A Perspective on Managing a Multi-Agency International Project

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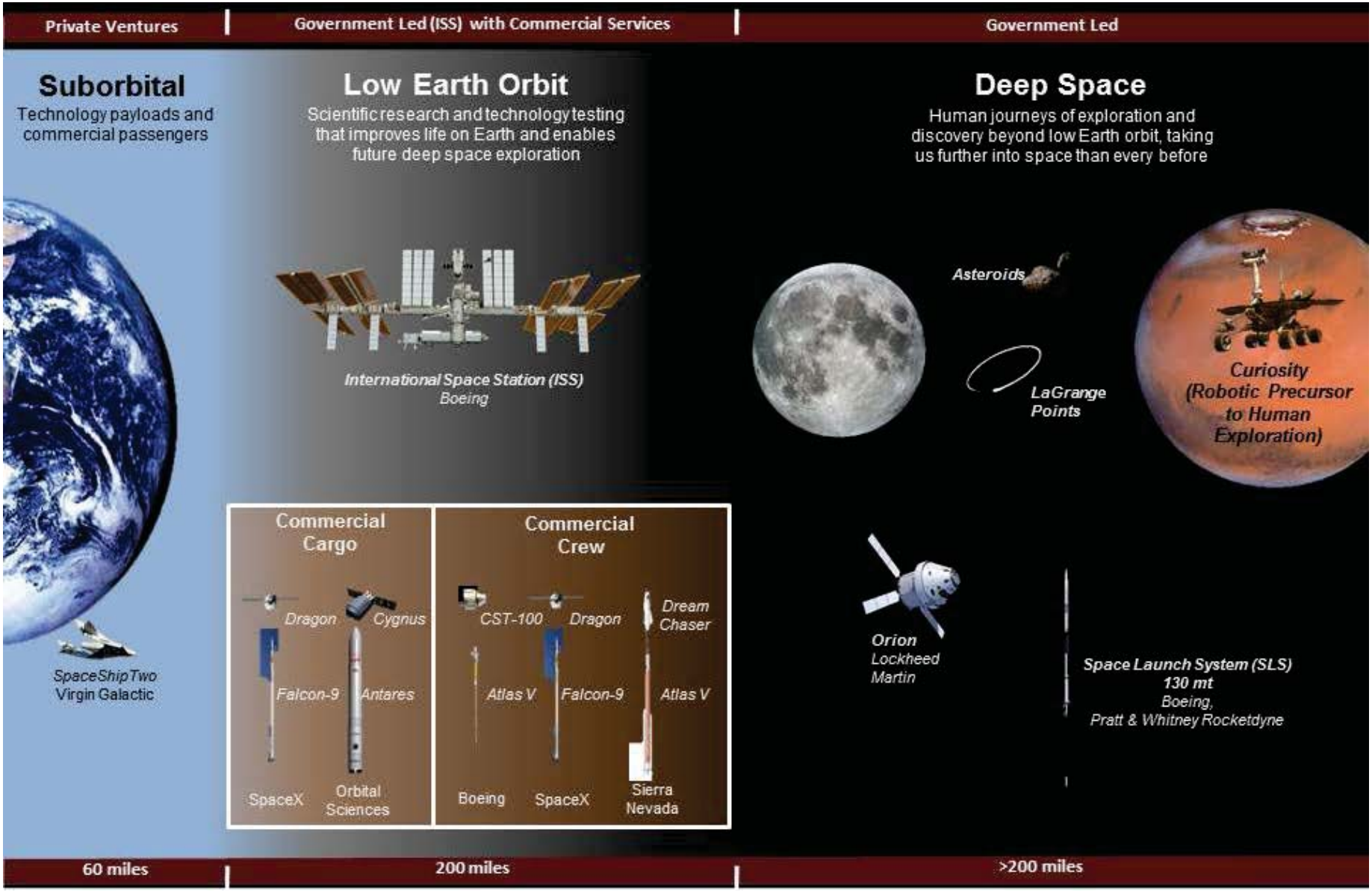
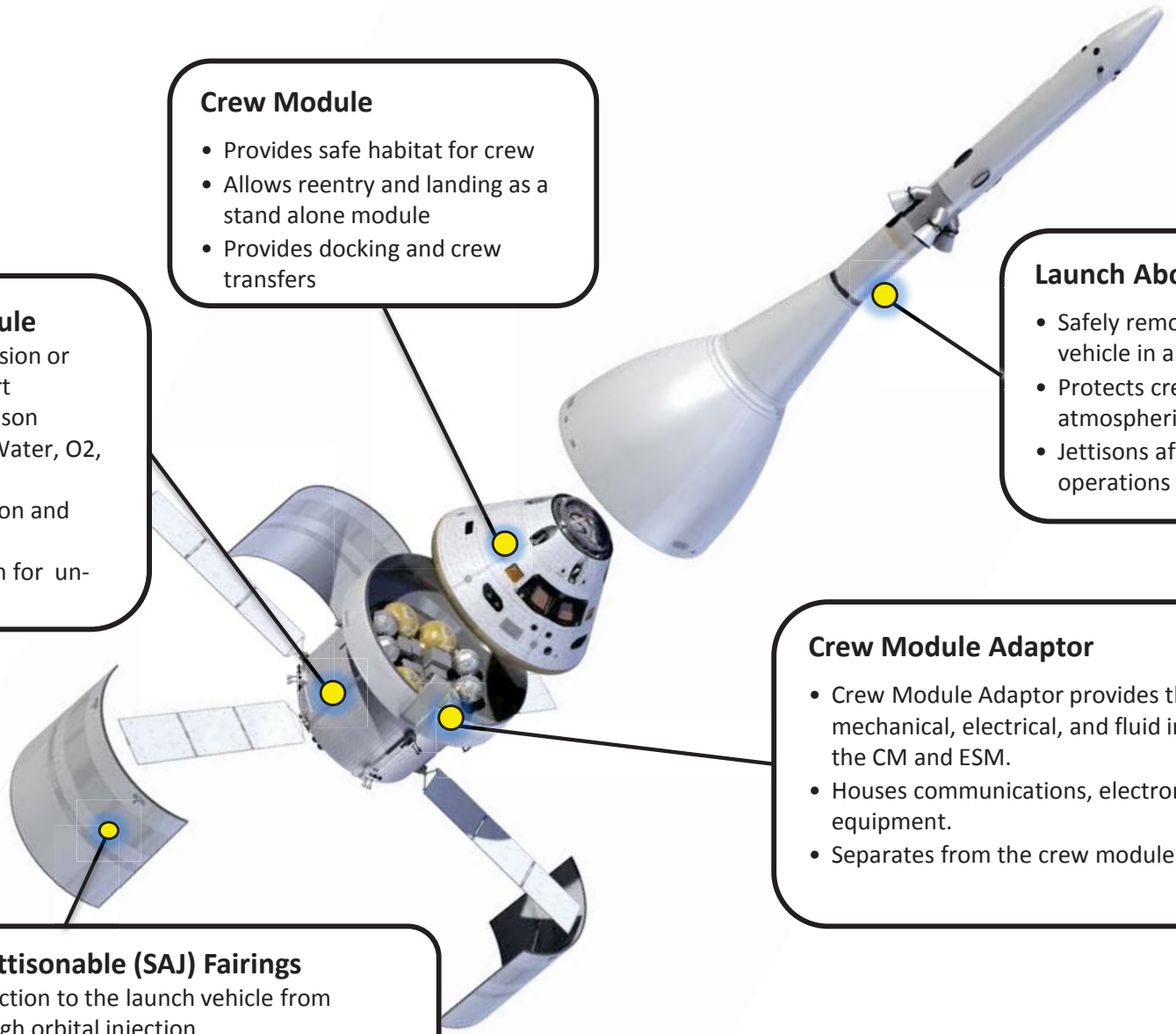
Todays Elements of Human Exploration



Why Do Humans Explore? Discovery, International Cooperation, Economic Vitality, Human Health, Education

Orion Overview



Crew Module

- Provides safe habitat for crew
- Allows reentry and landing as a stand alone module
- Provides docking and crew transfers

Launch Abort System

- Safely removes the crew from launch vehicle in an emergency
- Protects crew module from atmospheric loads and heating
- Jettisons after successful pad operations and first stage flight

European Service Module

- Provides in-space propulsion or high altitude ascent abort propulsion after LAS jettison
- Provides consumables (Water, O2, and N2 storage)
- Provides power generation and thermal control
- Provides accommodation for un-pressurized cargo

Crew Module Adaptor

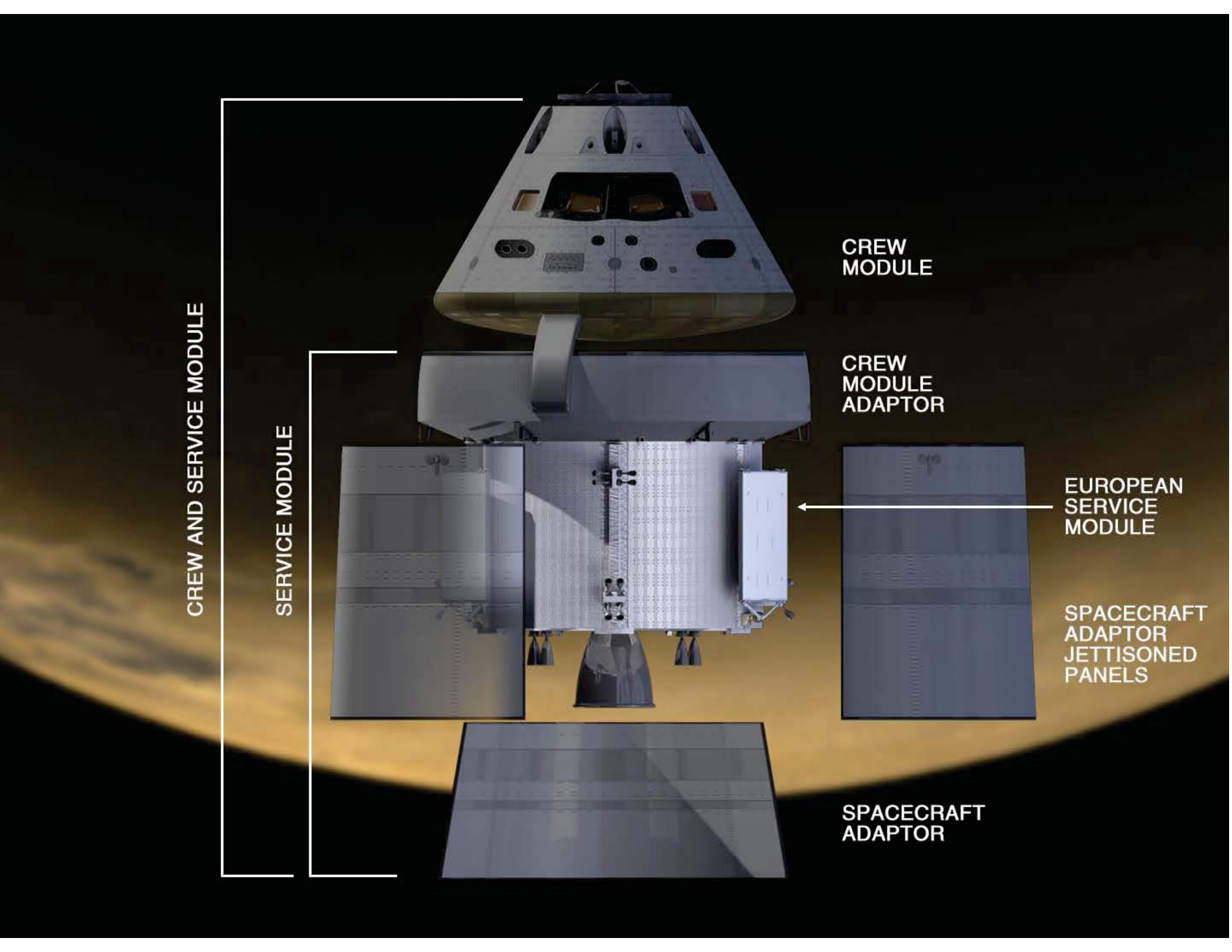
- Crew Module Adaptor provides the structural, mechanical, electrical, and fluid interface between the CM and ESM.
- Houses communications, electronics, and power equipment.
- Separates from the crew module before re-entry

Spacecraft Adaptor Jettisonable (SAJ) Fairings

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

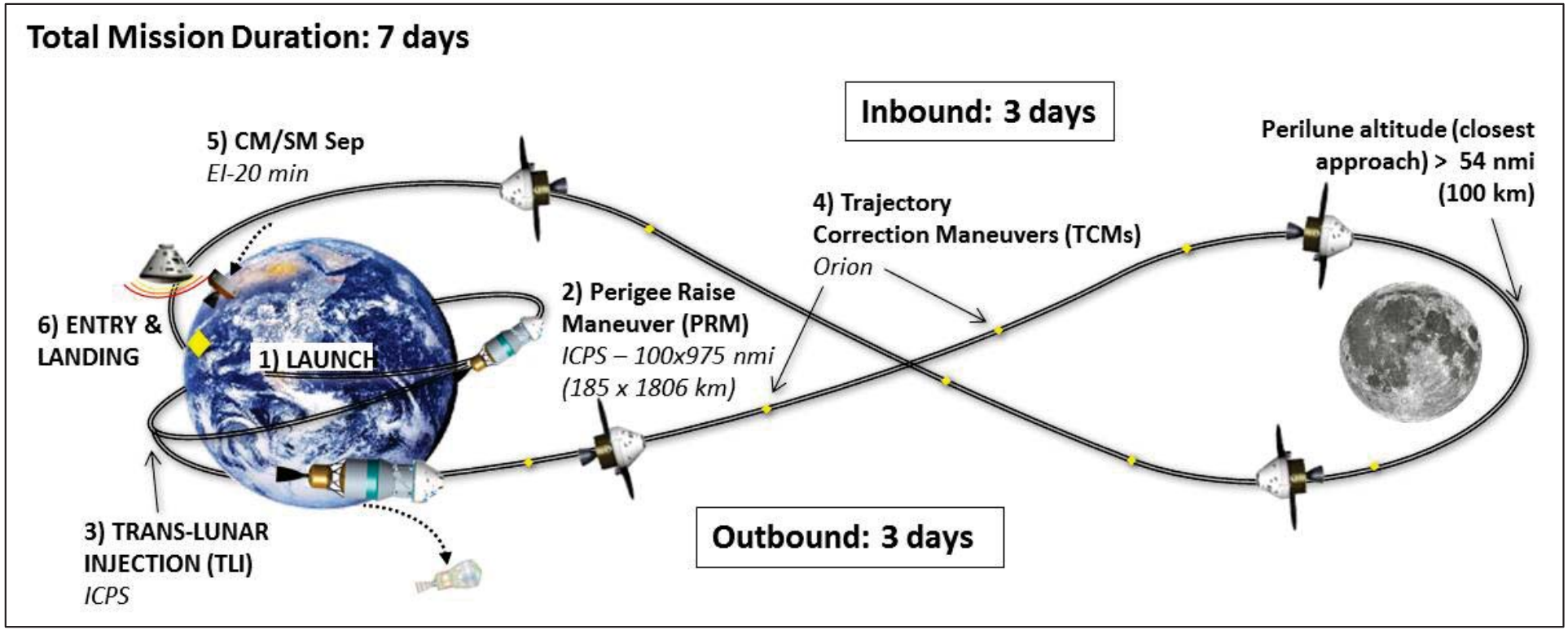
European Service Module (ESM) Implementing Arrangement

- ESA decided in its Council Meeting in March 2011 to partially offset the European International Space Station obligations post 2015, valued at 450M €, with different means than ATVs.
- NASA and ESA considered a number of barter options, NASA concluded that the provision by ESA of the Service Module for the NASA Orion Multi-Purpose Crew Vehicle (MPCV) was the barter with the most interest and benefit.
- A joint ESA - NASA working group was established in May 2011 to assess the feasibility of Europe developing the Service Module based on ATV heritage.
- The team continued the activity through Phase A/B1 that included the successful completion of two reviews, the System Requirements Review (SRR) and the System Definition Review (SDR), carried out in 2012.
- The agreement between NASA and ESA was ratified in December 2012.
- Recently completed the ESM System level Preliminary Design Review and Orion Delta PDR and received approval to proceed to CDR with successful closeout of major PDR actions.
- ESA will supply the European Service Module for the first Exploration Mission (EM-1) of Orion.

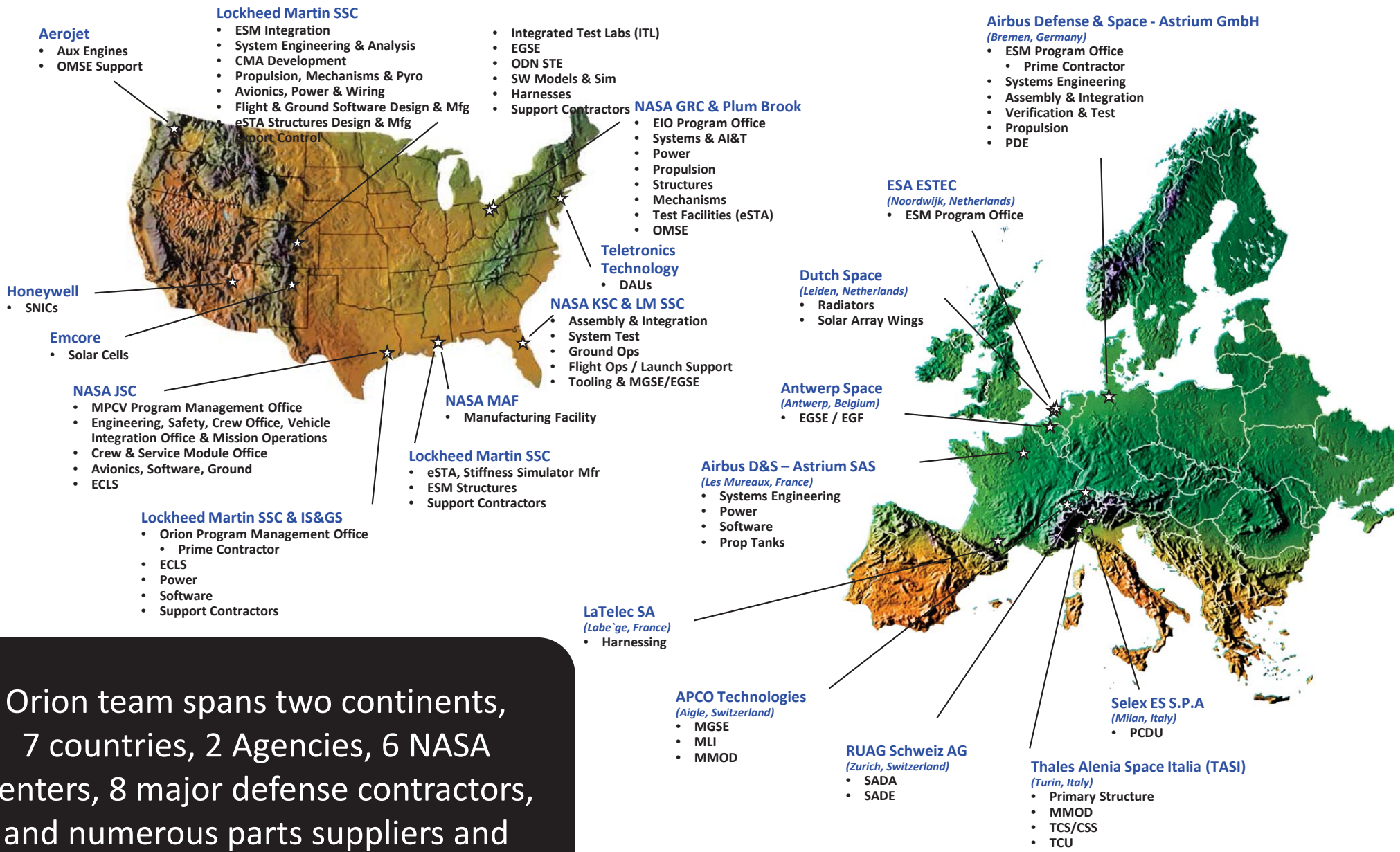

CREW AND SERVICE MODULE
SERVICE MODULE
CREW MODULE
CREW MODULE ADAPTOR
EUROPEAN SERVICE MODULE
SPACECRAFT ADAPTOR JETTISONED PANELS
SPACECRAFT ADAPTOR

Orion EM-1 and EM-2 orbits

EM-1 is planned as an un-crewed lunar flyby mission on a free return trajectory, mission duration of approximately 7 days



Orion Team



Aerojet
- Aux Engines
- OMSE Support

Lockheed Martin SSC
- ESM Integration
- System Engineering & Analysis
- CMA Development
- Propulsion, Mechanisms & Pyro
- Avionics, Power & Wiring
- Flight & Ground Software Design & Mfg
- eSTA Structures Design & Mfg
- Export Control
- Integrated Test Labs (ITL)
- EGSE
- ODN STE
- SW Models & Sim
- Harnesses
- Support Contractors

NASA GRC & Plum Brook
- EIO Program Office
- Systems & AI&T
- Power
- Propulsion
- Structures
- Mechanisms
- Test Facilities (eSTA)
- OMSE

Teletronics Technology
- DAUs

Honeywell
- SNICs

Emcore
- Solar Cells

NASA KSC & LM SSC
- Assembly & Integration
- System Test
- Ground Ops
- Flight Ops / Launch Support
- Tooling & MGSE/EGSE

NASA JSC
- MPCV Program Management Office
- Engineering, Safety, Crew Office, Vehicle Integration Office & Mission Operations
- Crew & Service Module Office
- Avionics, Software, Ground
- ECLS

NASA MAF
- Manufacturing Facility

Lockheed Martin SSC
- eSTA, Stiffness Simulator Mfr
- ESM Structures
- Support Contractors

Lockheed Martin SSC & IS&GS
- Orion Program Management Office
  - Prime Contractor
- ECLS
- Power
- Software
- Support Contractors

Airbus Defense & Space - Astrium GmbH
(Bremen, Germany)
- ESM Program Office
  - Prime Contractor
- Systems Engineering
- Assembly & Integration
- Verification & Test
- Propulsion
- PDE

ESA ESTEC
(Noordwijk, Netherlands)
- ESM Program Office

Dutch Space
(Leiden, Netherlands)
- Radiators
- Solar Array Wings

Antwerp Space
(Antwerp, Belgium)
- EGSE / EGF

Airbus D&S – Astrium SAS
(Les Mureaux, France)
- Systems Engineering
- Power
- Software
- Prop Tanks

LaTelec SA
(Labe`ge, France)
- Harnessing

APCO Technologies
(Aigle, Switzerland)
- MGSE
- MLI
- MMOD

RUAG Schweiz AG
(Zurich, Switzerland)
- SADA
- SADE

Thales Alenia Space Italia (TASI)
(Turin, Italy)
- Primary Structure
- MMOD
- TCS/CSS
- TCU

Selex ES S.P.A
(Milan, Italy)
- PCDU

Orion team spans two continents, 7 countries, 2 Agencies, 6 NASA Centers, 8 major defense contractors, and numerous parts suppliers and subcontractors.

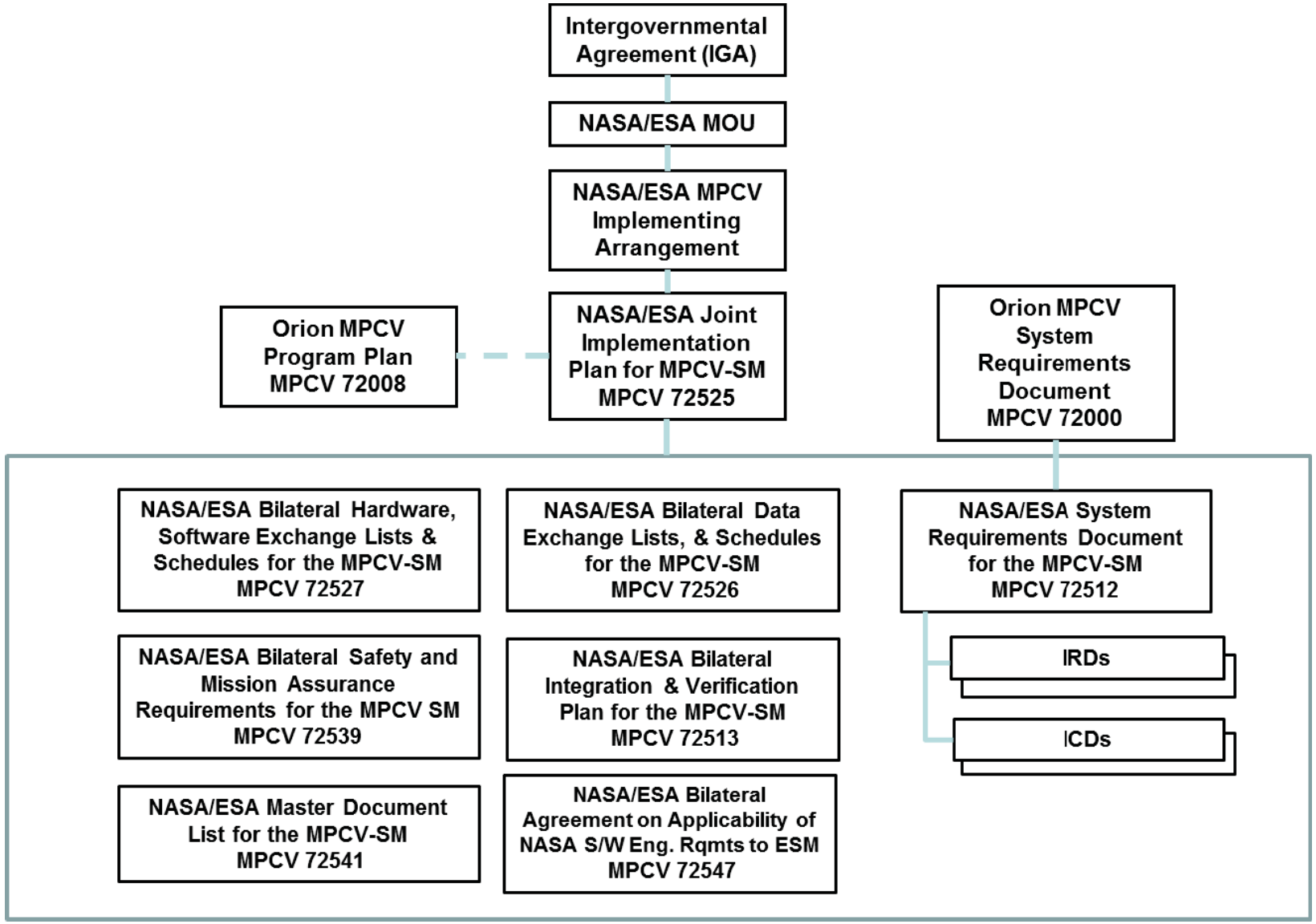
Perspectives on Managing the Partnership

- NASA and ESA is a **partner** relationship governed by the IA
  - Work together as collaborators
  - Foster a management approach based on TRUST and RESPECT!!!
  - Recognize each others expertise and ability to contribute
- Key is to "**intelligently combine**" our knowledge and capabilities and remove roadblocks quickly.
- **Communicate** early and often! Identify and highlight **issues** as soon as they arise.
  - Bad news doesn't get better with time
  - In many cases both parties need to be part of the solution, how can you reframe a problem.
  - Plan and conduct regular reviews/co-locations to ensure communication/exchange, allow for mid-course adjustments. Including industry is essential.

Perspectives on Managing the Partnership

- Be clear about project organization and interfaces, keep key team members aligned.
- Establish **bilateral** and **requirements** documents early. Plan time to iterate and include contractors as appropriate.
  - Clearly define and jointly understand expectations, products, and agreements
  - Plans need to be specific enough to guide the project without being overly prescriptive
  - Establish a Master document list and be clear about what standards will apply as early as practical.

Summary of Bilateral Documents



Perspectives on Managing the Partnership

- Establish implementation plans for major **heritage hardware**
  - Understand and address risks associated with use of heritage hardware
- Do not under estimate the effort required to **integrate**!
  - Integration takes time and effort
  - Think globally, integration is everyone's job
  - Systems engineering is more than requirements tracking and documents! Systems engineering plays a critical role in design analysis, trade studies/analysis of alternatives, system margin management…
  - Schedule design analysis cycles to iterate and refine design
  - Integrate schedules and understand the interdependencies (Agency/Program/Project/Procurement/Contract)

Managing the Schedules

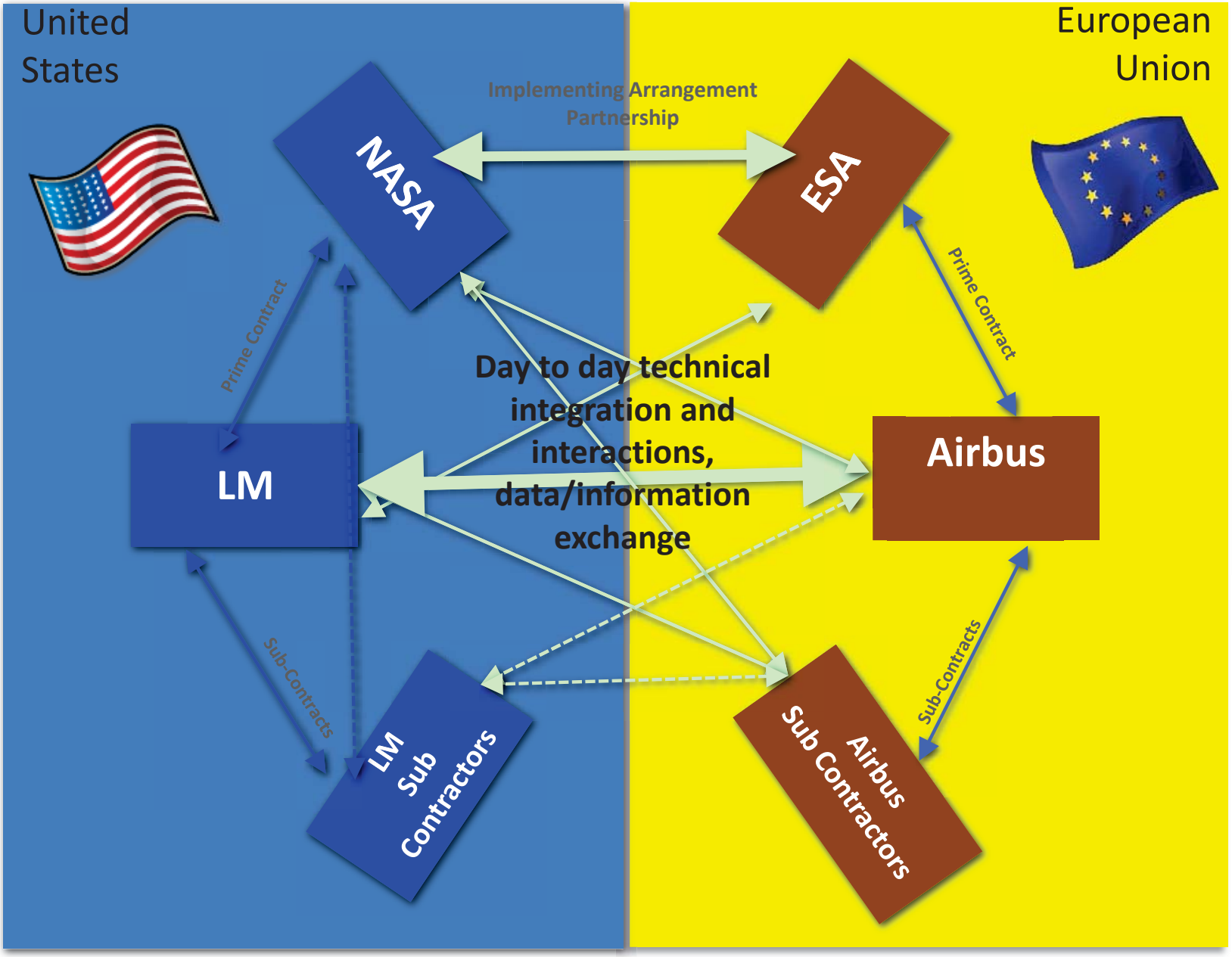
Parkinson's Law: Work Expands to Fill the Time Available

- Instill a sense of urgency from the beginning
- Delivery will only be as early as the delivery date on your schedule
  - Aggressive schedules help keep team focused on earlier date
  - A schedule that is more conservative may give up margin needed later on
  - Do not lose schedule margin at front end of effort

Perspectives on Managing the Partnership

- Discuss **risks** and continuously manage risk mitigations
  - Understand relationship between Cost, Schedule, Performance(KDPs) and Risk
  - Decide where you can take calculated risks
- **Communications** are challenging!!! Multiple languages, countries, time zones!!
  - Work to LISTEN and UNDERSTAND each other, its easy to get frustrated and stop listening.
  - Talk issues, talk again and talk again…each time you will come to a new understanding.
  - Synchronize often on both programmatic and technical topics.
- Program interactions are complex!

MPCV Program Interactions



Perspectives on Managing the Partnership

- The project management objectives, methods, and tools that are used to implement projects are similar to both Agencies even if implemented a little differently

- All are essential to effective project management, successful partnering, and mission success
  - Planning
  - Performance Measurement including goals and metrics
  - Baseline & change control
  - Process controls
  - Contract management
  - Risk & Opportunity management
  - Lifecycle reviews

- Maintain meaningful and measurable performance metrics and/or areas of emphasis.
- Pay attention to what matters most for the phase of the project that you are in

Closing Thoughts on Project Management

- Take the time up front to develop the plans and processes, they are the foundation of the project
- Partnering and teamwork is essential
- Trust each others motives
- Empower and delegate authority to the appropriate levels
- Communicate openly and truthfully with respect for the views of others. Open discussions and constructive conflict lead to stronger decisions.
- Hold ourselves and each other accountable
- Anticipate future issues, expect change, design flexibility
  - In 2020, what will we wish we had done in 2014?
- Our ultimate commitment is a safe, reliable, operable, affordable human spaceflight system
- Appreciate the opportunity. What we are tasked to do is UNIQUE, CHALLENGING and REWARDING
- Don’t forget the human side!


RION