

# European Exploration Envelope Programme (E3P) in Period 3 (2023-2025)

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- Terrae Novae in Period 3 (2023-2025)
- ExPeRT
- Leo, Moon and Mars future Studies
- Technologies for Exploration



# ESA has an exciting exploration plan

## TERRAE NOVAE 2030+

2020 > 2030

ESA in mutual inter-dependence

2030 > 2040

European-led capabilities



ExoMars  
2016



ExoMars  
2022



Mars Sample Return



Orion - European  
Service Module



Gateway – permanent  
habitation in deep space



Preparing to send humans to Mars



Living and working on the Moon



Core ISS Partner



Post-ISS  
Commercial stations



Cargo launch  
and return



Independent  
human transport



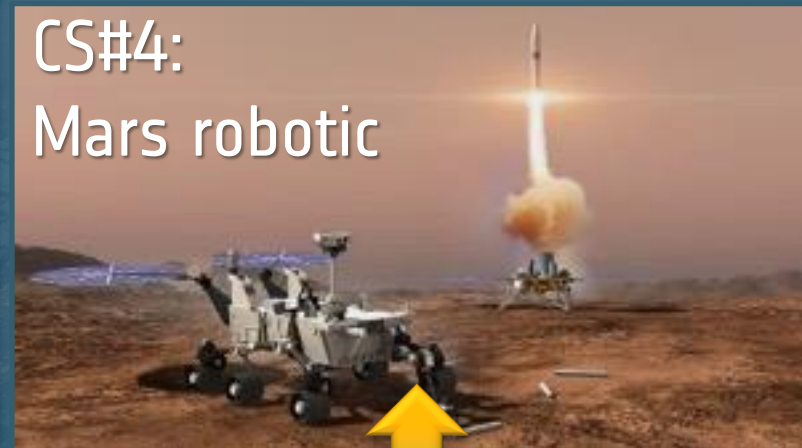


# E3P Programme Structure

Commercialisation as a cross-cutting theme



ExPeRT



SciSpace



ExPeRT = Mission studies and mid-TRL technology

SciSpace = Science in the Space Environment



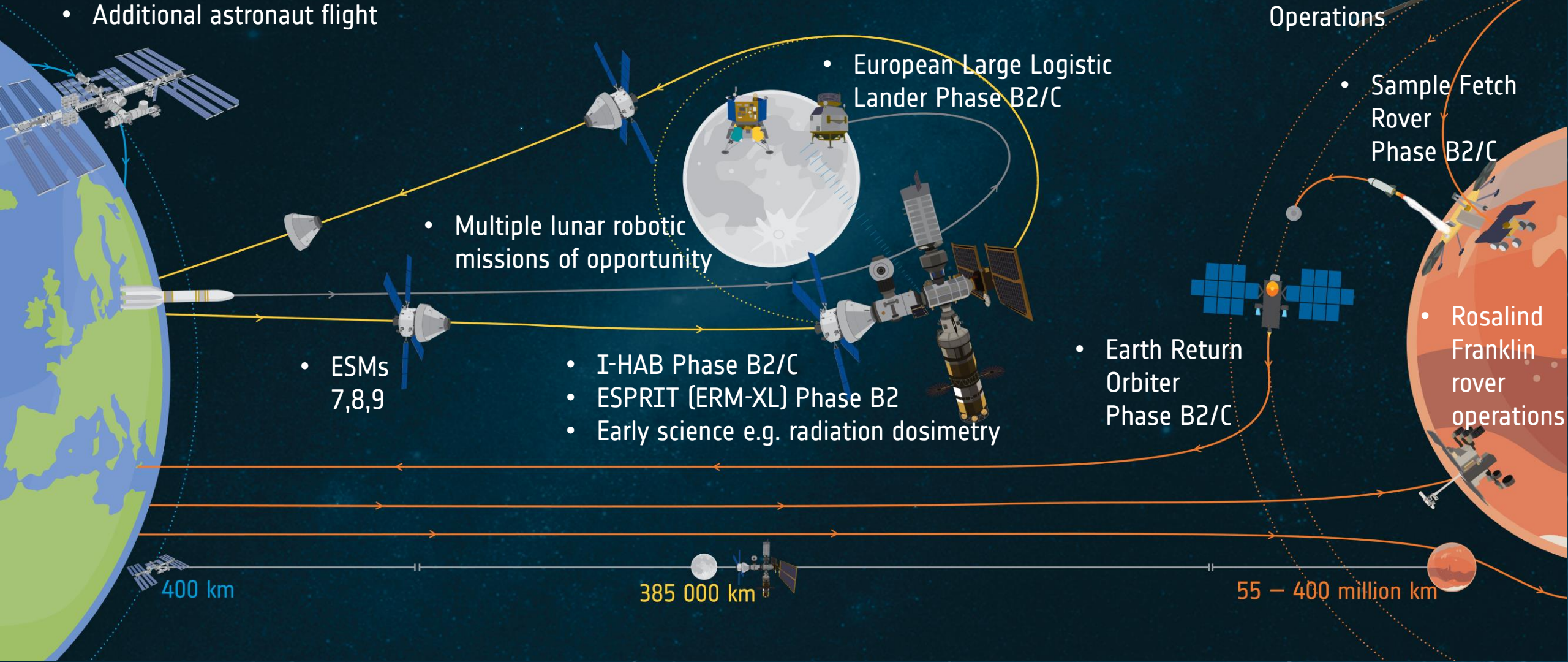
# Major elements of *Terrae Novae* Period 3 Programme Proposal



- ISS extension until 2030
- Science and technology
- One astronaut assignment
- Additional astronaut flight

- Business in Space Growth Network (LEO market stimulation)
- Future mission studies & technology (LEO, Moon, Mars)

- Trace Gas Orbiter Operations



- ESMS 7,8,9

- Multiple lunar robotic missions of opportunity

- European Large Logistic Lander Phase B2/C

- I-HAB Phase B2/C
- ESPRIT (ERM-XL) Phase B2
- Early science e.g. radiation dosimetry

- Earth Return Orbiter Phase B2/C

- Sample Fetch Rover Phase B2/C

- Rosalind Franklin rover operations

400 km

385 000 km

55 – 400 million km



# CM22: *Terrae Novae* Period 3 – continuity and new opportunities

SciSpacE = Science in the Space Environment

**CS#1:**  
Humans  
in LEO



**CS#2:**  
Humans  
beyond LEO



**CS#3:**  
Moon  
robotic



**CS#4:**  
Mars  
robotic



Continue Implementation of  
Projects, Science, &  
Operations agreed at  
Space19+

Fulfilment of current  
international commitments  
is top priority

Implement new Projects,  
Science, Operations

Candidate new activities  
increase autonomy  
and enable European  
boots on the Moon by

Start activities for  
implementation in Period  
4/5+

New mission studies

LEO commercialisation

Growing commercialisation

ExPeRT = Mission studies and mid-TRL technology



# Terrae Novae (E3P) Period 3: Executive Summary

**Political goals:** Europe at the top table of exploration and extension of ISS operations to 2030

## Key deliverables:

- ✓ 2 ISS astronaut flights
- ✓ First Orion/Gateway astronaut mission assignment
- ✓ Science in LEO; around the Moon; and on the Moon
- ✓ Implementation of option(s) for ExoMars Rosalind Franklin rover
- ✓ CDR level development of Gateway and MSR contributions

Candidate new activities  
increase autonomy  
... and enable European  
boots on the Moon by 2030

Fulfilment of current  
international  
commitments is top  
priority

Block 1  
Continue Implementation of  
Projects, Science, & Operations  
agreed at Space19+

Block 2

Implement new Projects,  
Science, Operations

Block 3

Start activities for  
implementation in Period 4/5+

New mission studies

LEO  
commercialisation



# European Large Logistic Lander (EL3) programme

- Enable European autonomy in lunar surface exploration
- European contribution to international lunar exploration programmes

□ up to 1.8 tonnes of payload to lunar surface, Ariane 64 block2/EVO bk2 launch

- Throttleable main engine
- precision GNC for landing in human operations environment
- night survival systems

Cargo/asset delivery for human exploration

Large research payloads



EL3 cargo lander as contribution to Artemis



EL3 delivering large scale science



## Commercial Exploitation of Existing Infrastructure



Commercial Lunar Services

## New Commercial Services



Post-ISS Business in LEO

## Market Stimulation across Europe



Commercial Services

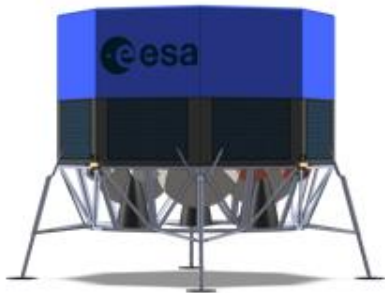


Commercial Products & Applications

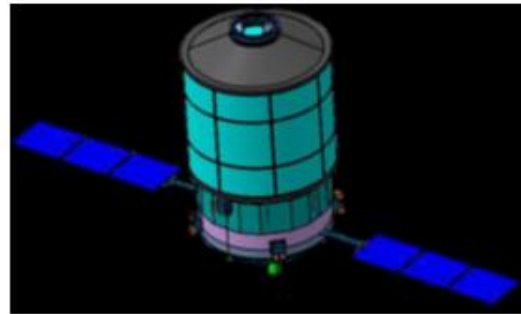


- By preparing the future, ExPeRT is **an enabling element for implementing the Terrae Novae 2030+ strategy**
- ExPeRT has the mandate to:
  - **Prepare & de-risk** future exploration missions, projects and associated technologies (Phase-0, Pre-Phase A, Phase A/B1);
  - Raise **critical technologies to TRL5** to facilitate selection and development of new exploration missions and projects;
  - Contribute to new **international partnerships** (both existing and new partners) to create future exploration opportunities;

Hence allowing Europe **to be flexible** and to adapt to a fast-evolving international exploration context



Phase A/B1: EL3 Moon Lander



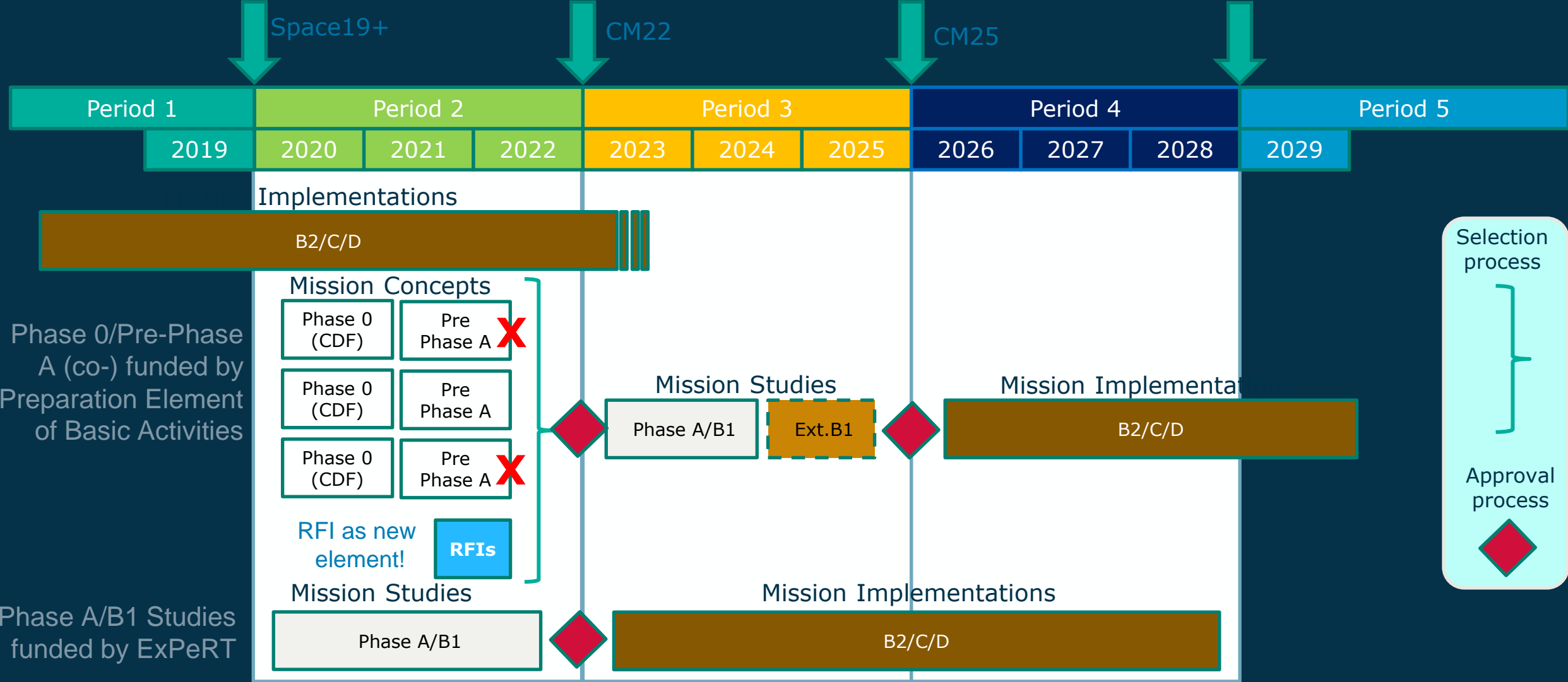
Phase A/B1: CLTV Transport Vehicle



Phase A/B1: ISRU DM



# ExPeRT: Phase A/B1 Mission Studies in Period 3



Phase 0/Pre-Phase A (co-) funded by Preparation Element of Basic Activities

Phase A/B1 Studies funded by ExPeRT

Note: A notional process flow is shown.



- Terrae Novae 2030+ strategy
  - ESA-PBHME(2021)19 rev1 (Feb. 2022)
- E3P Programme Proposal
  - ESA-PBHME(2021)23 rev1

- HRE-S for overall strategy and implementation coordination
- HRE-E (ExPeRT) for future missions and technologies definition
- HRE-R (SciSpace) for science strategy
- National experts and industry experts
- Workshops with Participating States and industry

# Mission Definition and Implementation

## HRE-E ExPeRT

- Phase 0/PrePhase A/Phase A/B1 for LEO, Moon and Mars
- Identification of Critical Technologies for Exploration Missions
- Definition of technology needs and requirements in coordination with D/TEC
- Technologies WorkPlan
- Technologies Maturation up to TRL5/6 in coordination with D/TEC
- Maturation of Technology P/Ls

## HRE-R SciSpace

- Definition of Science Strategy for Exploration
- Definition of Science content for LEO, Moon, Mars missions
- Call/AO for experiments
- P/Ls development
- Support to Phase 0/pre-Phase A/Phase A/B1/ Phase B2/CD/E studies and missions
- Science P/L developments

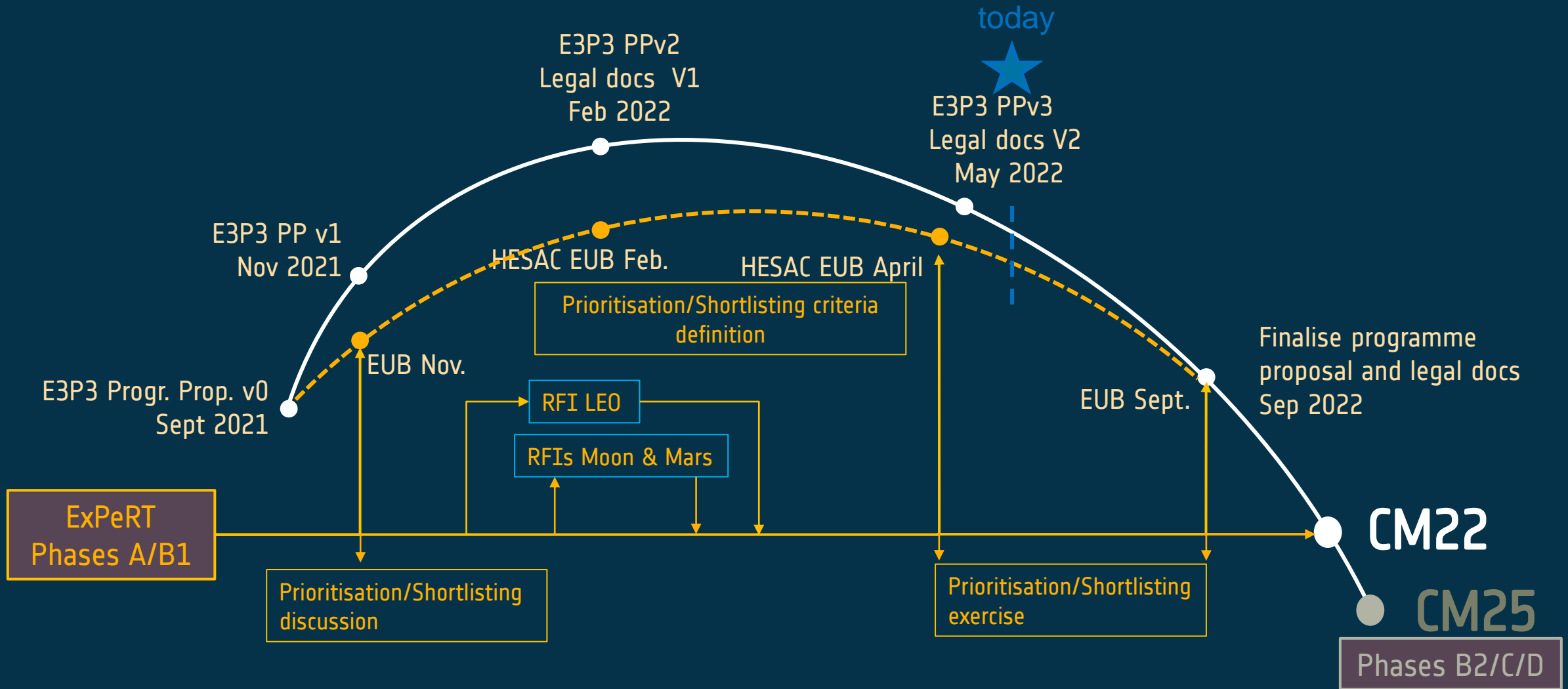
## HRE-O, HRE-L, HRE-M Destination leaders CS1-CS4

- Implementation Phase B2/C/D/E of LEO, Moon and Mars missions
- Maturation of technologies from TRL5/6 up to TRL8

- ESA HRE is engaged in a **prioritization and selection exercise** with the Member States and the Exploration Scientific Community (HESAC) in order to frame the future studies of Period 3 of Terrae Novae and to consolidate the programmatic and strategic planning.
- This process will benefit from **industrial insights** into the European capabilities and interests. It is exactly for this reason that ESA has issued a **Request For Information (RFI)** to European industry as initial step in a coordinated interaction with European stakeholders.
- **RFIs for Leo, Moon and Mars** have been issued in Dec 21 and we are now collecting and processing the results



# Roadmap CM22 – European Exploration Envelope Programme (E3P3)



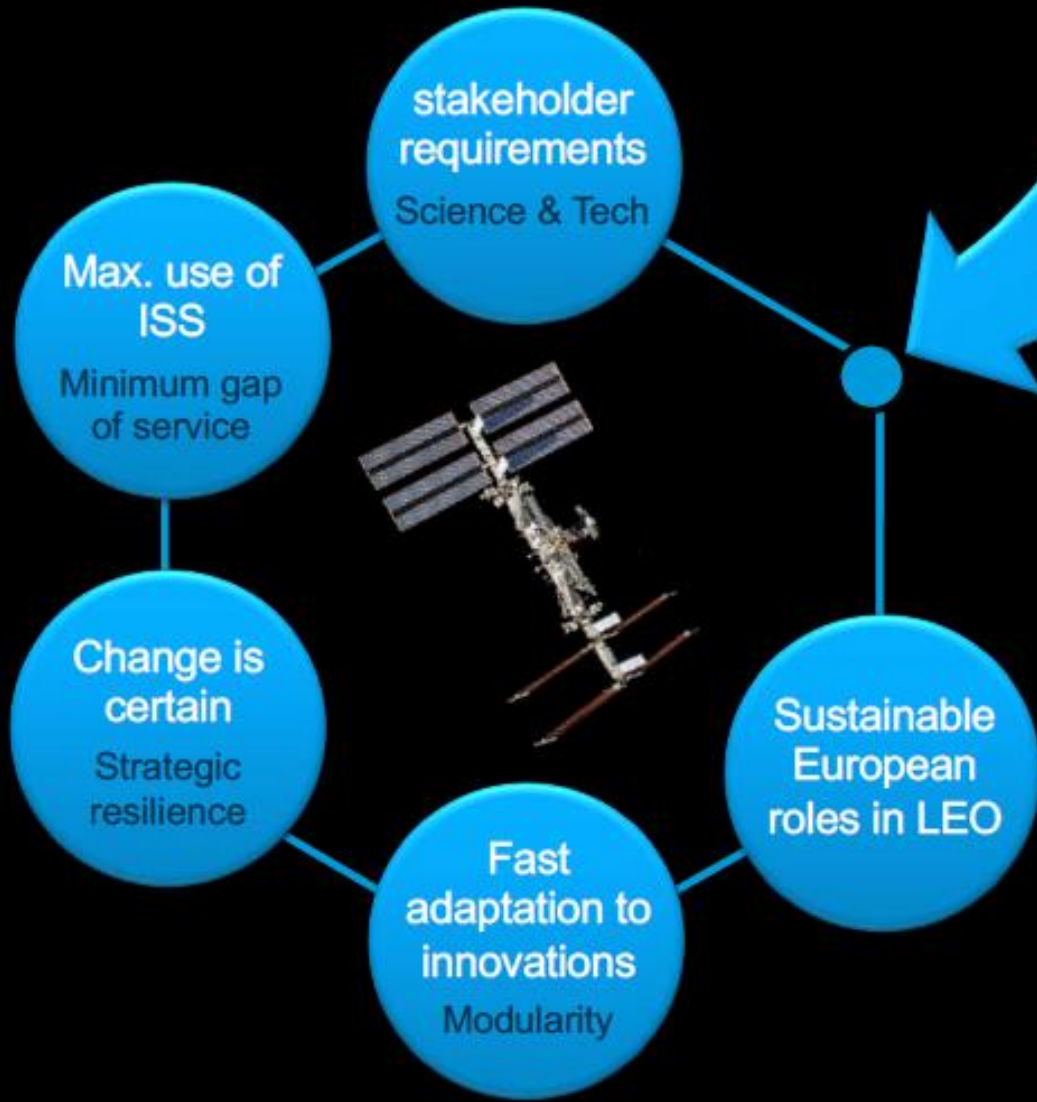
EUB = European Utilisation Board (Delegation level)

# - Low Earth Orbit -



# Making Space for Europe in Low Earth Orbit

- ESA heritage**
- Esprit
  - I-Hab
  - Orion ESMs
  - ATVs
  - Columbus
  - X-38
  - ARD
  - Spacelab



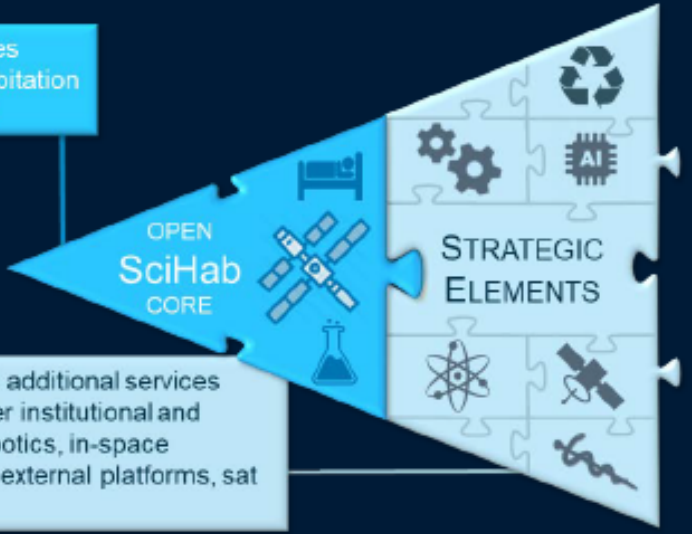
## Space transportation



## European roles in LEO

- On-orbit infrastructure & capabilities for science & technology
- Deep space exploration preparation
- European commercial services & operational competence
- Inspiration & European identity
- Leadership & international cooperation

- Providing post-ISS LEO services
- Covering basic science and habitation
- Open for partnerships, flexible



- Modular strategic elements and additional services
- Fulfil requirements of ESA, other institutional and commercial customers (e.g. robotics, in-space manufacturing, science airlock, external platforms, sat launches, AI, etc)

## Description

- Ensuring ESA's long-term LEO utilisation needs as well as commercial activities beyond 2030
- Issue Request for Information (RFI) on private sector interest to provide SciHab core and additional strategic elements as commercial services
- End-to-end commercial services to include cargo & crew transportation, operations, utilisation management, payload development, crew training elements and other

# SciHab LEO Concept

## Potential Technologies

- Science airlock & external platforms
- In-space manufacturing
- Satellite launches
- In-orbit servicing & refuelling
- Advanced Life Support Systems
- Robotics & AI
- Space-Based Solar Power Demos
- Human Mars Transit Technologies

## Science

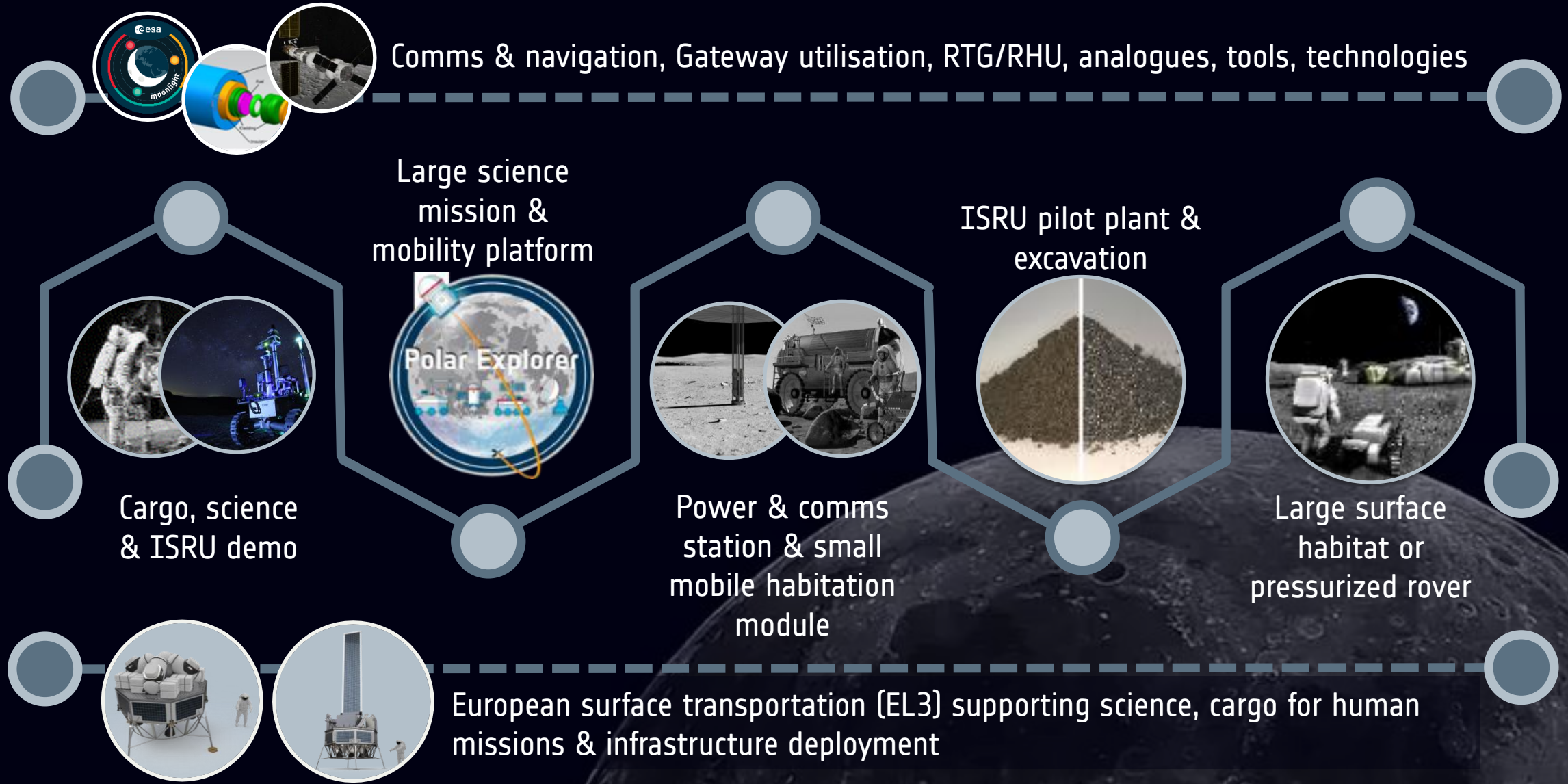
- SciSpacE strategy is in development
- In LEO, a particular focus will be on next generation microgravity research, including biology, material sciences, and long duration human research

## Schedule

- **RFI Release in Nov 2021**  
Offering maximum flexibility to industry to propose end-to-end service concept. Participation of non-European providers in European-led consortia is possible.
- **Next Steps**  
Intended open competition with selected companies to mature their concept of service

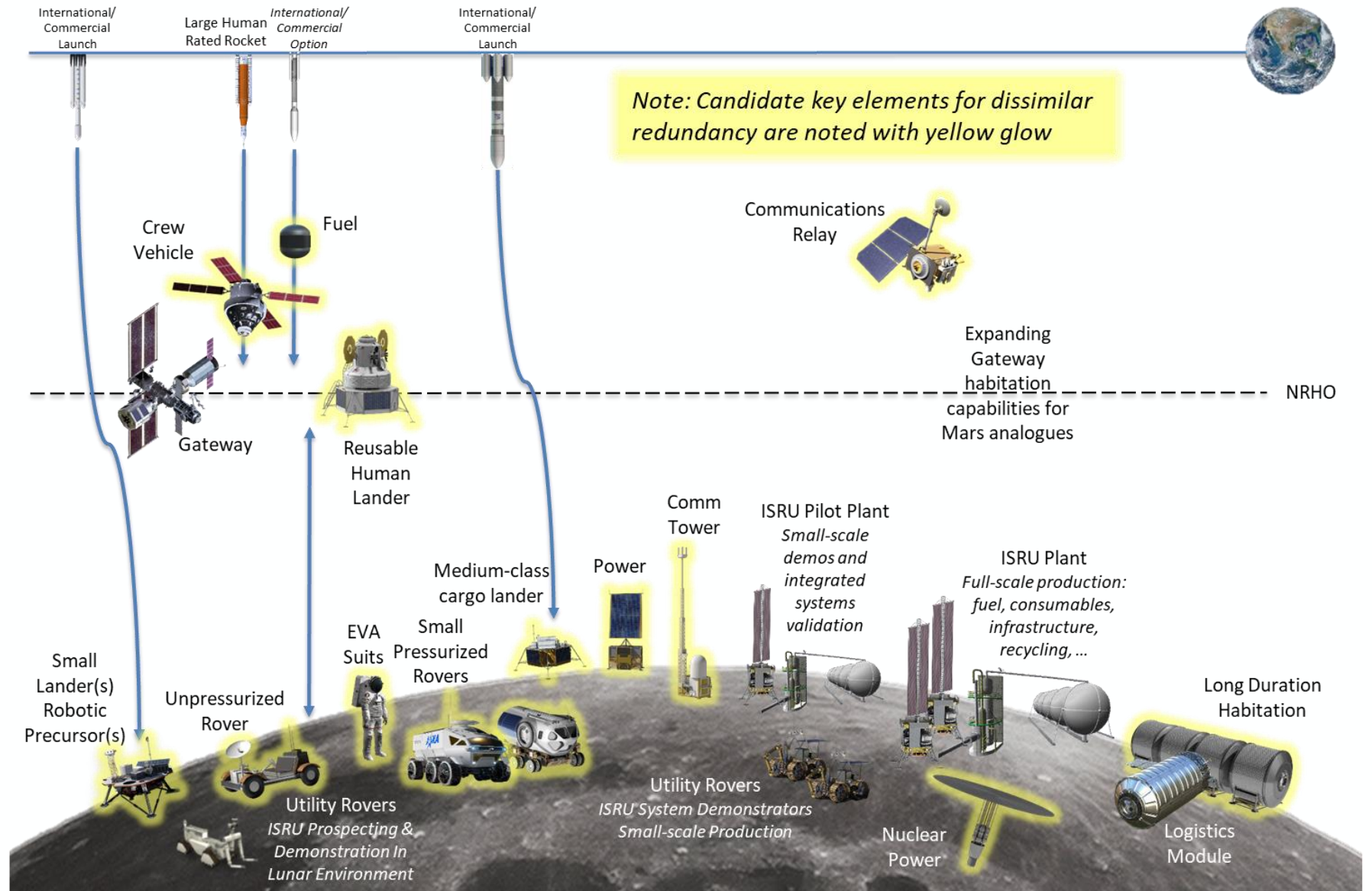
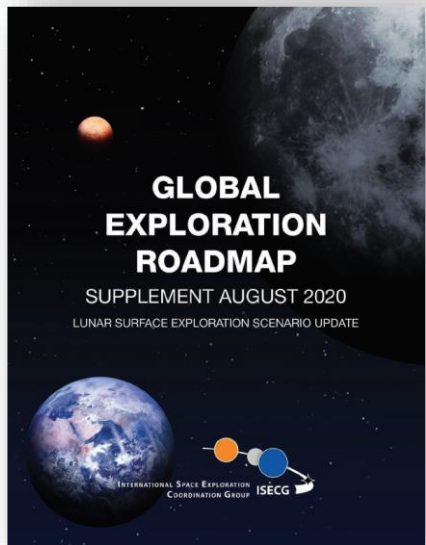
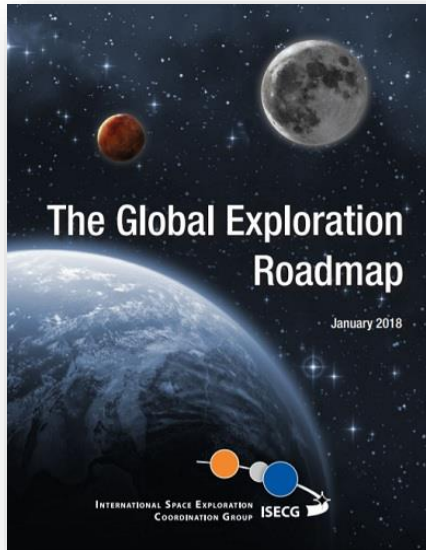


# - Moon Mission/Element Options -





# ISECG GER Lunar Surface Scenario



# Moon missions study candidates

- Cargo Logistic Mission (CDF study completed on Cargo CPE, pre-Phase A with Primes)
- Polar Explorer Mission (CDF study completed, pre-Phase A with Primes)
  
- Astrophysical Lunar Observatory (ALO) Mission (CDF study complete)
- European Charging Station for the Moon (CDF study complete on Power Plant, pre-Phase A in preparation)
  
- European Moon Rover System (EMRS) (Pre-Phase A released)
- Versatile Mobility Platform
  
- Bioscience on the Moon Mission (CDF study completed)
  
- Geology Mission (CDF study planned 2022)
- ISRU Pilot Plant Mission (CDF study complete in 2018, new CDF study planned in 2022)





## Description



- Multi-purpose modular mobility solution for future EL3 mission concepts requiring rover element:
  - Polar Explorer (science rover)
  - ALO (antenna deployment)
  - ISRU Pilot Plant (excavator rover)
- Mobility class of few hundreds of kg
- Precursors ground demonstrations using challenge-based innovation to attract non-space industry SMEs, start-ups, incl. in smaller Participating States

# European Moon Rover System (EMRS)



## Technology



## Science



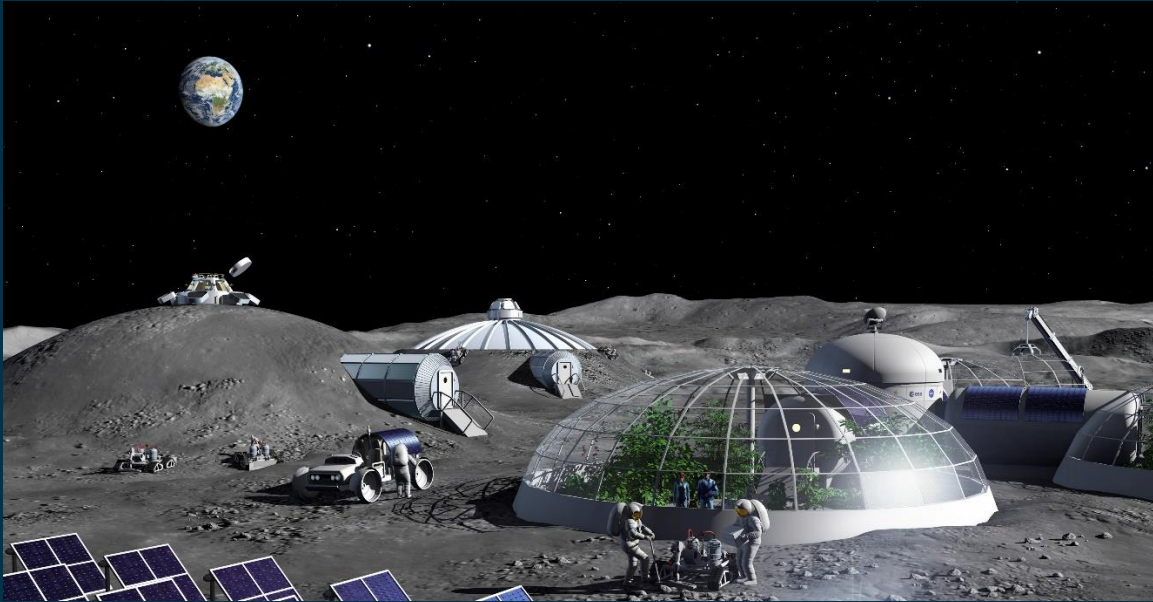
## Schedule

- Surface mobility considered key for planetary exploration
- Built on ExoMars/SFR rover heritage
- Technology maturation themes (e.g.):
  - Locomotion
  - Power, thermal & night survival
  - Communications & Navigation
  - Robotics
  - Dust resilience, etc.

- Science instrumentation based on mission concept
- Closure of knowledge gaps around surface mobility and exploration in lunar environment

- Pre-Phase A  
CDF (PE, ALO) completed in 2020/21  
Open ITT for pre-phase A in 2022
- Potential Phase A/B1  
Advanced rover study in parallel to EL3 and payload developments in P3
- Possibility to be provided / co-developed by national agencies





- Study to understand common platform baseline of a versatile and modular surface locomotion platform for crewed and uncrewed mobility in 2030-2040 timeframe, e.g.
  - ❖ Infrastructure deployment (e.g. surface habitat elements)
  - ❖ Short-range unpressurised crew mobility
  - ❖ Long-range pressurised mobility
  - ❖ ISRU related transportation capability

## Versatile Mobility Platform



### Technology

- Progress and breadboards/ demonstrators for locomotion, navigation, communication, night survival, dust resilience, etc.
- Pressurised cabin for crew mobility
- Life support
- Power



### Science

- SciSpacE strategy is in development.
- Possibility of human-subject and human-tended science
- Possibility to accommodate integrated scientific instrumentation



### Schedule

- Potential Phase A/B1 Studies starting in 2024

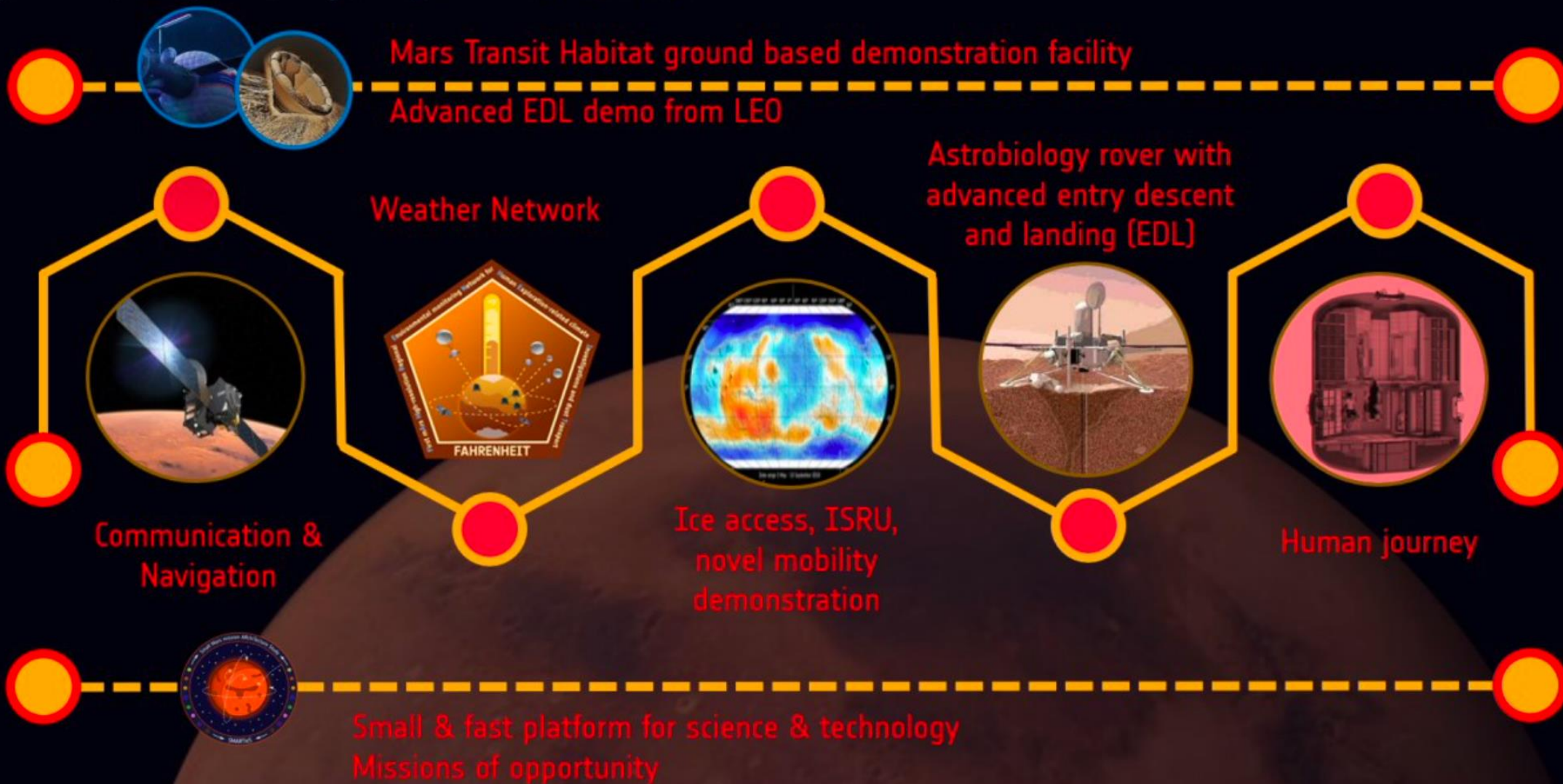


# - Mars Mission Options -



# TERRAE NOVAE 2030+

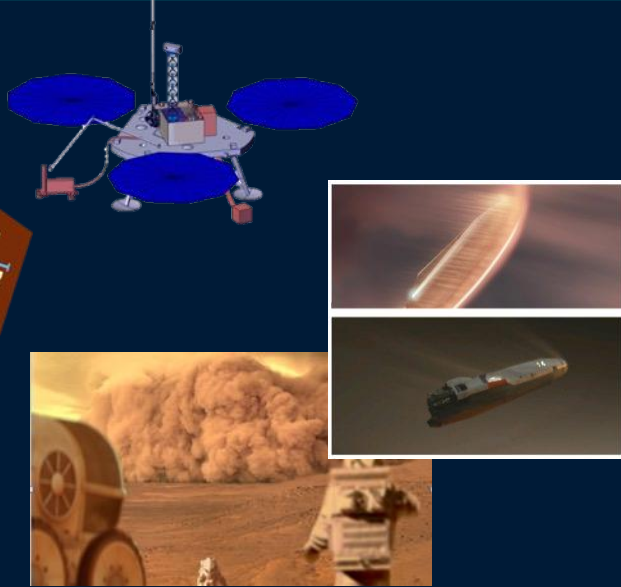
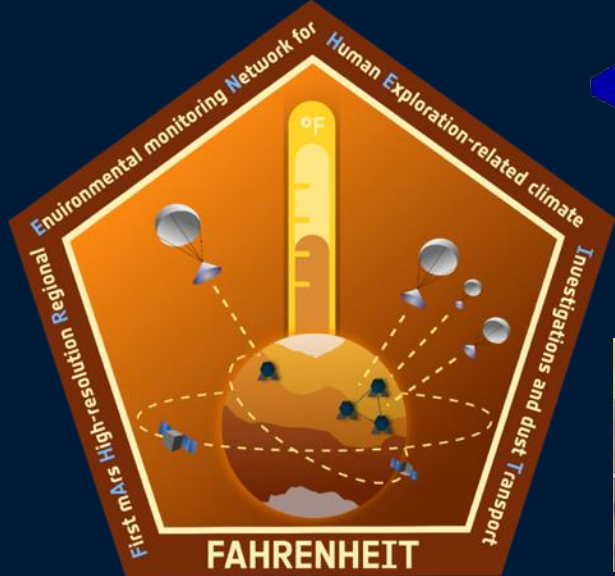
# Mars





# Mars missions study candidates

- Weather Network Mission (CDF study completed, FAHRENHEIT)
- Ice Access Lander and ISRU Demonstration Mission (CDF study completed, ARMADILLO)
- Small Science Orbiter with Aerocapture Demonstrator (built upon SMARTIES CDF study completed in 2020 and Small Mars missions industrial studies completed in June 2021)
- Communication and Navigation Network Infrastructure Mission (on-going internal ESA study group, MARCONI)
- Mars Transit Habitat – Ground Demo Facility (built upon MARGARITA CDF study completed)
- Advanced EDL demonstrator from LEO



## Description

- Multi-orbiter/lander network offering comprehensive climate & weather studies, feeding forward to human exploration through improving knowledge of atmospheric behaviour, origin of dust storms and transport of biological contamination for planetary protection
- Secures end-to-end European Entry, Descent & Landing capability, through full use of European technologies and multiple landings in the same mission
- Opportunity for robust partnerships with clean interfaces

# Mars Long-lived Weather Network Mission

## Technology

- Throttleable monopropellant landing engine
- Lightweight, large area solar arrays
- Solar array dust cleaning systems
- Highly-integrated avionics
- RHUs (possibly RTGs), landing legs

## Science

- SciSpacE strategy is in development.
- Atmosphere, dust and radiation investigations to learn about Mars for planetary knowledge and to inform human exploration to Mars
- Studies on anthropogenic contamination of Mars to support planetary protection as Mars exploration activities increase

## Schedule

CDF completed in 2021, pre-Phase A intended in 2022

- **Potential Phase A**  
2023: In 'competition' with Ice Access, Astrobiology and ISRU Demo Mission
- **Potential Phase B1**  
2024-2025: Down-selection of one of the concepts
- **Potential Phase B2-C-D**  
Implementation decision at CM25 for launch in 2033

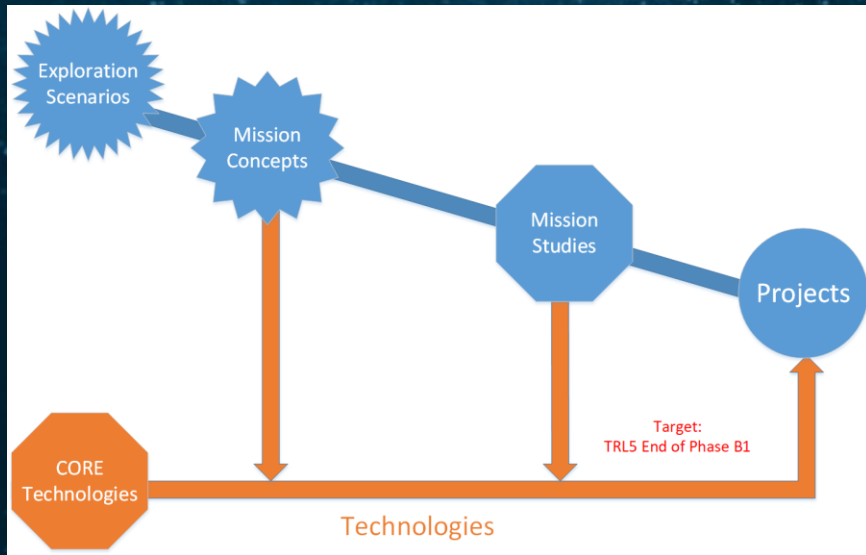




# - Technologies for Exploration -



- Timely development of critical technologies is essential to achieve optimum cost and performance on time
- ESA requires TRL5 for new technologies by end of system Phase B1
- Principle of maximising open competition for the excellence of the products



Activities	Generalised institutional programme expectation of TRA outcome per phase						
	PHASE 0	PHASE A	PHASE B	PHASE C	PHASE D	PHASE E	PHASE F
TRA for current project	up to TRL6						
Mission / Function	MDR	PRR	SRR	PDR			
Requirements					CDR		
Definition					QR	AR	
Verification							
Production						FRR	CRR
Utilization							
Disposal							LRR
TRA opportunity for following projects			TRL6		TRL7	TRL8	TRL9
							ELR
							MCR



1. Propulsion
2. Novel Energy Systems
3. Robotics and Mechanisms
4. Artificial Intelligence
5. Advanced Life Support Systems
6. In-Situ Manufacturing
7. Crew Health Management
8. Space Resources
9. Radiation Protection
10. Communication and Navigation
11. Subsurface Sampling/Deep Drilling
12. Guidance Navigation and Control
13. Avionics
14. (re-)Entry Descent and Landing
15. Thermal Control Systems
16. Mission Operations Data Systems



ExPeRT activities in the optional E3P are coordinated with the mandatory Discovery, Preparation and Technology Programme and the optional General Support Technology Programme (GSTP) through internal TECNET Working Groups

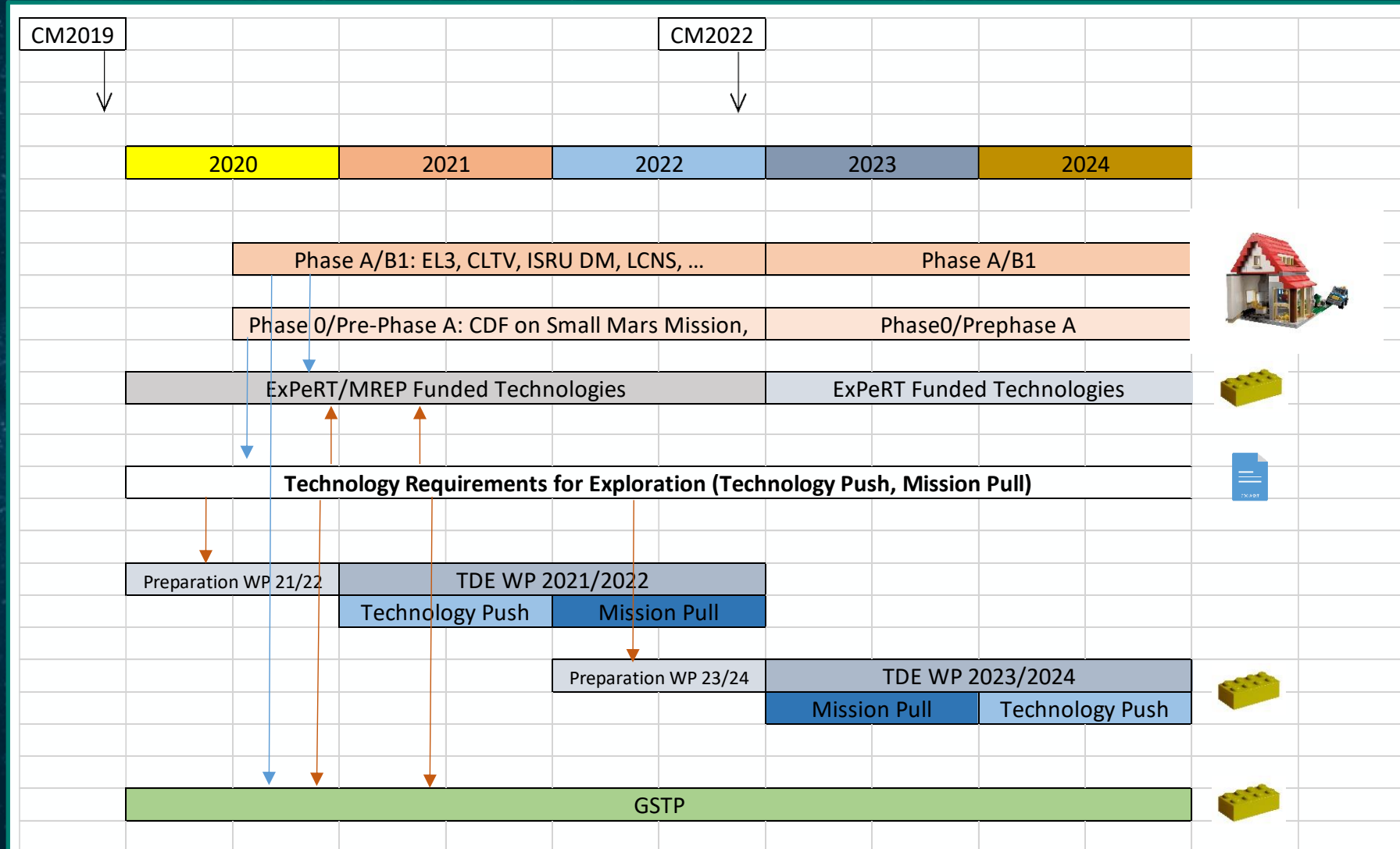
Thus exploration technologies can exploit 3(4) funding pillars:

1. TDE (ex-TRP): TRL1 → TRL4 (technology push or mission pull)
2. GSTP: TRL3 → TRL9 (product competitiveness or market pull)
3. ExPeRT: TRL3 → TRL5/6 (mission Pull or core capability)
4. (MREP: legacy programme nearing completion – TRL4 → TRL6: mission pull or core capability)



# Technologies for Exploration: Requirements

ExPeRT has defined **Technology Push** requirements for future **Exploration Missions** and **Mission Pull** technology requirements. Documents are available\* and can be used to inspire national programmes and/or industrial activities.



\* [https://www.esa.int/About\\_Us/Business\\_with\\_ESA/Business\\_Opportunities/ExPeRT\\_Exploration\\_Preparation\\_Research\\_and\\_Technology](https://www.esa.int/About_Us/Business_with_ESA/Business_Opportunities/ExPeRT_Exploration_Preparation_Research_and_Technology)



A vertical line with three circular markers of increasing size from top to bottom, representing a scale of distance.

Low  
Earth  
Orbit

Moon

Mars

# Thank you for your attention

## we explore. you benefit.

Human Spaceflight and Robotic Exploration

