Introduction

Orion is NASA's next exploration spacecraft to send humans into space. It is designed to send astronauts farther into space than ever before, beyond the Moon to asteroids and even Mars.

The first mission, called Artemis 1 will send the spacecraft beyond the Moon and back. This Artemis 1 will not carry a crew but will instead be controlled from the ground.

The spacecraft will perform a flyby of the Moon, using lunar gravity to gain speed and insert itself in a distant retrograde orbit around the Moon. The first Orion will travel 70,000 km beyond the Moon, almost half a million km from Earth – farther than any human has ever travelled.

The total trip will take around 20 days, ending with a splashdown in the Pacific Ocean without the European Service Module – it separates and burns up harmlessly in the atmosphere.

ESA has designed and is overseeing the development of the part of the Orion spacecraft that supplies air, electricity and propulsion. Much like a train engine pulls passenger carriages and supplies power, the European Service Module will take the Orion capsule to its destination and back.

More than 20 companies around Europe are now building the European Service Module as NASA works on Orion and the Space Launch System.

Artemis 2
Work is already well under way for the second mission that will propel astronauts further than ever before, also with a European Service Module.

The crew of up to four astronauts will fly Orion to 70,000 km beyond the Moon before completing a lunar flyby and returning to Earth. The mission can take a minimum of 8 days and will collect valuable flight test data.

Artemis 3
The contract to build the third European Service Module for Orion has been signed. The third Artemis mission will fly astronauts to Earth’s natural satellite in 2024 – the first to land on the Moon since Apollo 17 following a hiatus of more than 50 years.

ABOUT THIS DOCUMENT
This document contains links to download the images, infographics, videos and to visit web pages for more information. Explore the European Service Module through the series of infographics. Roll over the graphic elements to discover hyperlinks to more information on related webpages. Links to recommended images, videos and animations are provided towards the end of this media kit. An internet connection is required to access the external webpages.
What is Orion?

Orion is a NASA spacecraft set for missions to the Moon, Mars and beyond.

ESA has designed Orion’s European Service Module – the powerhouse that will supply the spacecraft with electricity, propulsion, thermal control, air and water.

This is the first collaboration between ESA and NASA on a transportation vehicle that will carry astronauts farther into space than ever before.

#ForwardToTheMoon
The spacecraft

**CREW MODULE**

Habitat for *four astronauts* and cargo from launch to landing.

Only part of the spacecraft that *lands back on Earth*.

**CREW MODULE ADAPTER**

*Connects* electrical, data and fluid systems between the main modules.

Contains electronic equipment for *communications, power and control*.

**EUROPEAN SERVICE MODULE**

Provides electricity, propulsion, *air and water*.

Keeps the spacecraft *at the right temperature and on course* to its destination and back.

**SOLAR ARRAYS**

The solar array turns on two axes to remain aligned with the Sun for *maximum power*.

#ForwardToTheMoon
The rocket – how to get to the Moon

Orion will be launched by NASA’s Space Launch System – the most powerful rocket ever built. The heavy-lift rocket will allow Orion to break free of Earth’s gravity to explore our Solar System.

- **Launch abort system**: If anything were to go wrong during launch, an abort will propel the crew capsule up and away from the danger, returning it to the ground by parachute.
- **Crew Module**: European Service Module and Crew Module Adapter
  - **Spacecraft adaptor**: Attaches Orion to the rocket. When the vehicle is on its way to space, the fairings are jettisoned.
- **Orion spacecraft**
- **Upper stage**
- **Core stage**

**Dimensions**
- Height: 98 m
- Diameter: 8.4 m

#ForwardToTheMoon
ORION

Dimensions

Crew Module
10 387 kg

European Service Module
15 461 kg

Height: 7.3 m

25 848 kg
= 5x

#ForwardToTheMoon
The spacecraft is designed for astronauts. Up to four people can travel inside the Crew Module.
The journey

1. Structure
   The European Service Module structure is built in Italy

2. Assembly
   The European Service Module is assembled in Germany

3. Transport
   Service Module and solar arrays transported from Germany to USA

4. Celebration
   European Service Module and Crew Module Adapter connected

5. Assembly
   Complete Orion Service Module and Crew Module at NASA's Kennedy Space Center, Florida

6. Testing before launch
   At NASA's Plum Brook station, Ohio

7. Rocket integration

8. Liftoff!

#ForwardToTheMoon
Artemis 1 step-by-step

1. Launch
   Liftoff from Kennedy Space Center, Florida, USA

2. Low Earth orbit
   Solar array deployment

3. Trans-lunar injection
   Propulsion standby for launcher/spacecraft separation

4. Outbound coasting phase
   Trajectory correction manoeuvres

5. Outbound powered lunar flyby
   Main engine burn (185 km above lunar surface)

6. Distant retrograde orbit
   Main engine burn for insertion

7. Distant retrograde orbit

8. Distant retrograde orbit departure
   Main engine burn

9. Inbound powered lunar flyby
   Main engine burn to return to Earth

10. Inbound coasting phase
    Trajectory correction manoeuvres

11. Service Module separation

12. European Service Module and Crew Module Adapter burn up

13. Splashdown in the Pacific Ocean

#ExploreFurther
Artemis 2 step-by-step

1. **Liftoff**
   Kennedy Space Center, Florida, USA

2. **Low Earth Orbit**
   European Service Module deploys solar arrays

3. **Perigee Raise Manoeuvre**
   Interim Cryogenic Propulsion propels Orion to a higher orbit

4. **Apogee Raise Burn**
   Second burn to high Earth orbit for 42-hour system checkout

5. **Separation**
   Interim Cryogenic Propulsion System separates from Orion

6. **Translunar injection**
   Orion's European Service Module main engine fires to propel the spacecraft to the Moon

7. **Outbound coasting phase**
   Four-day trip to lunar orbit with European Service Module correcting as necessary

8. **Lunar flyby**
   7500 km from the Moon's surface

9. **Return to Earth**
   Four-day trip with Return Trajectory Corrections supplied by Orion's European Service Module auxiliary engines

10. **Service Module separation**
    European Service Module and Crew Module Adapter separate from Crew Module

11. **Crew Module Reentry**
    European Service Module and Crew Module Adapter burn up

12. **Splashdown**
    Pacific Ocean

#ExploreFarther
Artemis 3 step-by-step

1. Launch
   Liftoff from Kennedy Space Center, Florida, USA

2. Low Earth orbit
   Solar array deployment

3. Trans-lunar injection
   Propulsion standby for launcher/spacecraft separation

4. Outbound coasting phase
   Trajectory correction manoeuvres

5. Outbound powered lunar flyby
   Main engine burn (185 km above lunar surface)

6. Gateway orbit insertion burn
   Rendezvous and dock with Gateway

7. Inbound powered lunar flyby
   Main engine burn to return to Earth

8. Human lander
   Landing on the Moon and return to Gateway

9. Inbound coasting phase
   Trajectory correction manoeuvres

10. Undocking
    Astronauts return to Earth in Orion

11. Service Module separation

12. Reentry
    European Service Module and Crew Module Adapter burn up

13. Splashdown in the Pacific Ocean

#ExploreFarther
The European powerhouse

Propulsion system
Main engine has enough thrust to lift a van on Earth.

Four tanks hold 8000 litres of fuel, enough to fill 200 cars with fuel.

Consumables
Supplies enough water and air for up to four astronauts on a 20-day mission.

Solar arrays
Provides enough electricity for two households.

Structure
Like the chassis of a car, the structure holds everything together.

Thermal control system
Heaters and coolant pumped through six radiators keep Orion running warm despite space temperatures of –75°C to +90°C.

Avionics
The brain: computers control all aspects of the European Service Module. Over 11 km of cables to send commands and receive information from sensors.

Supplies enough water and air for up to four astronauts on a 20-day mission.

Four tanks hold 8000 litres of fuel, enough to fill 200 cars with fuel.

Provides enough electricity for two households.

The European powerhouse

Like the chassis of a car, the structure holds everything together.

Heaters and coolant pumped through six radiators keep Orion running warm despite space temperatures of –75°C to +90°C.

Over 11 km of cables to send commands and receive information from sensors.

The brain: computers control all aspects of the European Service Module.
Orion relies on the engines of ESA's European Service Module to navigate and orient itself in space. The engines can be fired individually to move the spacecraft and rotate it to any position.

**Fuel**
- **Mixture:** MON oxidiser with MMH fuel
- Four tanks with 2000 l capacity each
- *Helium tanks* push the fuel to the engines

**33 engines, 3 types**
- Main engine has enough thrust to lift a van on Earth
- Eight backup thrusters *can lift* 50 kg each on Earth
- 24 smaller engines provide attitude control

#ForwardToTheMoon
The European Service Module provides air and water for the astronauts in the Orion spacecraft. The oxygen and nitrogen are stored separately, and mixed into the Crew Module for the astronauts to breathe.

240 litres of potable water

30 kg of nitrogen and 90 kg of oxygen

Enough to keep four astronauts alive on a 20-day mission

#ForwardToTheMoon
Four solar arrays provide electrical power to Orion. Each wing is made of three panels. The solar array uses gallium arsenide cells that are more efficient, resistant and lightweight. Provides enough electricity for two households: 11.2 kW. Provides more than double the power of ESA’s cargo spacecraft.
The European Service Module's structure is the backbone of the entire vehicle. The spacecraft withstands many stresses, from launch vibrations to temperature and pressure changes on its way to space. Like the chassis of a car, the structure holds everything together. Absorbs vibrations from launch – similar to the thrust of 34 Jumbo Jets. Covered with Kevlar to absorb shocks from micrometeorites and debris impacts.

#ForwardToTheMoon
Temperature control

Space is a harsh place with sharp changes in temperature. Radiators and heat exchangers control the temperature of the spacecraft to keep the astronauts comfortable and its equipment operating optimally.

Coolant is pumped in a closed circuit, similar to a car.

Six radiators outside the Service Module

Coolant: hydrofluoroether

Insulation: multi-layer insulation blankets

#ForwardToTheMoon
Avionics

The European Service Module's brain combines the full automatic capabilities of an unmanned vehicle and human spacecraft safety requirements.

Computers control all aspects of the service module.

Fly-by-wire: automatically regulates propulsion, water, electronics and temperature.

Over 11 km of cables send commands and receive information from sensors.

#ForwardToTheMoon
An international collaboration

**Germany**
- Prime contractor
- European Service Module assembly integration and verification
- Propulsion and propulsion drive electronics
- Centralised parts procurement agent
- Data network harness for Qualification Module
- Reaction control thrusters

**Italy**
- Structure
- Thermal control system
- Consumable storage system
- Power control and distribution unit
- Photovoltaic assembly
- Meteoroid and debris protection system

**Switzerland**
- Secondary structure
- Solar array drive assembly
- Solar array simulator
- Mechanical ground support equipment

**Belgium**
- Tank bulkhead
- Electrical ground support equipment
- Pressure regulation units

**France**
- System tasks
- Avionics qualification
- Direct current harness
- Electronics
- Helium filters

**USA**
- Gas tank
- Valves, pressure regulators and pumps
- Data network harness for Flight Module
- Main and auxiliary engines
- Solar cells

**Sweden**
- Propulsion Qualification Module integration

**Norway**
- Hydrophobic filter

**The Netherlands**
- Solar array wings

**Spain**
- Thermal control unit

**Denmark**
- Electronics
- Electrical ground support equipment

#ForwardToTheMoon
-orion-

→ ABORT SCENARIOS USING THE EUROPEAN SERVICE MODULE

Untargeted abort splashdown

1. Launch
2. Booster separation and jettison launch abort system
3. SLS main engines shutdown
4. Separation of Orion from SLS

#ForwardToTheMoon
5. Auxiliary thrusters fire to further separate Orion from launcher

6. Capsule separation

7. Capsule orientation and landing
Targeted abort splashdown

1. Launch
2. Booster separation and jettison launch abort system
3. SLS main engines shutdown
4. Separation of Orion from SLS

ABORT SCENARIOS USING THE EUROPEAN SERVICE MODULE
Firing of main and auxiliary engines to target a landing zone for splashdown

Capsule separation

Capsule orientation and landing
ABORT SCENARIOS USING THE EUROPEAN SERVICE MODULE

Ascent abort to orbit

1. Launch
2. Booster separation and jettison launch abort system
3. SLS main engine separation
4. Interim Cryogenic Propulsion Stage ignition and flight

#ForwardToTheMoon
Interim Cryogenic Propulsion Stage shutdown and separation

1. Auxiliary thrusters fire to further separate Orion from launcher
2. Firing of all thrusters for first burn to orbit
3. Firing of main engine to complete orbit insertion
4. Solar wings deploy
orion

→ ABORT SCENARIOS USING THE EUROPEAN SERVICE MODULE

1. Launch
2. Booster separation and jettison launch abort system
3. SLS main engines shutdown
4. Separation of Orion from SLS
5. ABORT
6. ABORT
7. #ForwardToTheMoon
**Untargeted abort splashdown**

1. Auxiliary thrusters fire to further separate Orion from launcher
2. Capsule separation
3. Capsule orientation and landing

**Targeted abort splashdown**

1. Firing of main and auxiliary engines to target a landing zone for splashdown
2. Capsule separation
3. Capsule orientation and landing

**Ascent abort to orbit**

1. SLS main engine separation
2. Interim Cryogenic Propulsion Stage ignition and flight
3. Interim Cryogenic Propulsion Stage shutdown and separation
4. Auxiliary thrusters fire to further separate Orion from launcher
5. Firing of all thrusters for first burn to orbit
6. Firing of main engine to complete orbit insertion
7. Solar wings deploy
Apollo

The Apollo spacecraft carried the first people to the Moon over 50 years ago. A complete lunar landing mission configuration was composed of the Apollo Command and Service Modules, plus a Lunar Module. The Command Module housed the crew and Service Module provided the propulsion for the lunar orbit insertion and trans-Earth burn for the return to Earth.

- **Crew**: 3
- **Length**: 9.9 m
- **Power**: Fuel cells
- **Launch weight**: 28 800 kg
- **Mission length**: 14 days
- **Distance traveled from Earth**: 400 171 km
- **Country**: USA

Automated Transfer Vehicle

Five Automated Transfer Vehicles delivered more than 31 500 kg of supplies over the course of their missions to the International Space Station from 2008 to 2015. They boosted the Station to raise its orbit numerous times and similarly moved it out of the way of space debris.
Orion
Orion is NASA's next spacecraft to send humans into deep space. It is designed to send astronauts farther into space than ever before, beyond the Moon and to asteroids. ESA has designed and is overseeing the development of the European Service Module, the part of the spacecraft that supplies air, electricity and propulsion.

USA and 10 European countries

7.3 m 33 446 21 days

Solar arrays 33 500 000 km

22.3 m 10 European countries

19 m 10 European countries

20 750 6 months

400 km

Automated Transfer Vehicle
Automated Transfer Vehicles delivered more than 31 500 kg in course of their missions to the International Space Station from 2008 to 2015. They boosted the Station to raise its orbit numerous times and similarly moved it out of the way of space debris.
Photos

- Acoustic testing, Structural Model
- Vibration testing, Structural Model
- Structure delivery
- Propulsion Qualification Model
- Working on propulsion
- Test article
- Test article assembled
- Test article with Crew Module Adapter
- Inside a rocket's belly
- View from below
- Waiting for the burn
- Orion's wings
- Fuel tank installation
- Fuel tank
- Radiator installation
- Packing the European Service Module
- Packing the European Service Module
- European Service Module team
- Moving the European Service Module
- Transport to Kennedy Space Center
- European Service Module 2 assembly
- Working on European Service Module 2 engines
- European Service Module 2 tanks
- First Orion complete
- Orion in Plum Brook
- Orion at Kennedy Space Center
Artist impressions

- Orion front view
- Orion side view with solar arrays unfolded
- Orion
- Orion back view
- Orion back view with solar arrays unfolded
- Orion
- Orion spacecraft launch configuration
- Orion leaving Earth
- Orion initial design
- Orion spacecraft
- Orion
- Orion spacecraft in Earth orbit
- Orion in the vicinity of the Moon
- Orion in the vicinity of the Moon
- Gateway over Moon
- European Large Logistic Lander approaching Moon
- European Large Logistic Lander unloading cargo
- European Large Logistics lander landing
Videos and animations

Orion from components to shipping
Orion engine firing
Shaking Orion's solar arrays
Human spaceflight and robotic exploration future
Orion and the European Service Module
European Service Module separation tests
Spacecraft materials kit classroom demonstration
Spacecraft materials kit challenge
How we are going to the Moon
Websites

Orion blog

Orion European Service Module Flickr
Media services

ESA Media Relations
media@esa.int
+33 1 53 69 72 99
European Space Agency
Headquarters, Paris, France

Rosita Suenson
Rosita.Suenson@esa.int
European Space Agency
ESTEC, Noordwijk, The Netherlands

Philippe Berthe
Philippe.Berthe@esa.int
European Space Agency
ESTEC, Noordwijk, The Netherlands

ESA Orion blog

www.esa.int/orion

@esaspaceflight
@esa
@NASA_Orion

Official hashtags: #ForwardToTheMoon
#ExploreFarther