

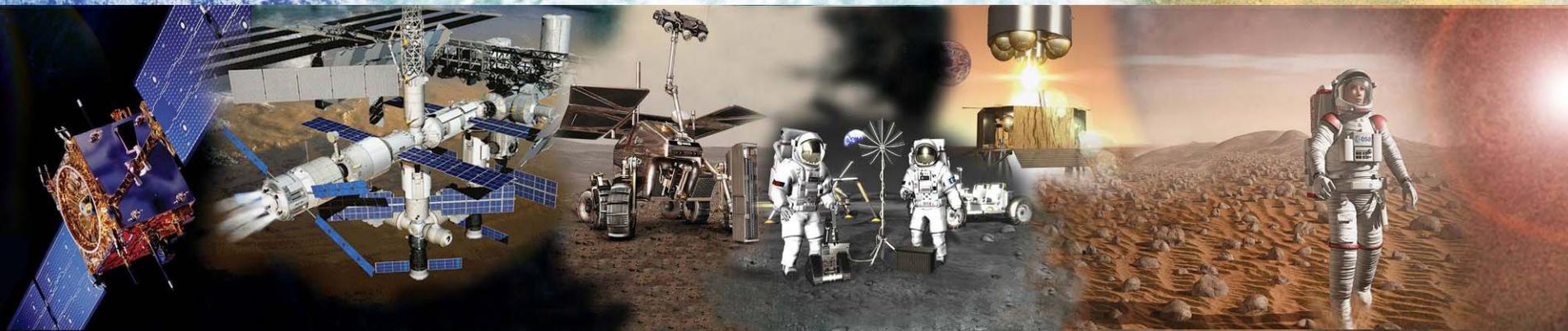


European Perspectives on International Cooperation for Sustainable Space Exploration

Bernhard Hufenbach, ESA
International Exploration Perspectives

4 – 6 December 2006

2nd International Space Exploration Conference
Houston, Texas





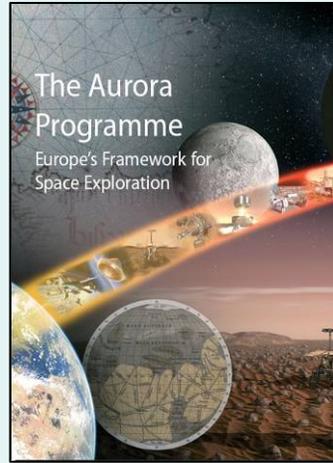
European Vision Space Exploration, A Global Societal Project



Programmatic Framework

Aurora Programme.

The objective of the Aurora Programme is first to formulate and then to implement a European long-term plan for the robotic and human exploration of solar system bodies holding promise for traces of life.



International Framework

International Strategic Framework for Sustainable Space Exploration.

As global citizens, we explore space to expand human knowledge, extend human frontiers, and serve society, starting from the Moon then going to Mars and beyond.



Strategic Study



Future of European Space Exploration: Towards a European Long term Strategy.

Europe will implement a visible, affordable and robust space exploration programme, driven by the long-term goal of the in-situ exploration of Mars by humans, which creates benefits for society, engages other space-faring nations through collaborative activities and, thereby, contributes significantly to societal development.

Strategic Study

Moon: the 8th Continent Human Spaceflight 2025.

In 2025, Europe will begin to operate a permanently manned outpost on the Moon as part of a multi-decade, international exploration effort to serve humanity, thus increasing our knowledge and helping us to address the global challenges of the future.

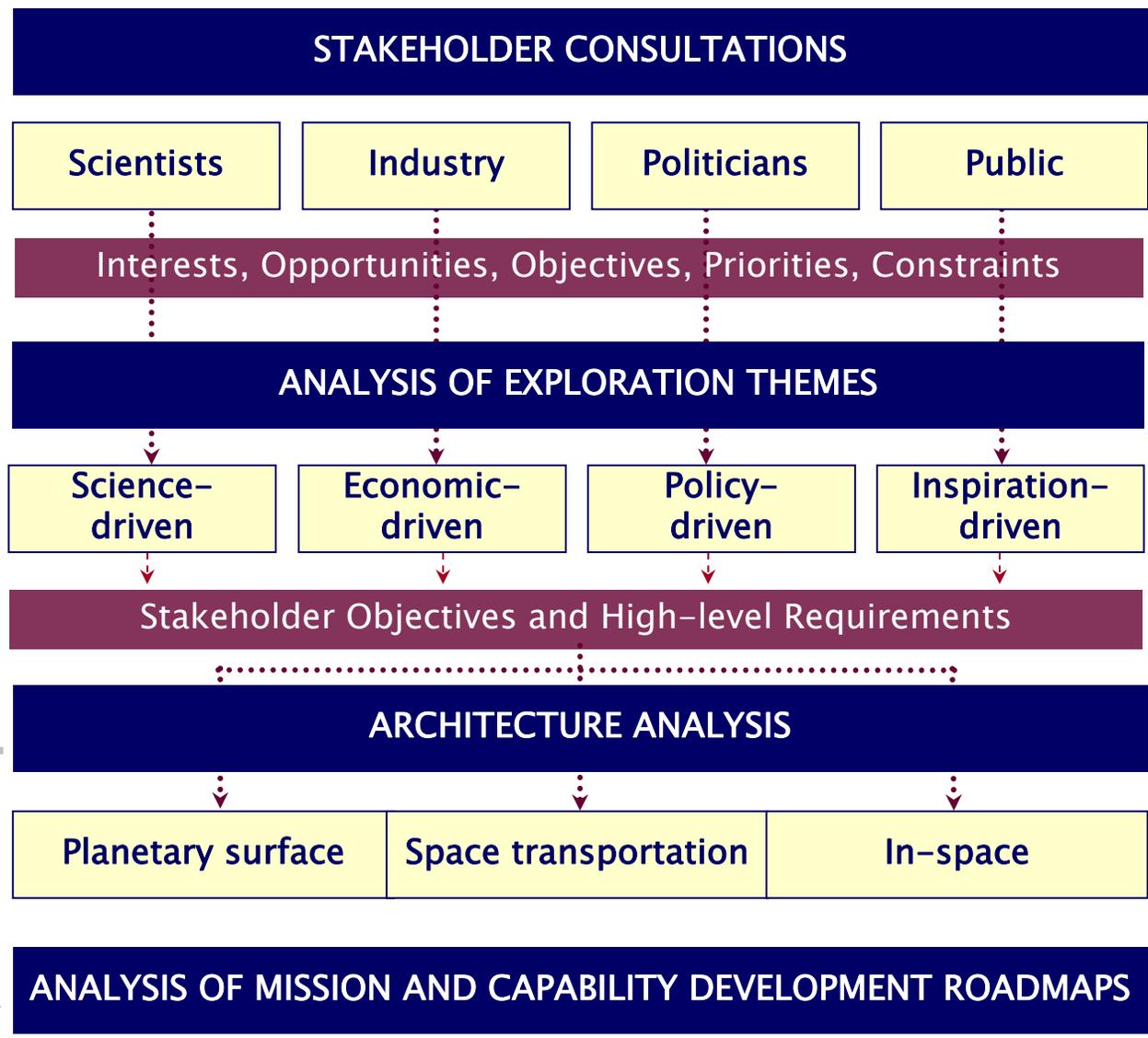




European Interests

Process for Consolidation of Strategic Approach

International
Plans and
Capabilities



Architecture
Consolidation



European Interests

European Programmes – Robotic Missions



MISSION



CASSINI-HUYGENS

Launch: 1997
Mission end: Huygens-2005 Cassini-2009

US/ EUROPE/ ITALY



Destination: Saturn/Titan

Mission objectives:
Exploration of Saturnian system. ESA's component – Huygens probe – entered atmosphere of Saturn's largest moon, Titan, and landed.

International partners:
NASA/ESA/ASI



SMART-1

Launch: 2003
Mission end: 2006

EUROPE



Destination: Moon

Mission objectives:
Technology demonstration of electric propulsion & Lunar science



MARS EXPRESS

Launch: 2003
Mission end: 2007

EUROPE



Destination: Mars

Mission objectives:
Comparative Planetology, Exobiology & 3D cartography

International partners:
Russia/Japan/USA



ROSETTA

Launch: 2004
Mission end: 2015

EUROPE



Destination: Comet

Mission objectives:
Rendezvous with and landing on Comet 67 P/Churyumov-Gerasimenko

International partners:
USA



VENUS EXPRESS

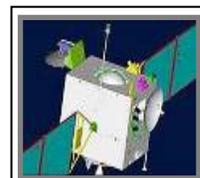
Launch: 2005
Mission end: 2007/8

EUROPE



Destination: Venus

Mission objectives:
Global investigation of the evolution of Venusian atmosphere



CHANG'É 1

Launch: 2007

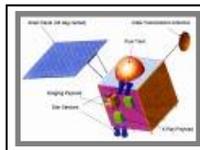
CHINA



Destination: Moon

Mission objectives:
Lunar orbiter as pathfinder for future lander, sample return and human missions

ESA's role:
Operations support



CHANDRAYAAN 1

Launch: 2008

INDIA



Destination: Moon

Mission objectives:
Survey and 3-D topography of lunar surface including polar regions

ESA's role:
Some experiments



EXOMARS

Launch: 2013

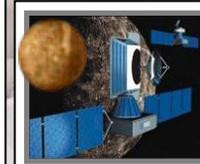
EUROPE



Destination: Mars

Mission objectives:
Technology demonstrations search for life, identification of hazards for future missions

International partners:
NASA, Roscosmos



BEPICOLOMBO

Launch: 2013
Mission end: 2020

EUROPE



Destination: Mercury

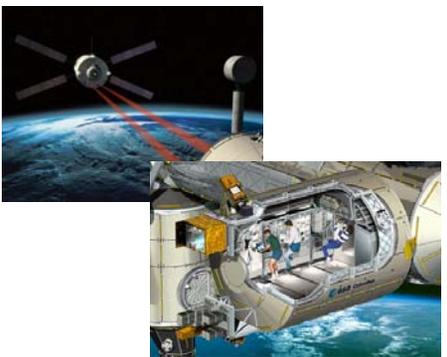
Mission objectives:
Planet and magnetosphere investigation

International partners:
Japan, Roscosmos

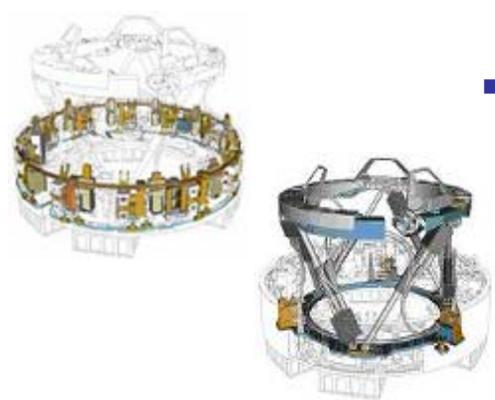
T I M E



European Interests Strategic Objectives



- Secure best return on investment in ISS Programme
- Secure European human access to space
- Support implementation of International Mars Sample Return mission
- Ensure that Europe acts as a significant player in global space exploration through
 - Development of enabling capabilities
 - Implementation of European-led international robotic mission
 - Promotion of broad societal engagement

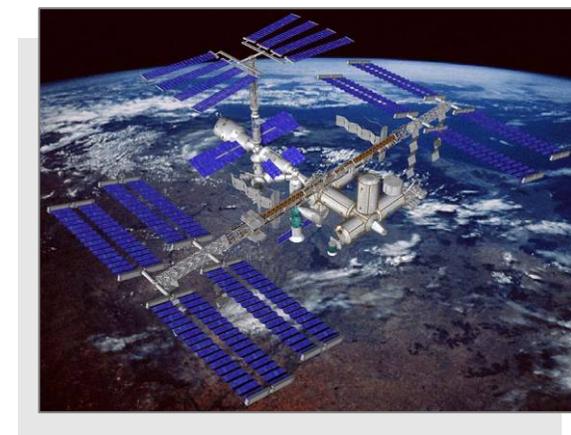




International Cooperation Past Cooperation with NASA

Human Spaceflight

Spacelab



ISS

Science



Ulysses



HST



SOHO



Cassini-Huygens



Cluster



Mars Express



Rosetta



Herschel



Planck



LISA Pathfinder



JWST



LISA

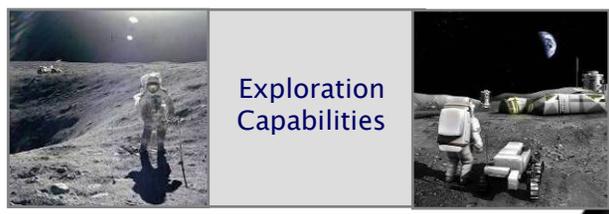
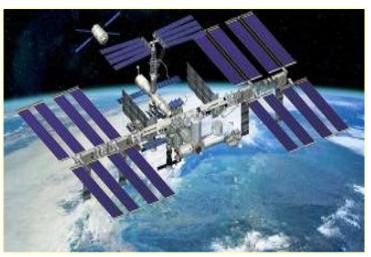




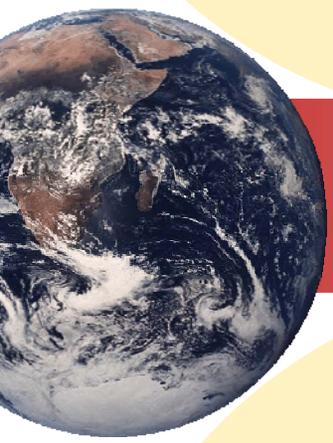
International Cooperation Roadmap

Cooperative capability development

ISS



Exploration Capabilities



Co-operative missions

ExoMars



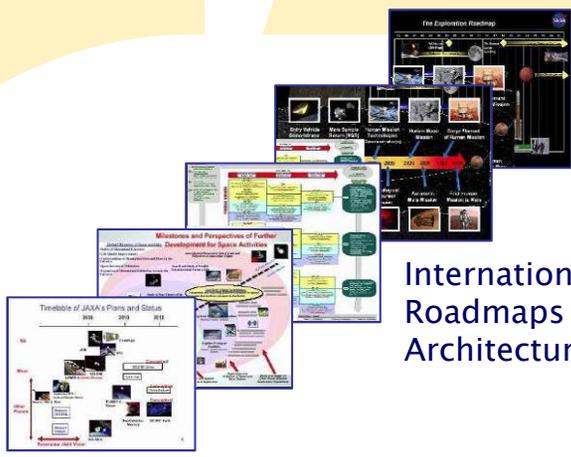
Cassini Huygens



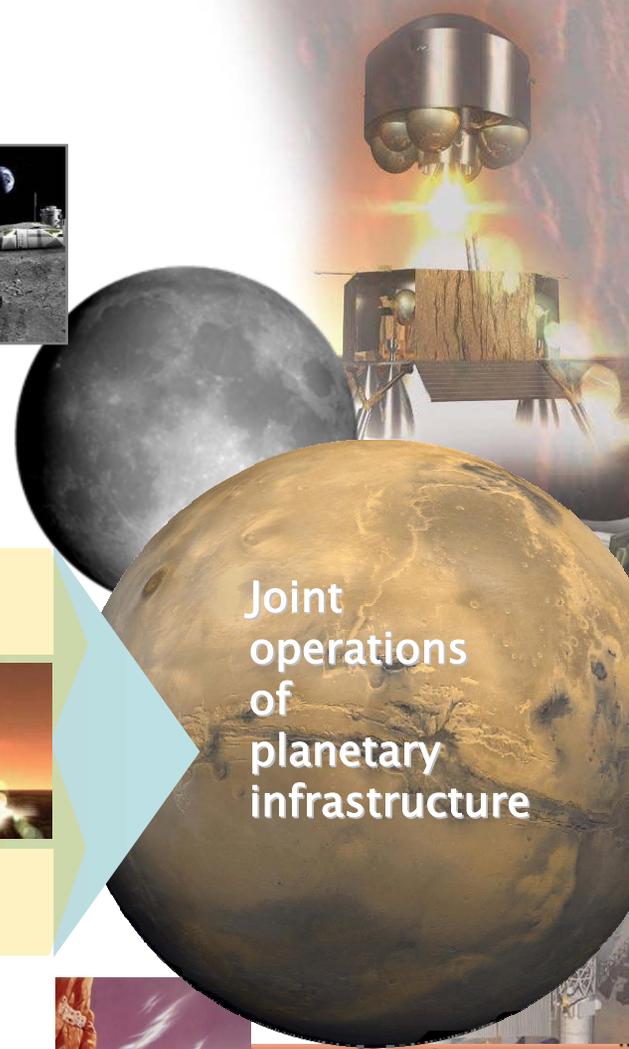
MSR

Joint operations of planetary infrastructure

Coordination of architectures and roadmaps

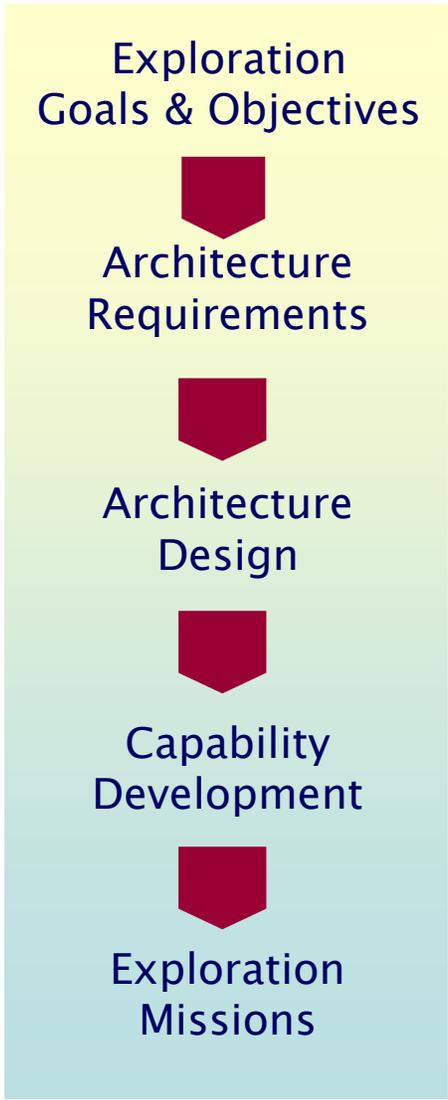


International Exploration Roadmaps and Architectures





**PLANNING AND
IMPLEMENTATION STEPS**



**PRODUCTS OF INTERNATIONAL
COORDINATION AND COOPERATION**

Global Strategic Framework

Global Reference Architecture

Cooperative Capability Development

Cooperative Mission Implementation





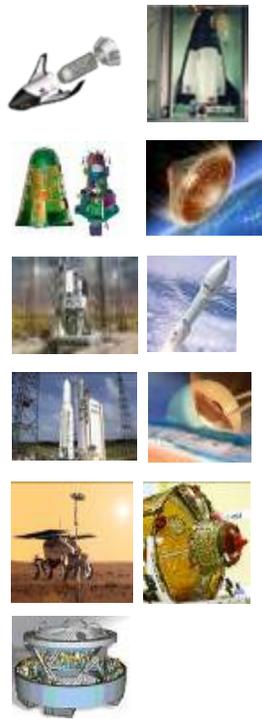
International Cooperation Global Reference Architecture – Capability Mapping



Early Robotic Capabilities



Transportation



EXPLORATION CAPABILITIES

Early Robotic Capabilities	Transportation	Space Based Services	Earth Based Services	Planetary Surface Operations
Remote Sensing	Crew Launchers	Telecommunication	Control centres	Habitation
Landing	Cargo Launchers	Navigation	Launch sites	Mobility and EVA support
Surface Mobility	Crew and cargo exploration vehicles	Remote Sensing	Ground tracking	Power provision & management
Drilling	Interplanetary transfer stages	Space Weather Forecast	Crew Medical centres	Local resource utilisation
Sample Return	Planetary descent and landing vehicles	Vehicle servicing	Data handling & processing	Logistic support services
	Planetary ascent vehicles	In-orbit assembly	Engineering support service	Food production
	Rendezvous and docking		Education and training	Science/research equipment
			Test facilities	Robotic assistance
			Ground based research	
			User Centres	

STATUS KEY:

- Demonstrated Capability
- Future Capability
- Heritage

Earth Based Services



Planetary Surface Operations

