin.
- The project is currently in phase B1 with the objective to prepare a technical and programmatic proposal for an ESA MPCV-SM development. This proposal will be one element of the package that ESA plans submit to go forward for approval by European Ministers in November 2012.

MPCV Concept & Missions

- The Multi-Purpose Crew Vehicle (MPCV), is the spacecraft that NASA intends to use to send humans and cargo into space beyond low earth orbit and to return them safely to earth
- The first two exploration missions consider an uncrewed lunar fly-around mission for system qualification at the end of 2017 as well as a crewed lunar circular orbit mission no later than at the end of 2021
- The MPCV configuration includes
  - Habitable Crew Module (CM)
  - Service Module (SM)
  - Crew Module Adaptor (CMA)
  - Spacecraft Adaptor (SA)
  - Spacecraft Adaptor Jettisoned Fairings (SAJ)
  - Launch Abort System (LAS) for crew safety
- The CM is larger than Apollo's and can support more crew members for short or long-duration missions
- The SM fuels and propels the spacecraft as well as storing oxygen and water for astronauts

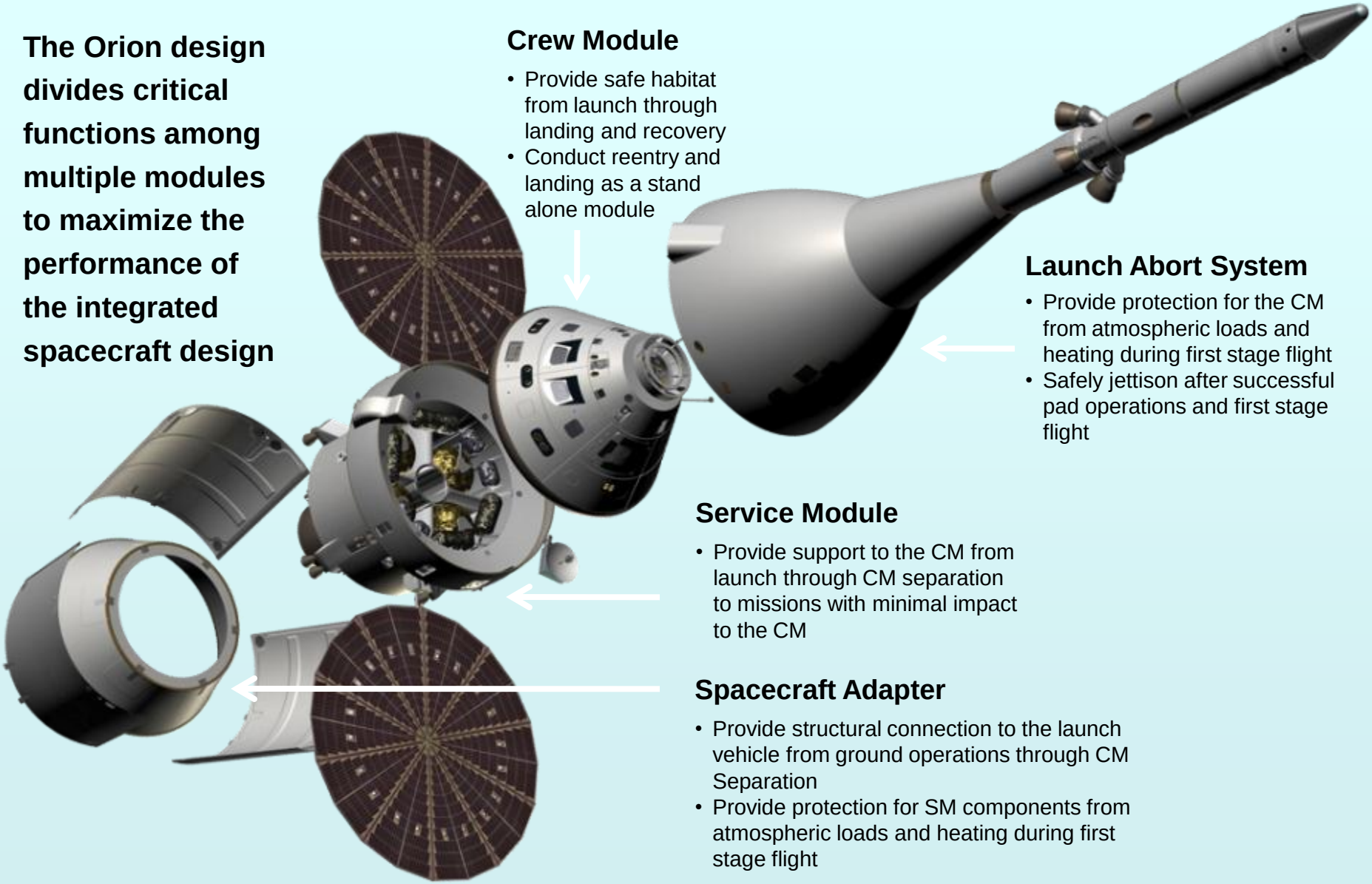
MPCV-CM (Orion)



MPCV with ESA SM

Spacecraft Overview

The Orion design divides critical functions among multiple modules to maximize the performance of the integrated spacecraft design



Crew Module

- Provide safe habitat from launch through landing and recovery
- Conduct reentry and landing as a stand alone module

Launch Abort System

- Provide protection for the CM from atmospheric loads and heating during first stage flight
- Safely jettison after successful pad operations and first stage flight

Service Module

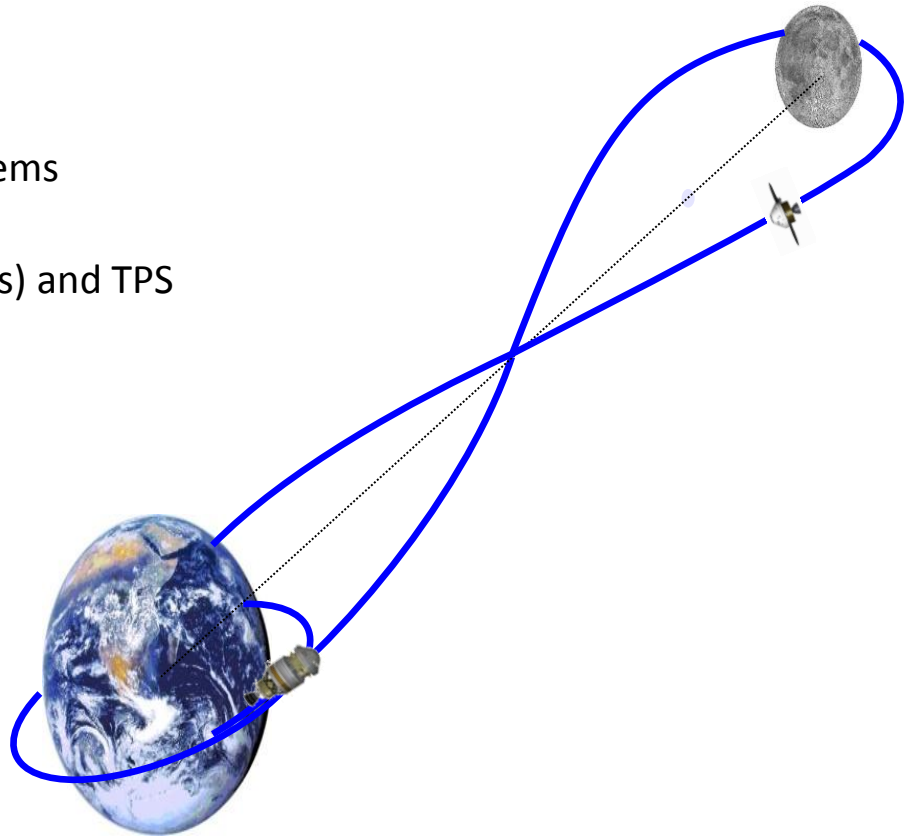
- Provide support to the CM from launch through CM separation to missions with minimal impact to the CM

Spacecraft Adapter

- Provide structural connection to the launch vehicle from ground operations through CM Separation
- Provide protection for SM components from atmospheric loads and heating during first stage flight

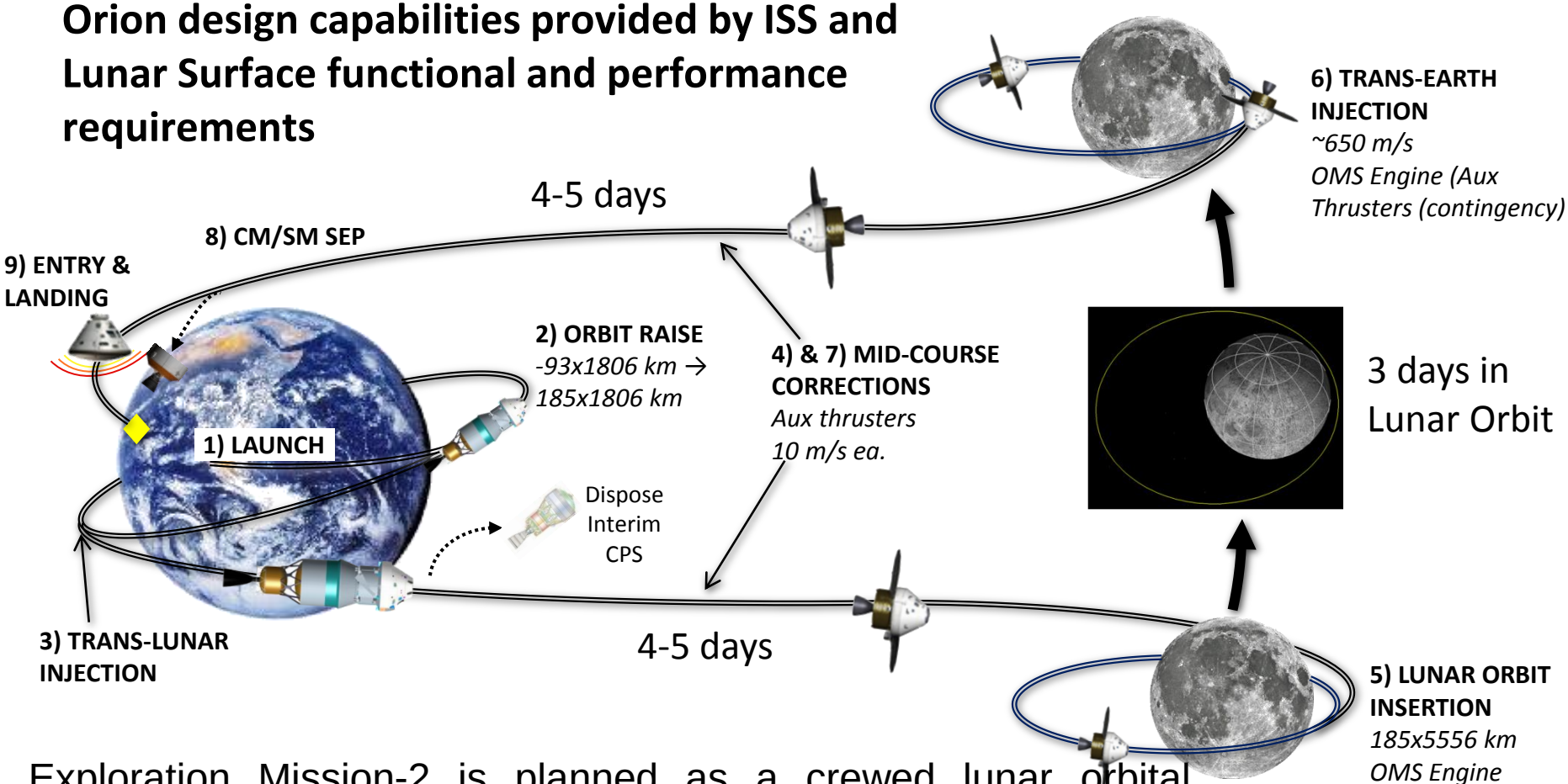
Exploration Mission 1 (EM-1) - Uncrewed High Lunar Orbit Mission Overview

- Mission description
  - Uncrewed circumlunar flight – free return trajectory
  - Mission duration ~7-10 days
- Mission objectives
  - Demonstrate integrated spacecraft systems performance prior to crewed flight
  - Demonstrate high speed entry (~11 km/s) and TPS prior to crewed flight
- Spacecraft configuration
  - Human-capable Orion
- Launch vehicle configuration
  - SLS Block 1
  - Interim Cryo Propulsion Stage
- Launch site
  - KSC LC-39B



Exploration Mission 2 (EM-2) - Crewed High Lunar Orbit Mission Overview

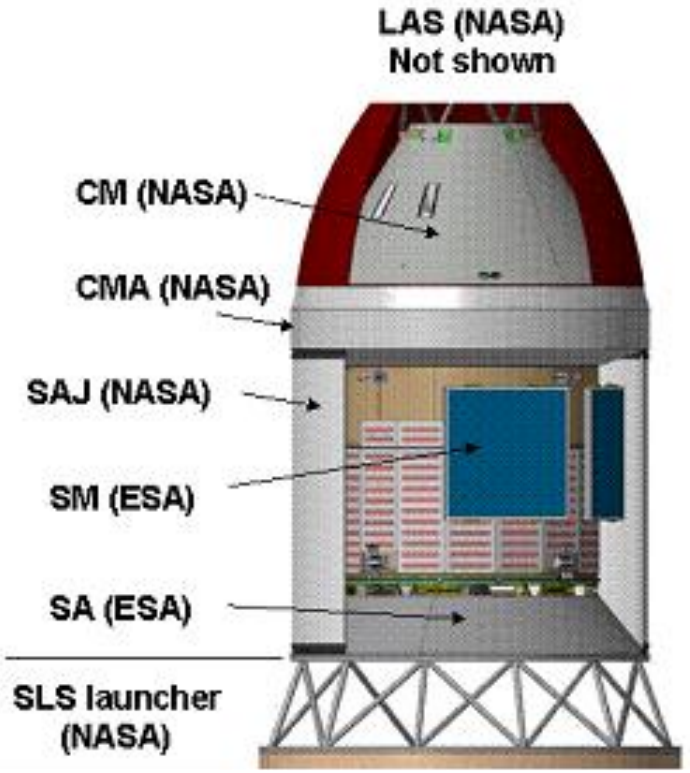
- **EM-2 mission design is tailored to fit within Orion design capabilities provided by ISS and Lunar Surface functional and performance requirements**



Exploration Mission-2 is planned as a crewed lunar orbital mission no later than 2021 , spending ca. four days in lunar orbit, overall duration of ca. 14 days.

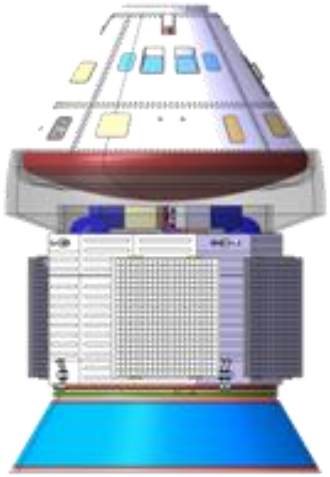
MPCV-SM ESA Concept

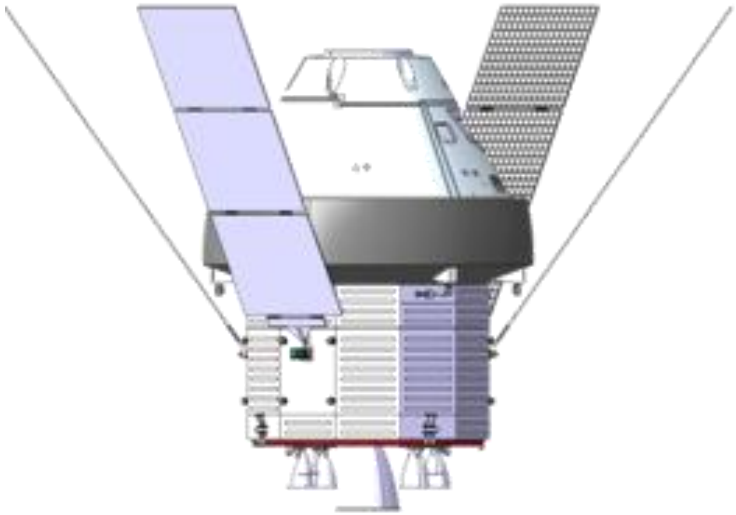
- The Crew Module and Service Module will physically interface via an interface ring called the Crew Module Adapter (CMA).
- The SM and CMA is attached to the CM from launch until just prior to the entry interface.
- NASA will be responsible for the CM, CMA, SAJ, and the LAS.
- ESA will be responsible for the Service Module and Spacecraft Adapter. The SM provides :
  - propulsion for ascent orbit circularization, orbital and reaction control maneuvering, trans-Earth injection, and mid-course correction maneuvers
  - life support consumables, power generation and storage, heat rejection, and volume reserved for unpressurized cargo
  - abort to orbit capability during portions of the launch profile
  - ISS backup capability for approach maneuvers, rendezvous, departure, and return trajectory



MPCV-SM ESA Concept

- **Major SM parameters for a lunar mission are:**
  - **Dimensions :** **ca. 4 x 4 m**
  - **Dry mass :** **ca. 3800 kg**
  - **Fuel :** **ca. 9200 kg**
  - **Solar array power :** **ca. 11 KW**
  - **Heat dissipation :** **up to ca. 5 KW**
  - **Propulsion :**
    - **1 main engine, ca. 30 KN**
    - **8 auxiliary thruster each 490 N**
    - **24 RCS thruster each 220 N**

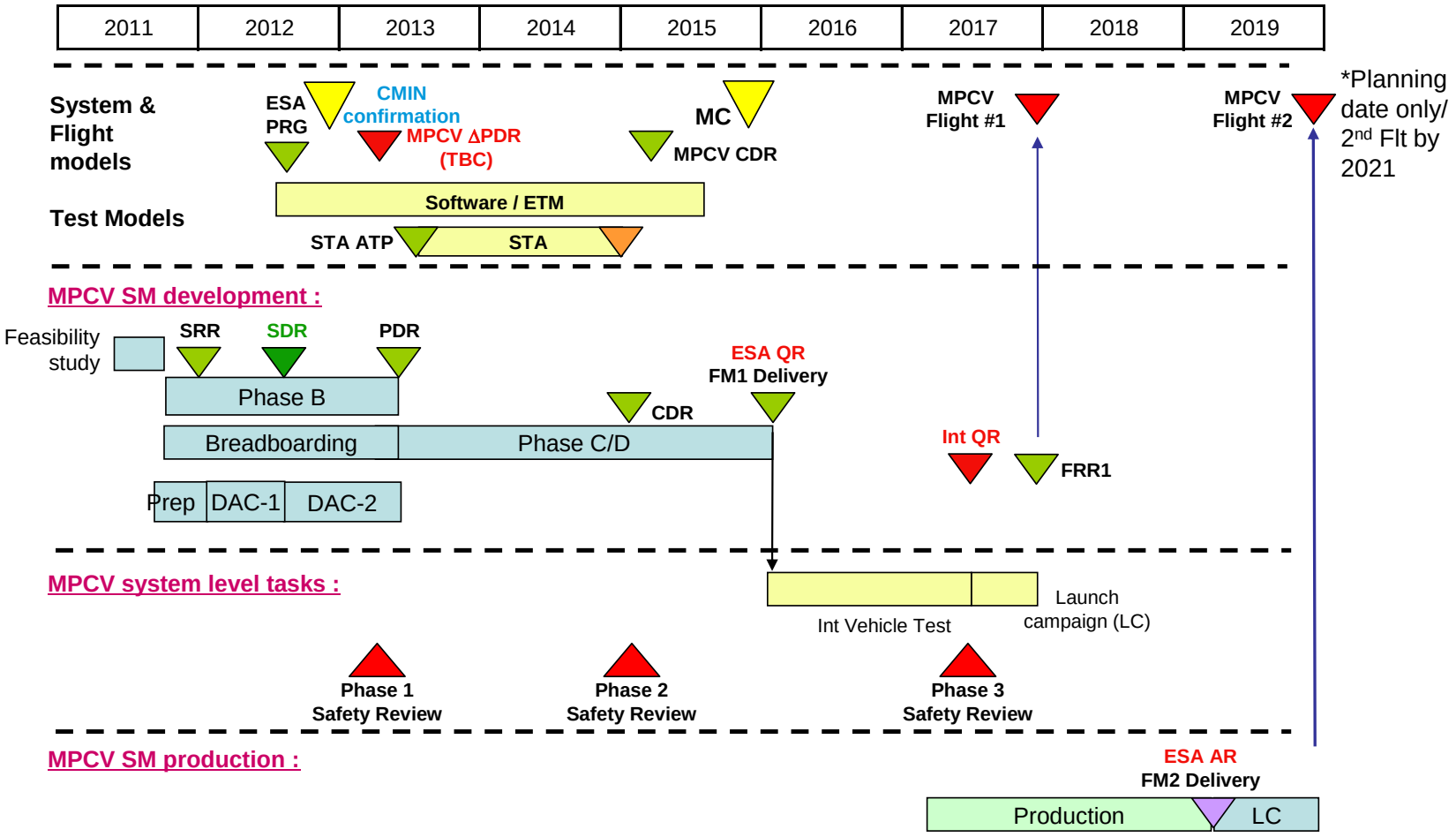




- **Ariane 5 compatibility to allow for possible future European application of MPCV SM design (e.g. as space tug)**

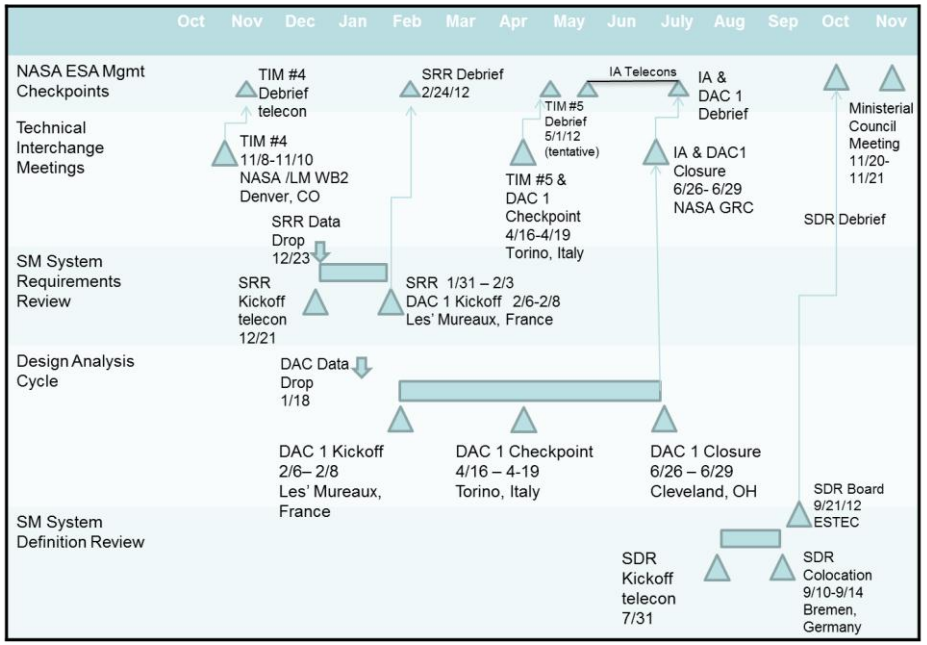
Programmatics

- **MPCV-SM Program Planning**



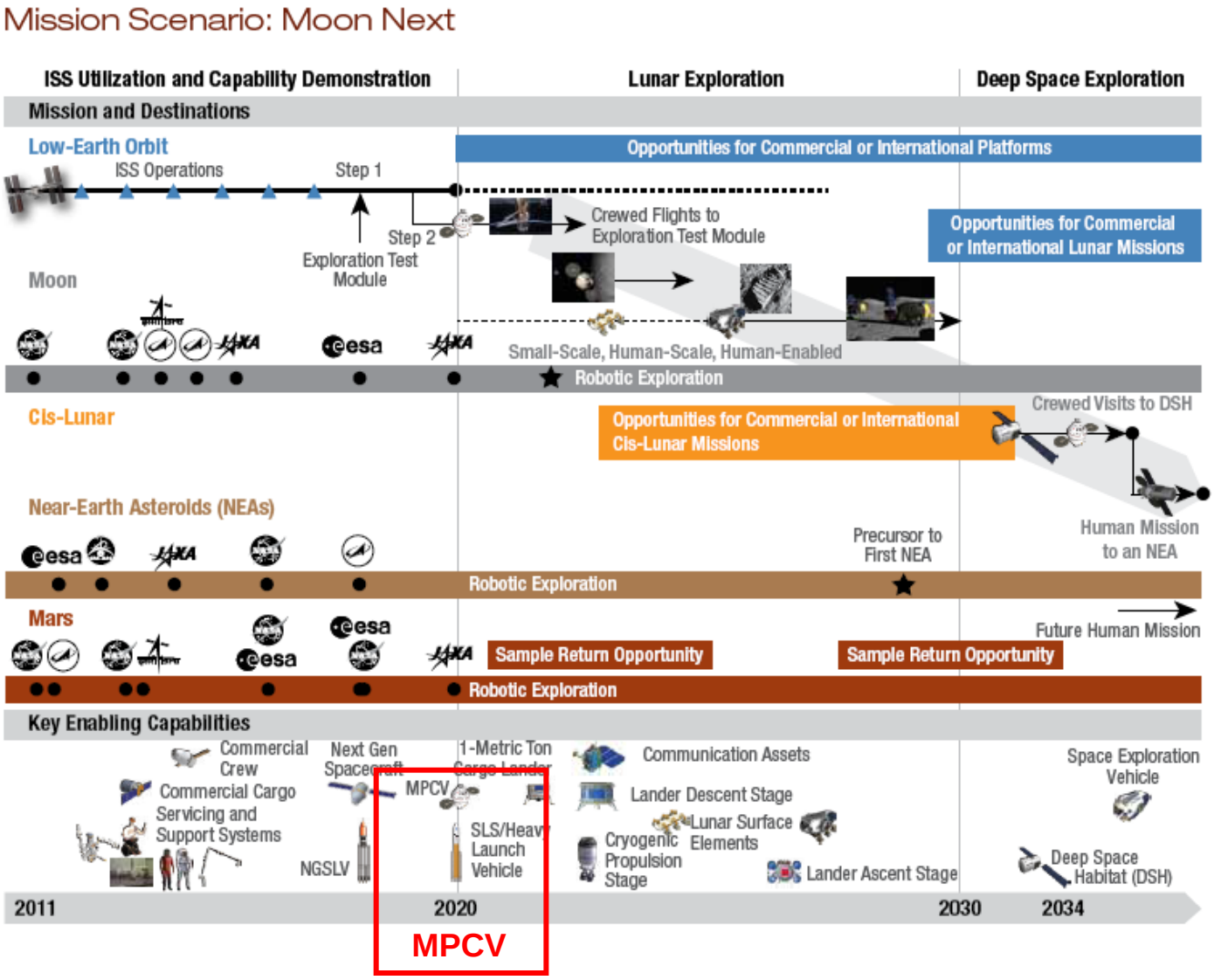
Project status

- Project phases 0/A have been performed between May 2011 and January 2012 concluding with a System Requirements Review early 2012.
- Phase B1 runs from February until November 2012 in order to prepare the technical and programmatic baseline for ESA - NASA decision about the implementation of MPCV-SM as a post ATV-5 barter.
- Phase B1 includes
  - integrated NASA - ESA (supported by industry) Design Analysis Cycle - 1 (DAC-1)
  - a joint System Definition Review SDR in September 2012.
- Industry teams :
  - NASA is industrially supported by Lockheed-Martin
  - In Europe Astrium in Bremen (prime) and Les Mureaux with TAS-I Turin plus other European suppliers from Germany, Italy, France, Belgium, Switzerland, the Netherlands, Spain and Austria



MPCV-SM Phase A/B1

Use in Global Exploration Roadmap



Conclusion

- The inclusion of an International Partner in the development of the MPCV can be of benefit to both NASA and ESA.
- Provides an opportunity for a significant International contribution towards NASA's exploration program.
- An ESA provided SM could accelerate the first crewed Orion MPCV flight by freeing the US contractors to concentrate on the Crew Module and Launch Abort System.
- An international partnership is consistent with the US National Space Policy .
- In addition, the MPCV SM provides ESA an opportunity for cooperation that builds on existing European knowledge and technology.
- An MPCV SM would also benefit ESA in the development of additional capability for use toward future ESA missions, creation of long term cooperation on future programs and strengthen the strategic partnership with NASA.
- The NASA and ESA teams including their respective contractors have worked very well together and have made swift progress towards the advancement of both a technical and programmatic baseline for an ESA provided SM.