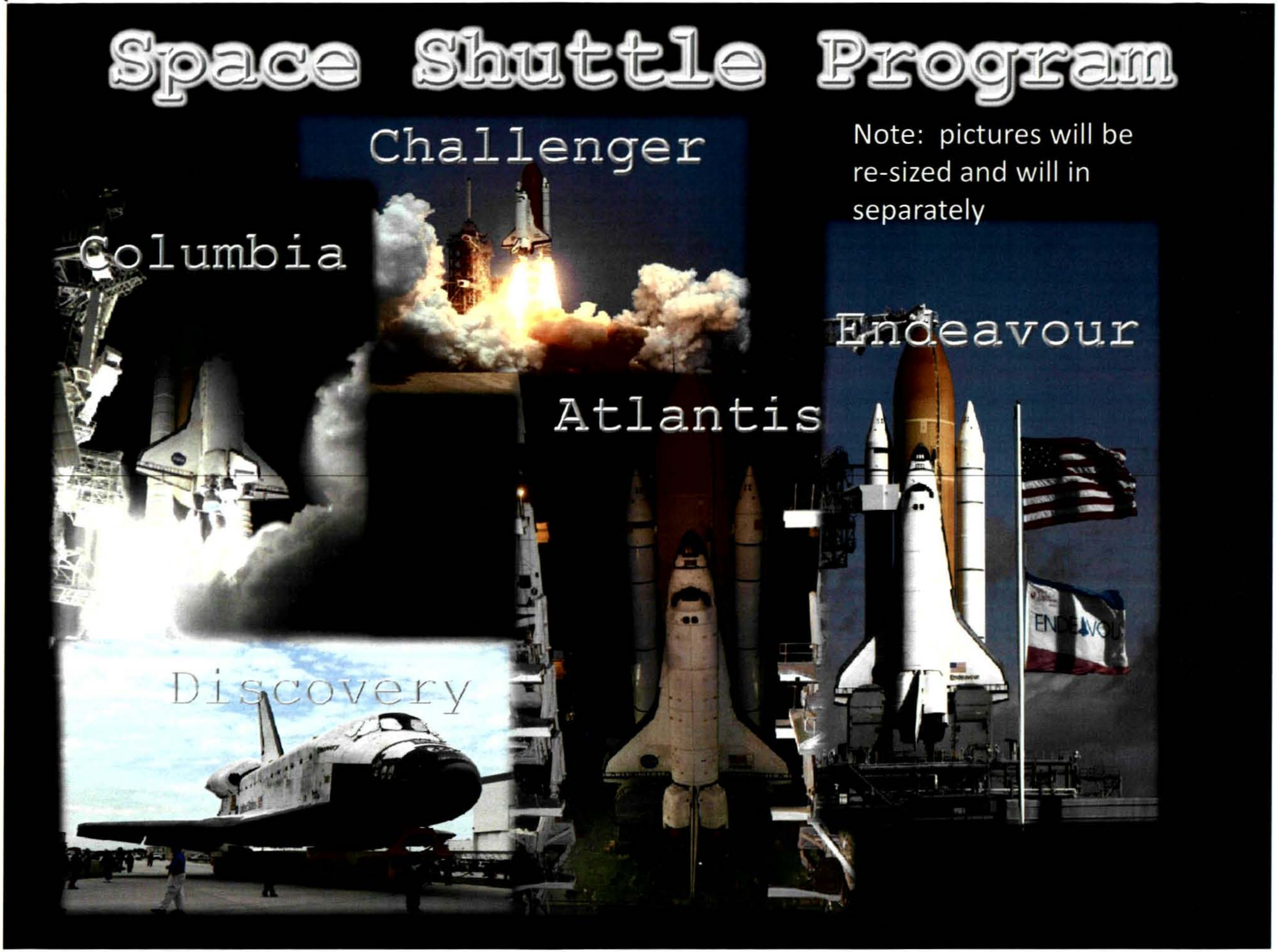
# Sustaining Human Space Flight:

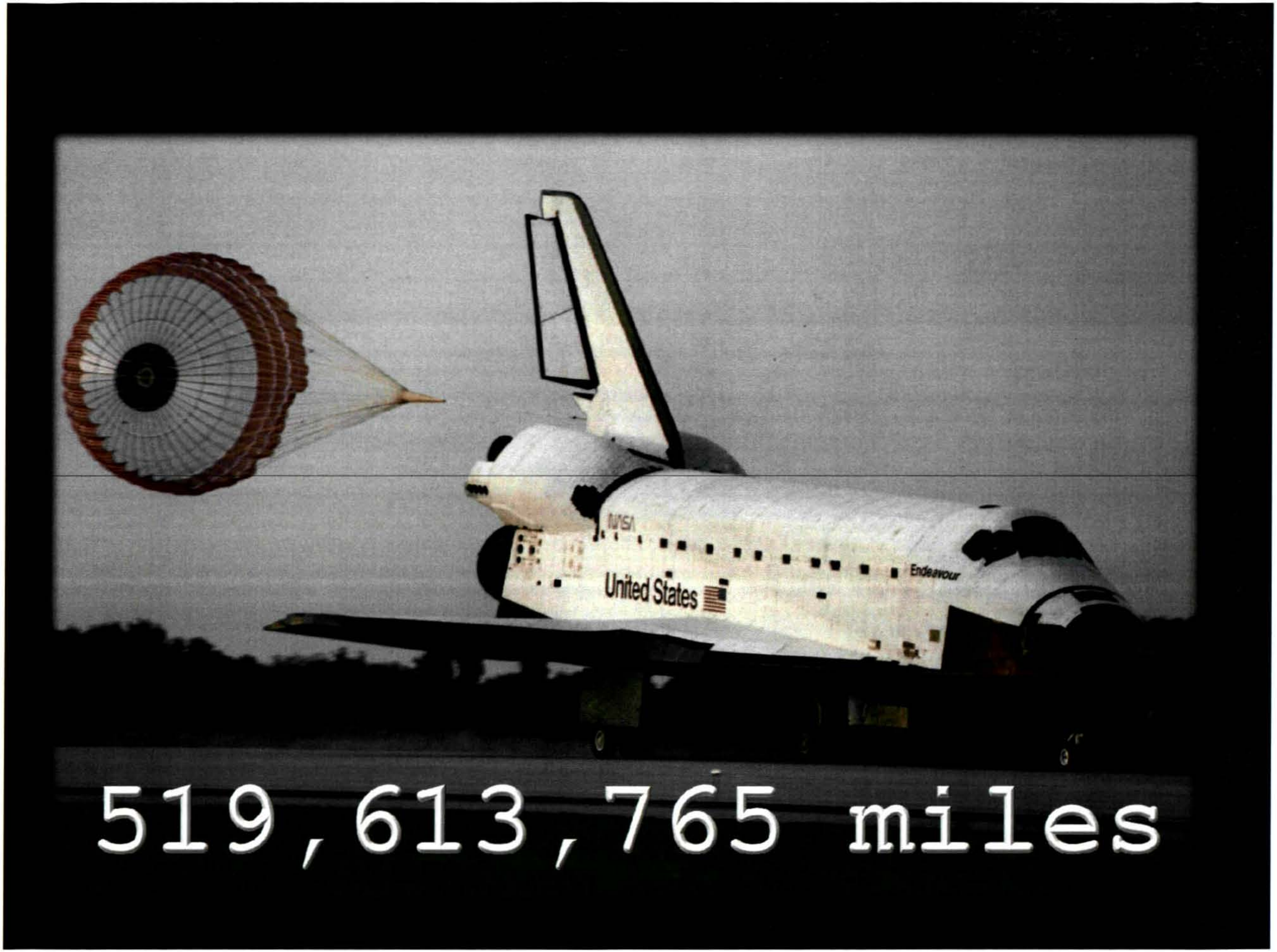
## From the Present to the Future

Rick Russell
NASA Kennedy Space Center
Florida


Space Shuttle Program
Challenger
Note: pictures will be re-sized and will in separately
Columbia
Endeavour
Atlantis
Discovery

# 131 Missions

Note: pictures will be re-sized and will in separately


NASA
United States
Endeavour
519,613,765 miles

# Aging Orbiter Fleet

•The Space Shuttle Orbiter has well exceeded it's original design life of 10 years or 100 missions.

•The Orbiter uses a wide variety of materials over a wide range of operating temperatures and pressures

•The Orbiter is subjected to harsh environments
- •Sea-coast exposure
- •Aggressive Fluid Systems
- •Vacuum

•The Orbiter's structural design is similar to normal airframe design
- •However, weight was often more important than corrosion resistance

•Many Orbiter systems were not designed for inspectability
- •Access
- •Intervals

•Logistics issues becoming more and more an issue
- •Vendors going out of business
- •Extra expenses due to unique hardware design

# Aging Orbiter Program

- Corrosion Control Review Board
- Aging Vehicle Assessment
- Aging Orbiter Working Group

# Corrosion Control Review Board (CCRB)

- Advisory Panel
- Membership
  - Materials & Processes (M&P)
  - Safety & Mission Assurance (S&MA)
  - Structures
- Objectives
  - Assessment of the extent & cause of corrosion
  - Providing short term and long term corrective actions
  - Generation and maintenance of a historical corrosion database
  - Development and implementation of methods for detecting corrosion
  - Development and implementation of corrosion training and certification programs

# Corrosion Control Review Board (CCRB)

- CCRB established in 1993
- Products include
  - History reports (3)
  - Database
  - Review of inspection and reporting requirements
  - Review of training requirements
  - Review and disposition of fleet wide and select unique corrosion issues
  - Proactive measures to prevent corrosion
    - Galvanic barriers
    - CPCs
    - Design changes
    - Washing exposed surfaces
    - Depainting/repainting
  - Review and disposition of a number of subsystem corrosion i

# Aging Vehicle Assessment (AVA)

- Part of certification assessment and verification for Return-to-Flight (RTF)
- Objective of Certification Verification is to access the integrity of hardware certification relative vehicle operational & processing environments
  - Ensure ground processing and operational practices over time have not exceeded the engineering basis of certification or introduced unknown risks (a.k.a. process creep)
  - Assess the adequacy of criticality hardware inspection requirements

# Aging Vehicle Assessment (AVA)

- Typical questions considered during AVA:
  - What are the differences between the Qual/Cert configuration and the configuration we operate with today?
  - Is the equipment still being used within Qual/Cert parameters?
  - Do original design documents accurately specify the conditions/environments in which the equipment is being used?
  - Do performance and maintenance histories indicate an issue with the existing design or certification?
  - Are existing hardware inspection requirements of critical hardware adequate to maintain hardware integrity through the certified life with consideration to current hardware processing and operations as well as aging vehicle concerns?

# Age Life Assessment of Materials

- Goal of study was to extend material age life from 20 to 40 years
  - ~ 75 material families with 1000 individual materials
  - ~500 criticality 1/1 parts
- Age Life Conclusions based on:
  - Independent available data on material performance
  - Program data on material's environment & historical performance
- Conclusions
  - ~20% Green – Good for 40 years
  - ~70% Yellow – No degradation data located to date, but lack of data to extend out to end of program
    - Corrective actions recommended
  - ~10% Red – Age Life Limited
    - Corrective actions recommended

# Aging Orbiter Working Group (AOWG)

- Began in June 2004
- Provides OPO oversight for aging issues such as corrosion, NDE, Non-metallics, Wiring and Subsystems
- Sub-teams
  - Adhesives
  - Wiring
  - Wing Leading Edge Metallic
  - Elastomers, Grease & Lubricants
  - Mechanisms
  - COPVs
  - Electric Motors

# AOWG Areas of Concern List

- To continue a proactive approach senior engineers from both NASA and contractor workforce were surveyed and an areas of concern list was assembled
- List was divided into four categories
  - Mechanical Generic
  - Mechanical Hardware Specific
  - Electrical Generic
  - Electrical Hardware Specific
- Each item assigned a lead
  - Quad chart developed
    - Tool for defining problem, identifying POCs, tracking actions and assessing risk.
  - Initial meeting held was product managers to assure Quad charts correct/complete
  - Closure strategy has been developed

# International Space Station

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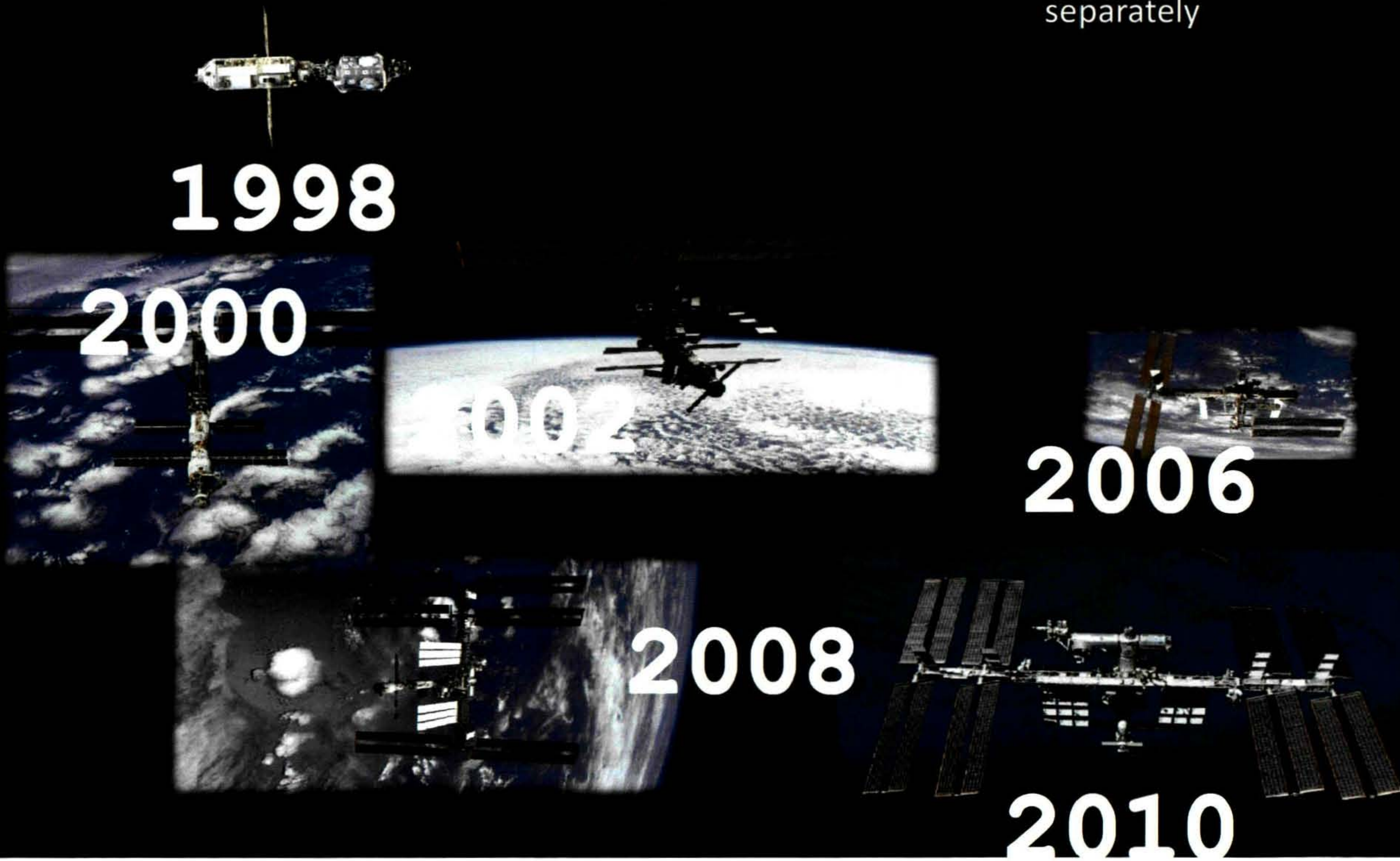

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# Continuous Sustained Crew Since 2000

# 5 Space Agencies

# 16 Countries

# 240 miles above Earth

Note: These texts will come into view in front of last ISS picture one at a time

**Traveling at 17,500 mph**

**Sustains a 6 person crew**

**Visible to the naked eye in the night sky**

**4188 Days in Orbit**

# Sustaining a 21st Century Launch Complex

- Up to $2B to update and modernize
  - Launch architecture
  - Environmental
  - Payload processing
  - Range Capabilities
- Partnering with the Air Force, State of Florida and FAA

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# Commercial Crew

- Create market to other space stations
- Transition from government to commercial
- Create LEO system to transport NASA crews to ISS
- Encourage markets to safely transport and return crew members to ISS

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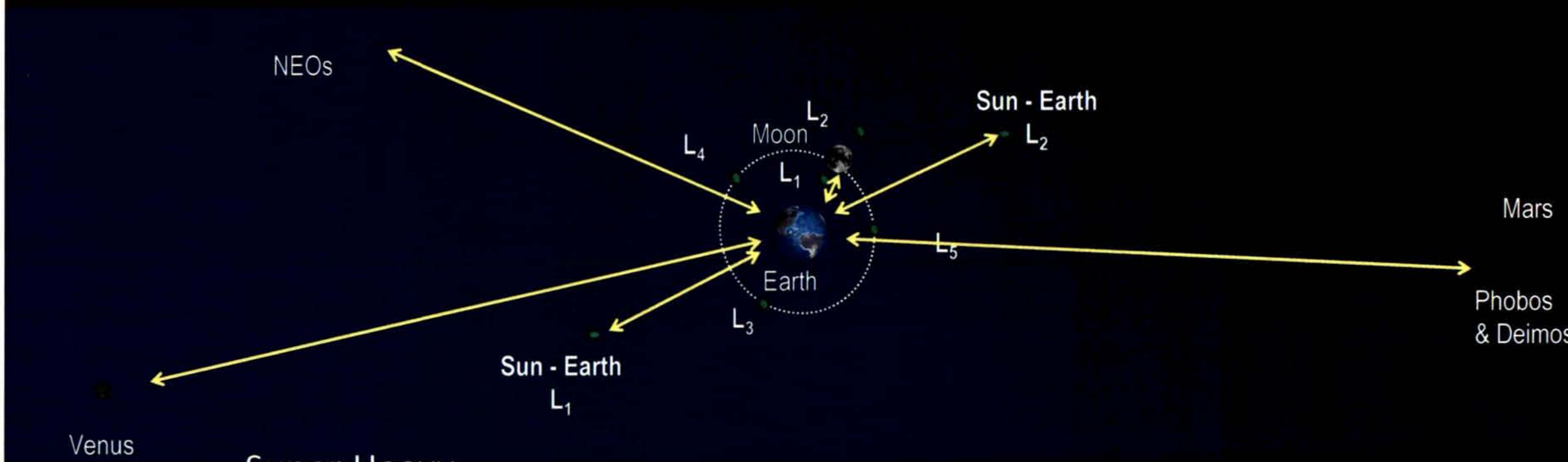
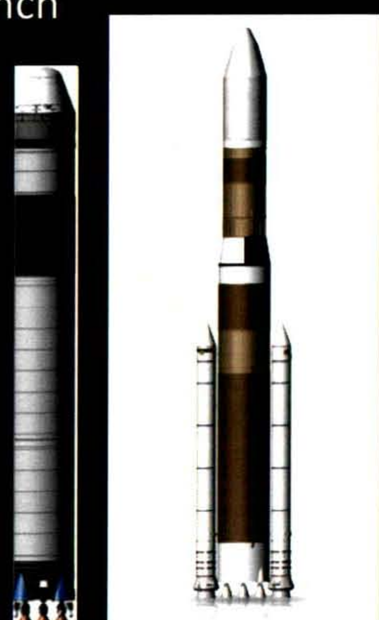
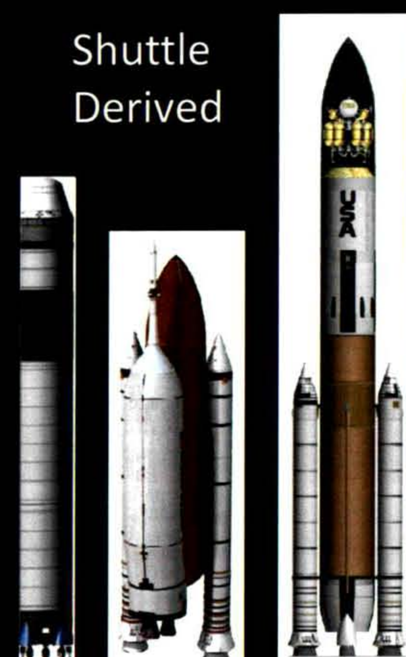
# Exploration




Super Heavy
Launch



Shuttle
Derived



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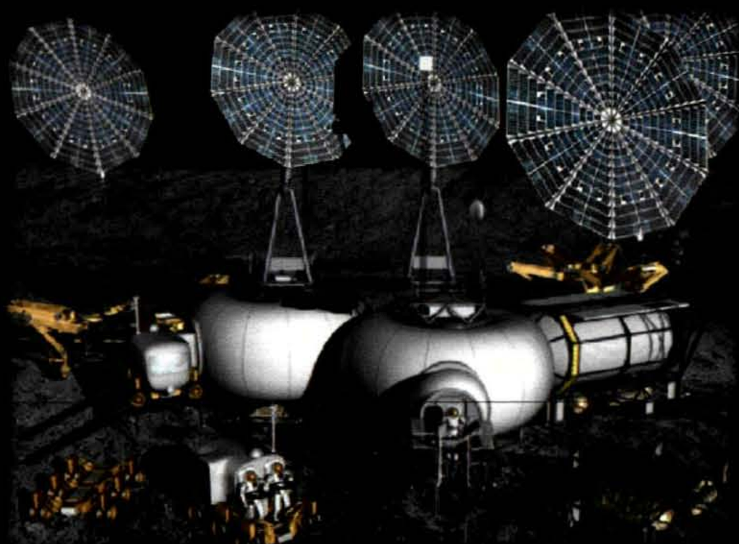

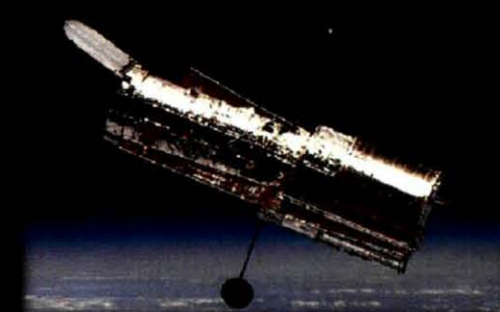

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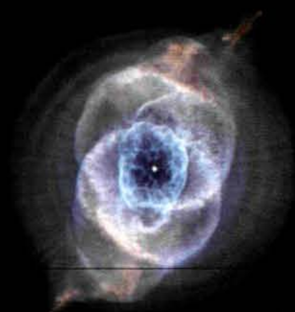

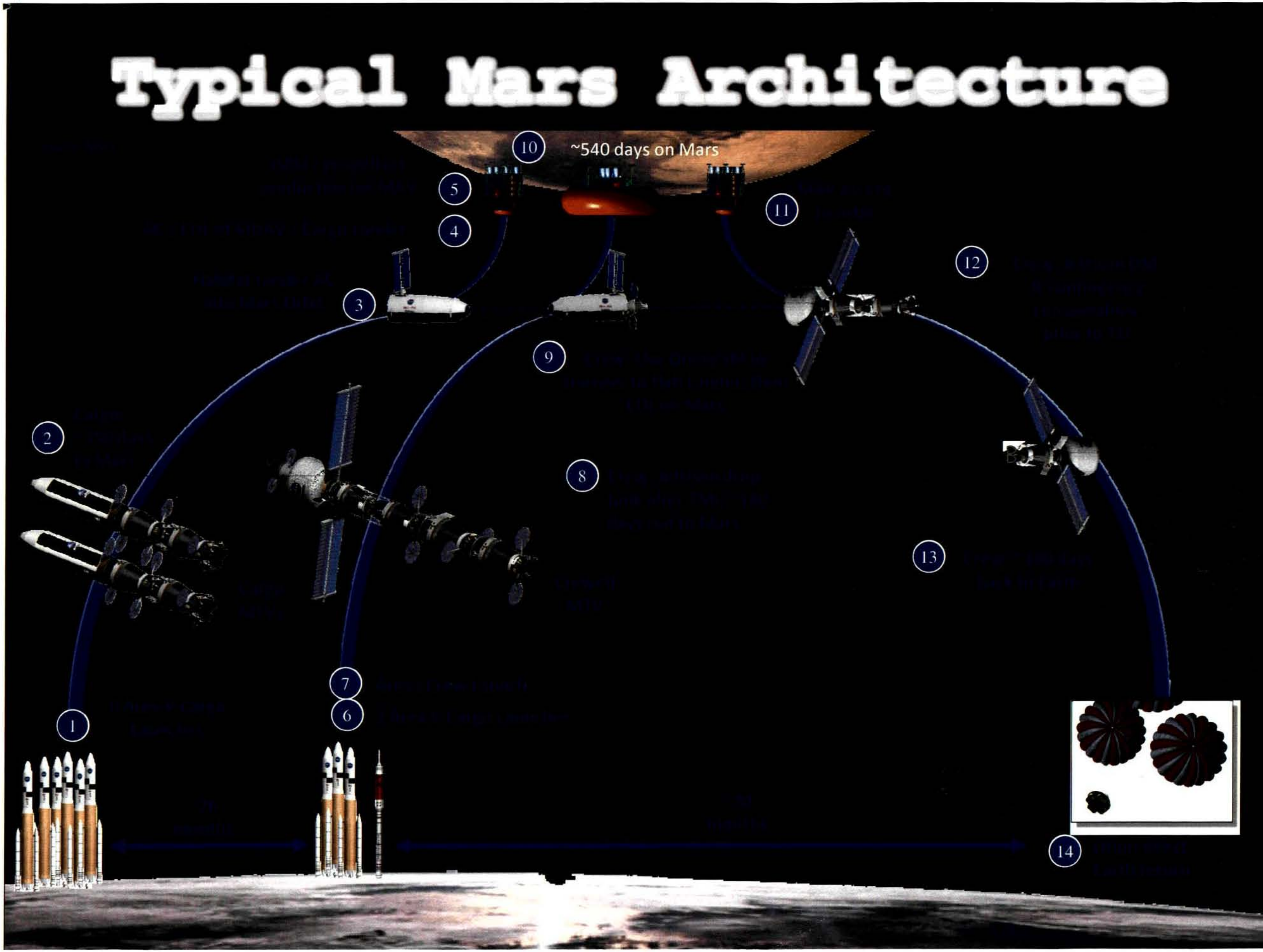
Typical Mars Architecture
10
~540 days on Mars
5
4
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14