The Advancement of Humans in Space

John Graves - NASA engineer at the Kennedy Space Center in Florida

- I have worked at the Kennedy Space Center for over 24 years
  - The Boeing Company – 18 years
  - NASA – 6 years
  - 2 children – Morgan and Kirby
- University of Tennessee – 1990
  - BS in Mechanical Engineering
- Embry-Riddle Aeronautical University – 2011
  - MS in Aerospace Operations
- Roles at KSC
  - Mechanical engineer for Space Shuttle Payloads
  - Payload Test Conductor
  - Boeing Advanced Projects
  - Payload Test Director
  - Deputy Chief of Flight Operations at KSC - currently

Aerospace Development Has Rapidly Increased in Speed

First Flight
1783

First Airplane
1903

First Jet
1939

First Jet Airliner
1949

747/Concorde
1969

120 years

36 years

10 years

20 years

Sputnik 1
1957

Freedom 7
1961

Apollo 8
1968

STS-1
1981

ISS
2011

3 years

7 years

13 years

30 years

But things are changing fast, and your generation will be the ones who will make it change faster

Early Rockets – Baby Steps

First Liquid Fueled Rocket - Nell
1926

Altitude: 12.5m
Distance: 56.1m
Payload: 0 kg

31 years

V-2
German Developments – 1939

Altitude: 88km
Distance: 320km
Payload: 1000 kg

R-7 Semyorka
First Ballistic Missile - 1957

Altitude: ~1,200 km
Distance: 8,800 km
Payload: 5,500 kg

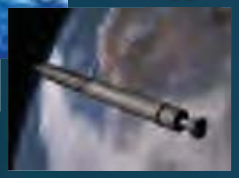
The driving force for this rapid expansion of technology was World War II and the Cold War

Rapid Growth – 1960's

Sputnik 1

October 1957

1958

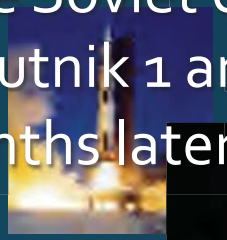


Explorer 1

In September 1957 nobody had put anything into space…ever…

12 years

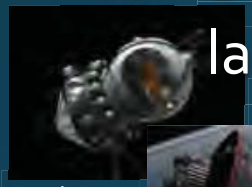
But on 4 October 1957, the Soviet Union changed that with the launch of Sputnik 1 and the United States followed a few months later with the launch of Explorer 1



First People on the Moon

July 20, 1969

Vostok

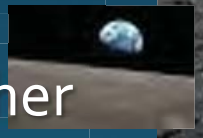


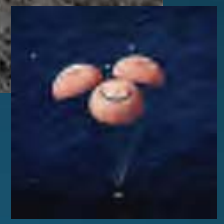
April 1961

Mercury

May 1961

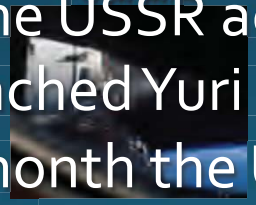
…But In July 1969, only 12 years later, people were walking on the Moon





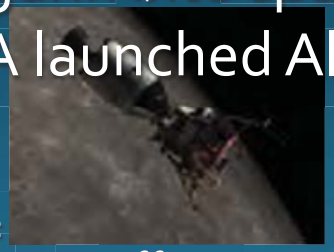
Three years later, the USSR achieved another first when they launched Yuri Gagarin into space, and the following month the USA launched Alan Sheppard into space

Gemini



1965-1966

Apollo



1966-1972

Sputnik 1: 577 km

11 Years

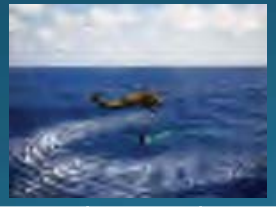
Apollo 8: 385,000 km

TODAY

1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040+

First Steps - Mercury

15m | 15m | 4h 55m | 4h 56m | 9h 13m | 1d 10h 19m



Crew:	1
Length:	3.3m
Diameter:	1.9m
Weight:	1,400kg
Space:	1.7m3
Proj. Cost:	¥181.7 billion (today)

1920 | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 2020 | 2030 | 2040+

Flying in Space - Gemini

3d 23h | 18m | 4h 52m | 4d 2h | 7d 22h | 13d 18h | 1d 2h | 10h 41m | 3d 20m | 2d 22h | 2d 23h | 3d 22h

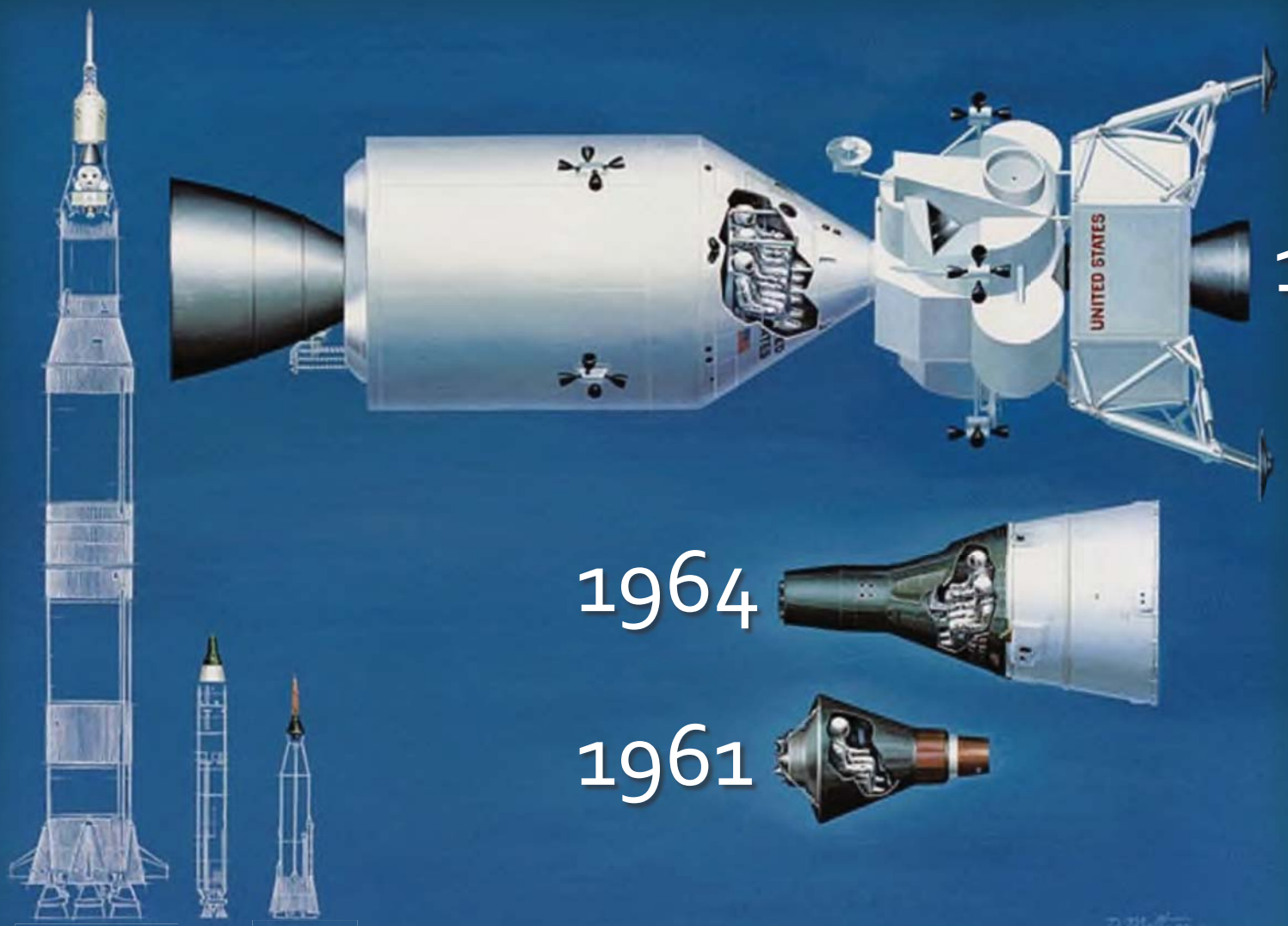
Crew:	2
Length:	5.8m
Diameter:	3m
Weight:	3,850kg
Space:	2.55m3
Proj. Cost:	¥767 billion (today)

Going to the Moon - Apollo

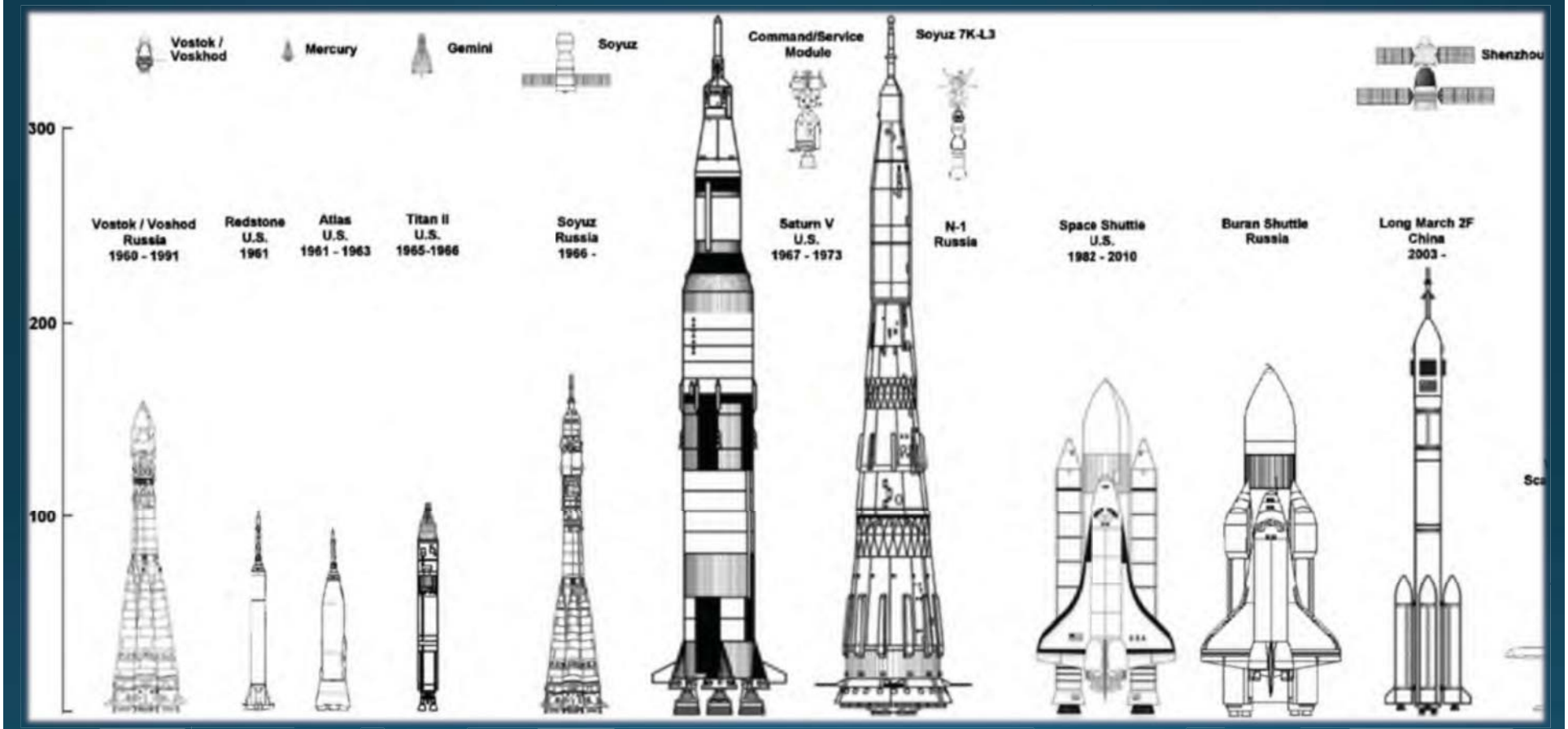
Crew:	3
Length:	11.03m
Diameter:	3.9m
Weight:	30,332kg
Space:	10.4m3
Proj. Cost:	¥11.4T

1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040+

Steps to the Moon



The World's Crewed Launch Vehicles



Vostok
Russia
1960-1991

Redstone
U.S.
1961

Atlas
U.S.
1961-63

Titan II
U.S.
1965-66

Soyuz
Russia
1966-

Saturn V
U.S.
1967-1973

N-1
Russia
1969

Space Shuttle
U.S.
1982-2011

Buran
Russia

Long March 2F
China
2003-

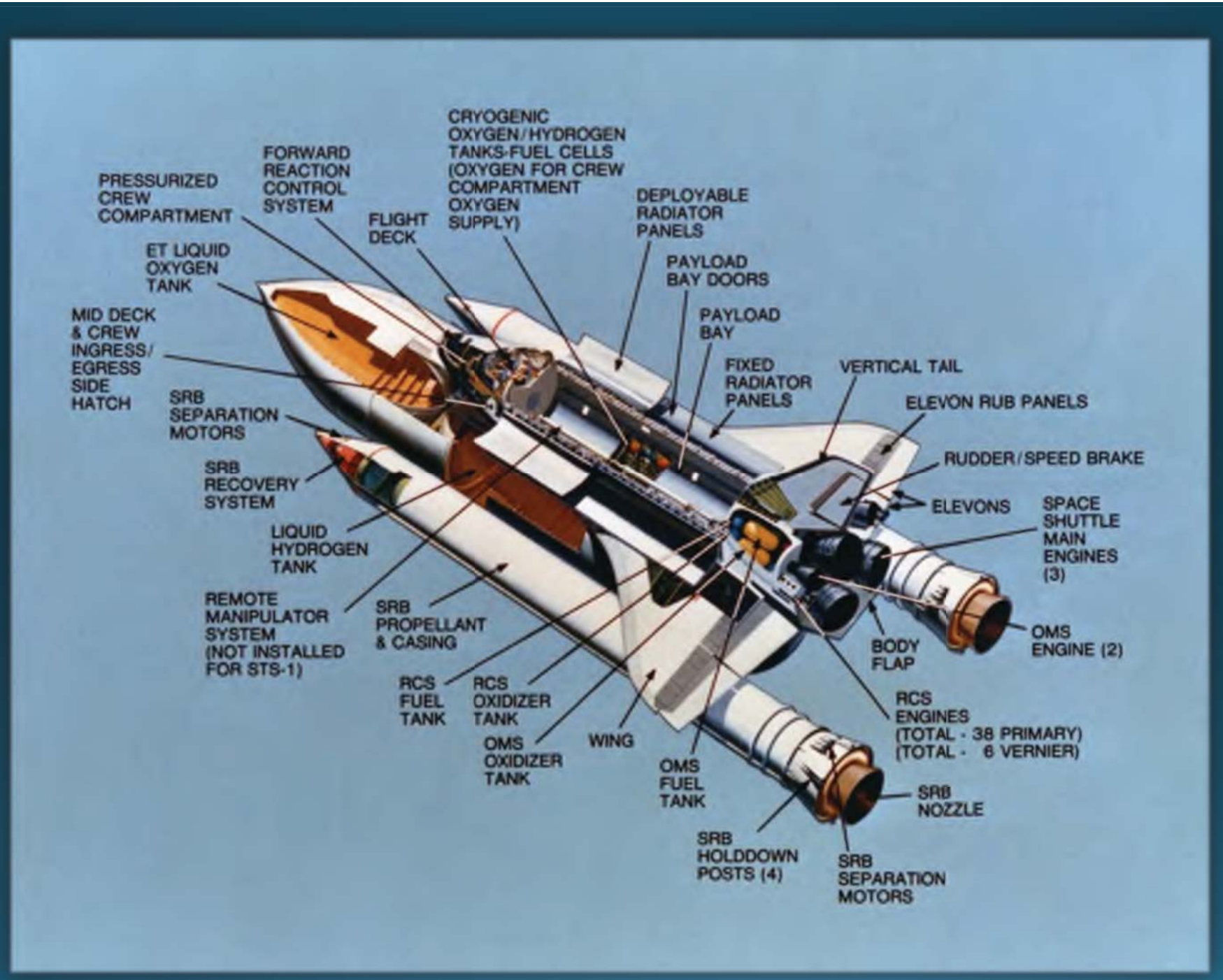
WORKING, LEARNING, AND BUILDING IN SPACE

Space Shuttle

Crew:	7
Length:	37.25m
Height:	17.27m
Wing Span:	23.79m
Weight:	99,318kg
Space:	65.8m3
Proj. Cost:	¥20.1 trillion (today)
Total Flights:	135

TODAY

1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040+


PRESSURIZED CREW COMPARTMENT
FORWARD REACTION CONTROL SYSTEM
CRYOGENIC OXYGEN/HYDROGEN TANKS-FUEL CELLS (OXYGEN FOR CREW COMPARTMENT OXYGEN SUPPLY)
FLIGHT DECK
DEPLOYABLE RADIATOR PANELS
ET LIQUID OXYGEN TANK
PAYLOAD BAY DOORS
PAYLOAD BAY
MID DECK & CREW INGRESS/ EGRESS SIDE HATCH
FIXED RADIATOR PANELS
VERTICAL TAIL
ELEVON RUB PANELS
SRB SEPARATION MOTORS
RUDDER/SPEED BRAKE
SRB RECOVERY SYSTEM
ELEVONS
SPACE SHUTTLE MAIN ENGINES (3)
LIQUID HYDROGEN TANK
REMOTE MANIPULATOR SYSTEM (NOT INSTALLED FOR STS-1)
SRB PROPELLANT & CASING
BODY FLAP
OMS ENGINE (2)
RCS FUEL TANK
RCS OXIDIZER TANK
RCS ENGINES (TOTAL - 38 PRIMARY) (TOTAL - 6 VERNIER)
OMS OXIDIZER TANK
WING
OMS FUEL TANK
SRB NOZZLE
SRB HOLDDOWN POSTS (4)
SRB SEPARATION MOTORS

Construction- BUILDING THE INTERNATIONAL SPACE STATION

Zarya

1998

2000

Assembly Flights:

41 total flights to build the International Space Station

37 Space Shuttle Flights

4 Russian Flights

2001

2007

Complete

2011

Flights to the International Space Station: 153

99 Russian

37 Space Shuttles

5 SpaceX Dragons

3 OSC Cygnus

5 European ATV's

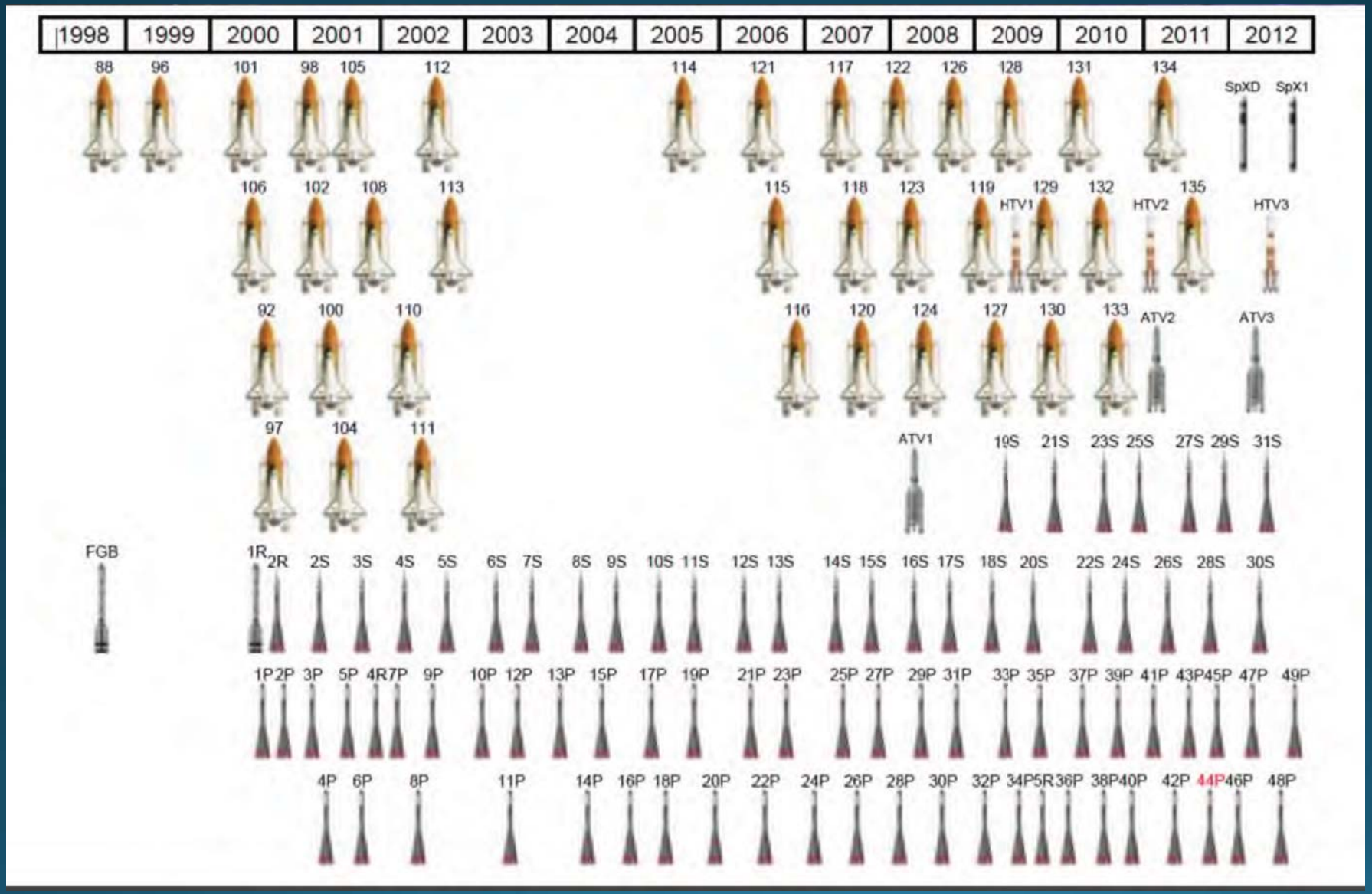
4 Japanese HTV's

Speed: 27,600 km/h

Altitude: 425 km

Days in Space: 5049+

Flights to the International Space Station



CONSTRUCTION- BUILDING THE INTERNATIONAL SPACE STATION

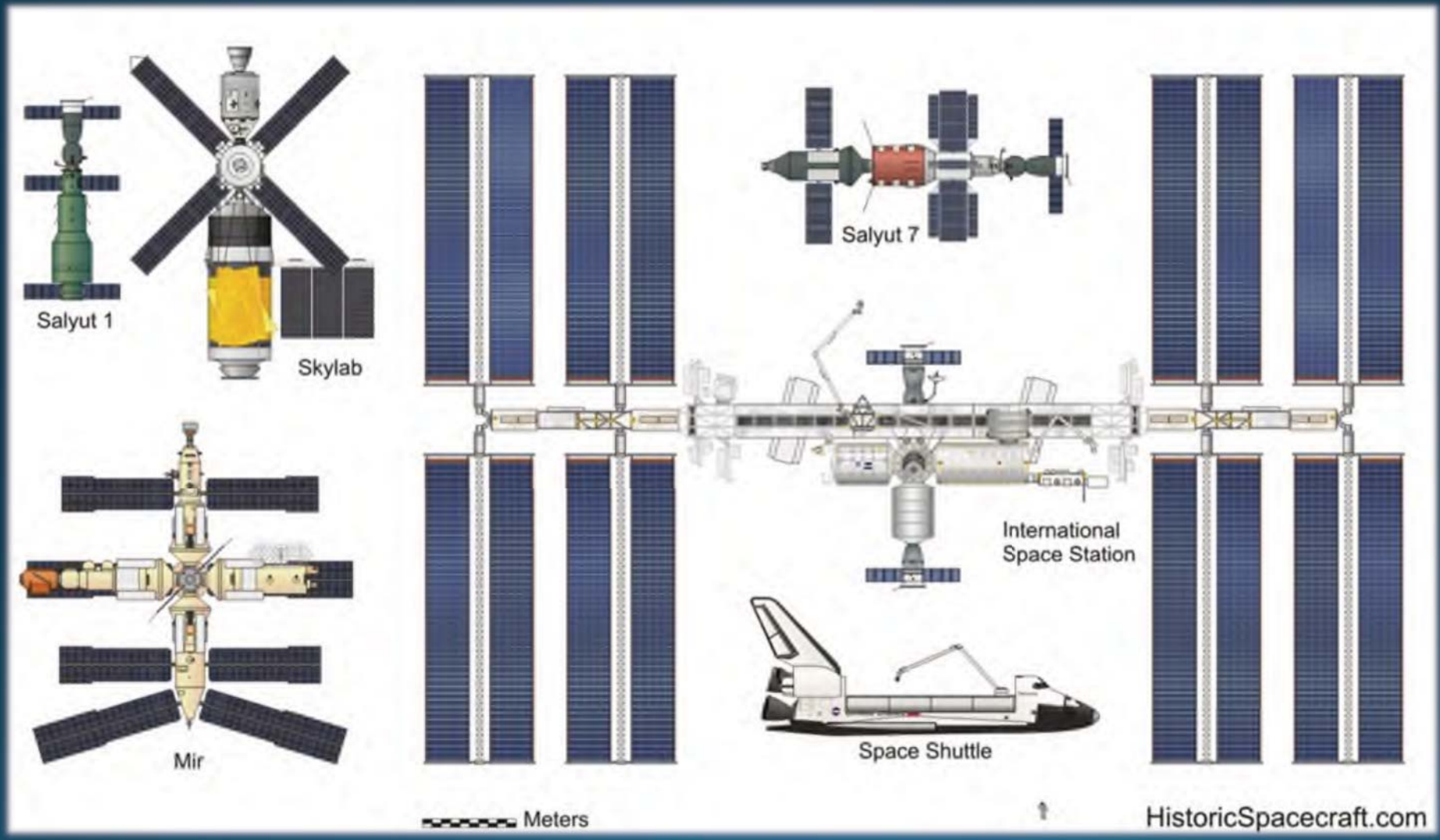
Weight: 419,455 kg

Over 2,414,016,000 kilometers travelled

TODAY

1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040+

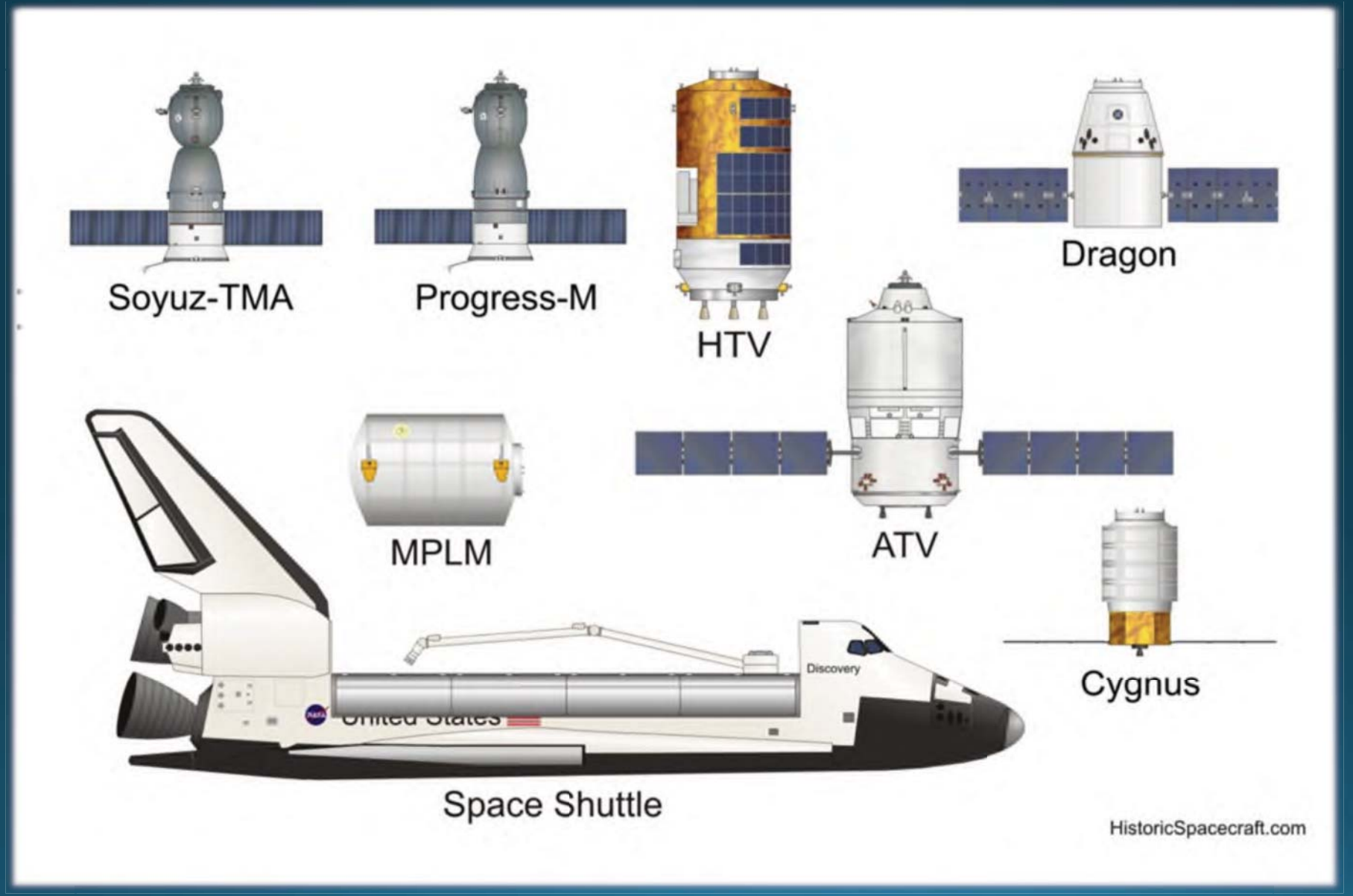
The Growth of Space Stations



TODAY

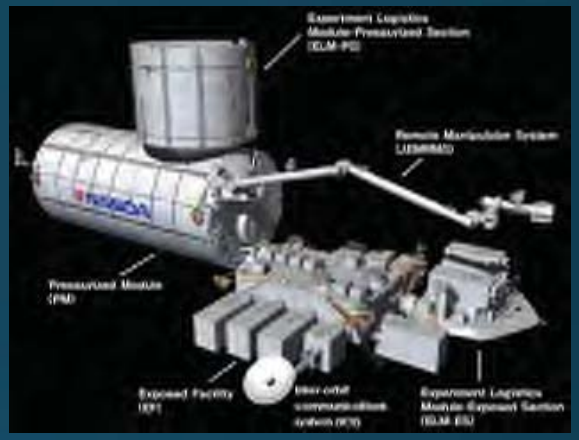
1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040+

International Space Station – A Spaceport in Orbit



Kibo


Kibo


Experiment Logistics
Module-Pressurized Section
(ELM-PS)
Remote Manipulator System
(JEMRMS)
Pressurized Module
(PM)
Exposed Facility
(EF)
Inter-orbit
communication
system (ICS)
Experiment Logistics
Module-Exposed Section
(ELM-ES)

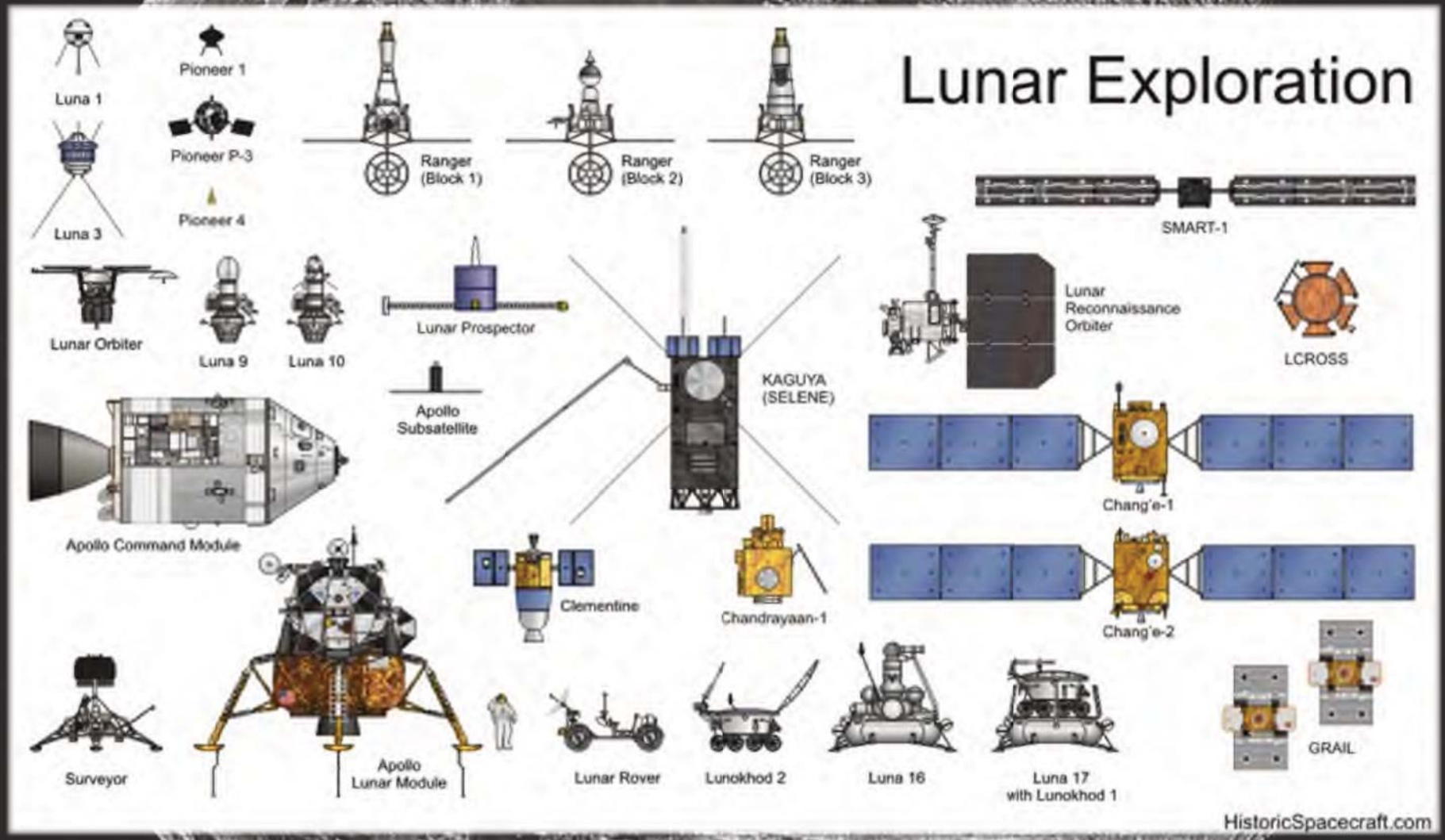
Living in Space

14+ years

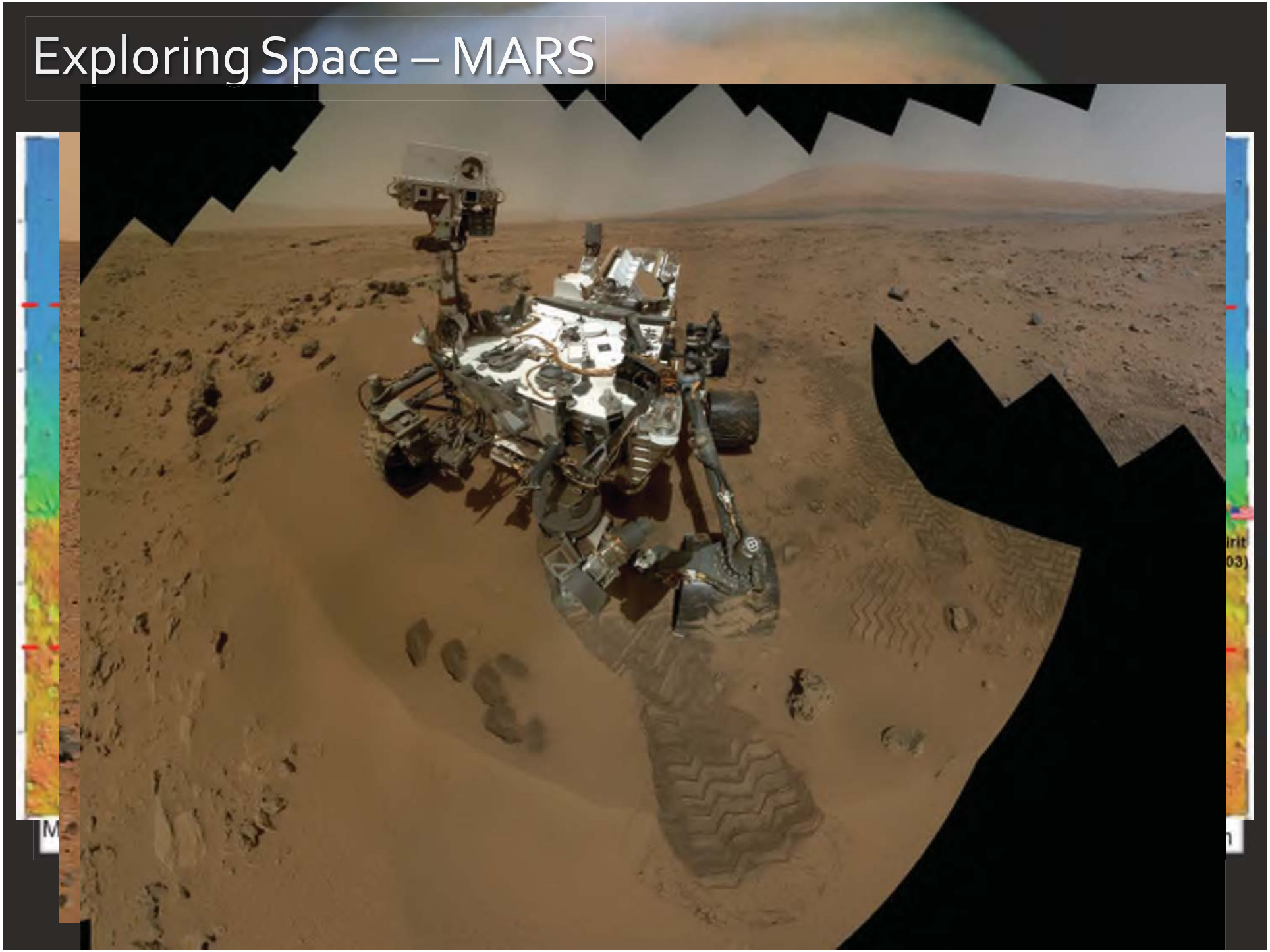
TODAY

1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040+

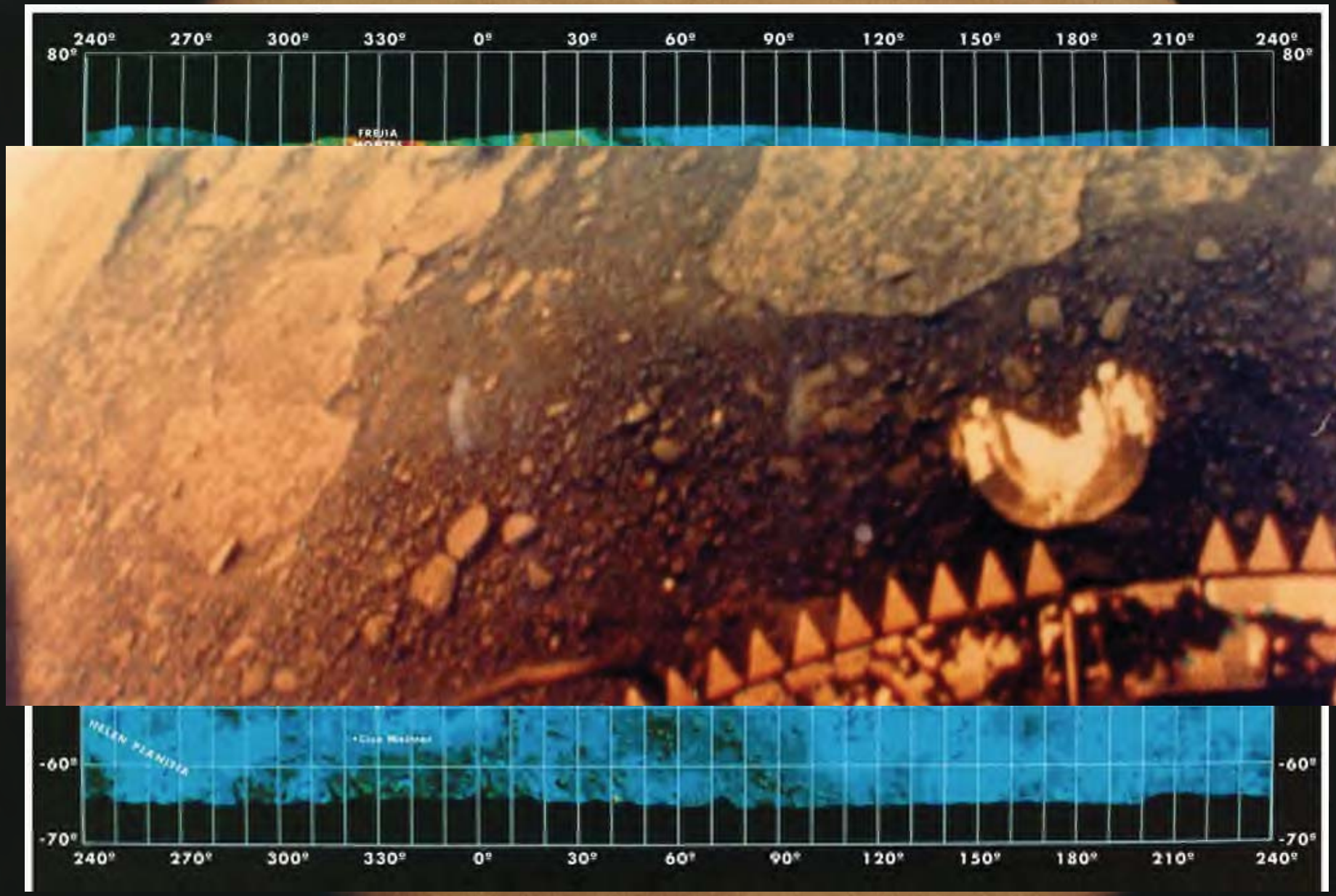
Exploring Space – Moon



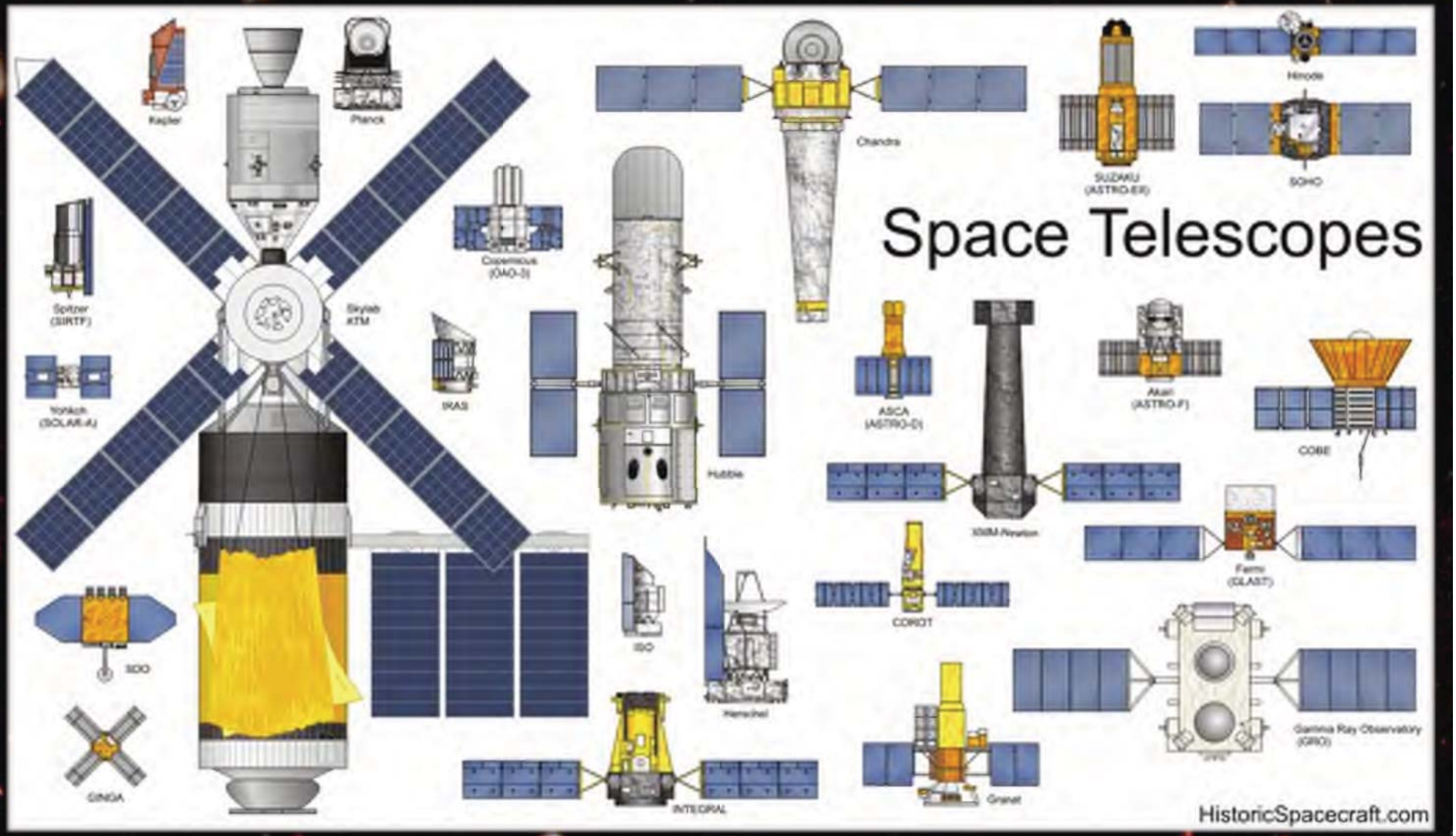
Exploring Space – MARS

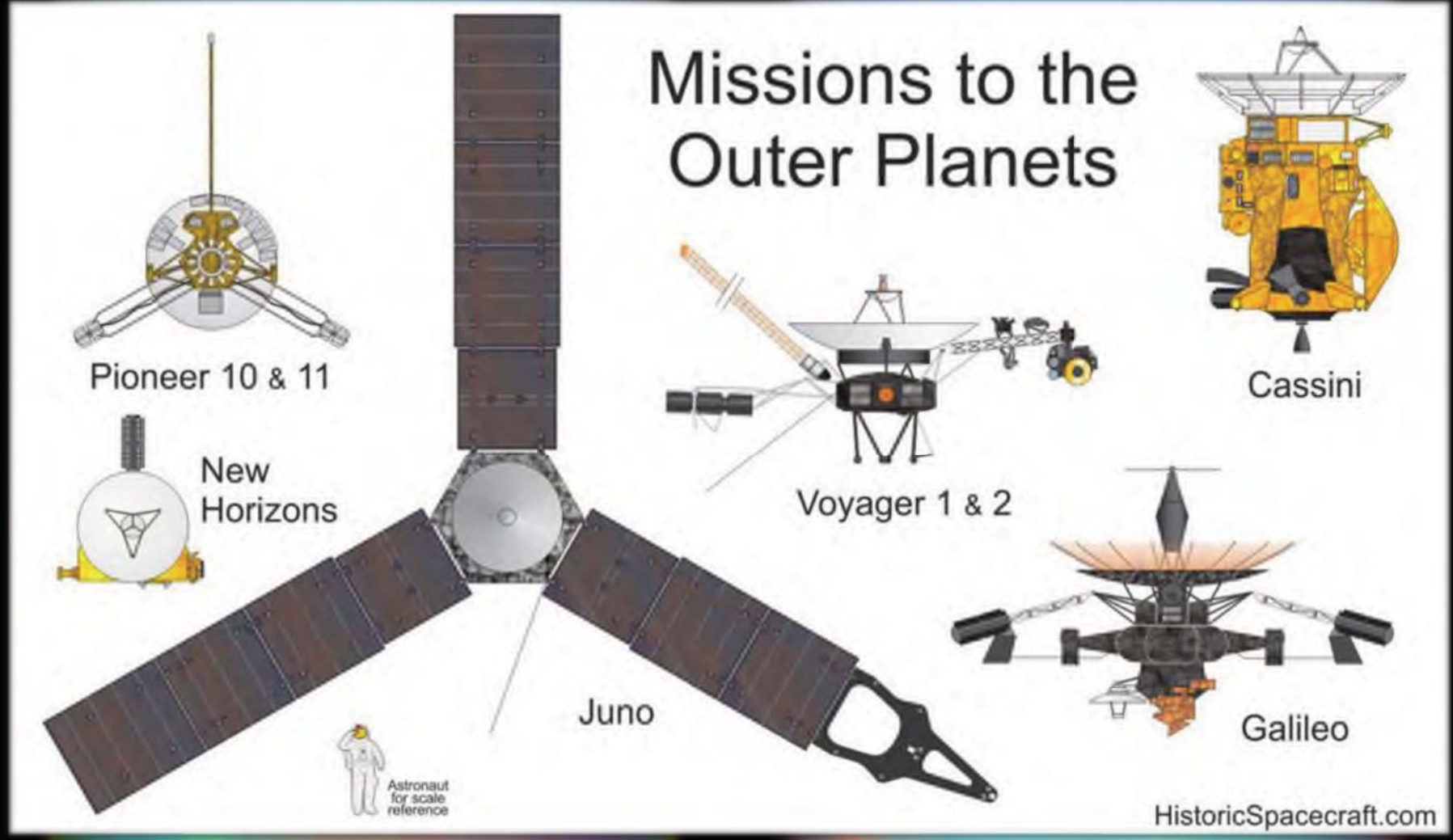


Exploring Space – VENUS



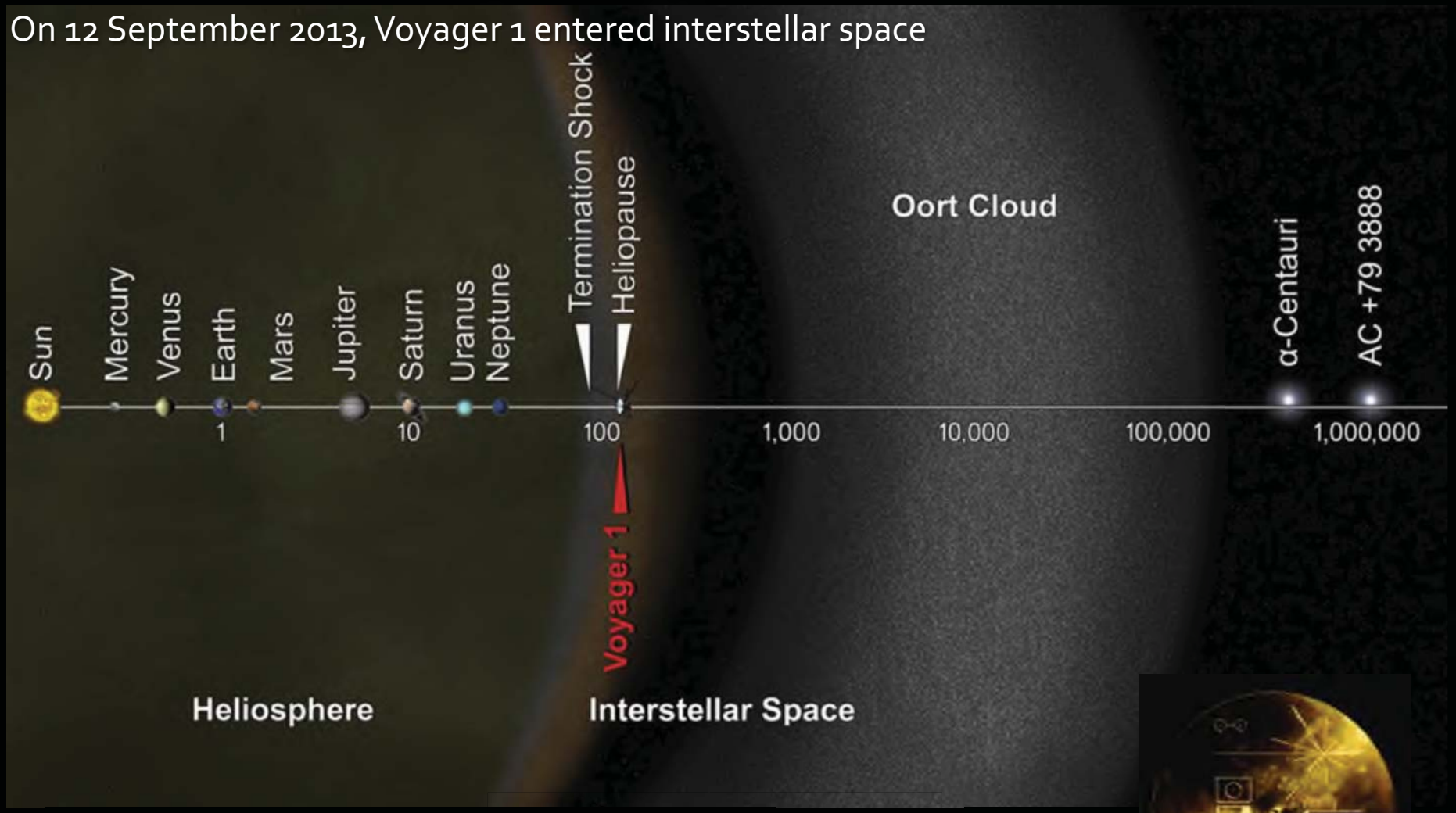
Exploring Space – Telescopes




Missions to the Outer Planets
Pioneer 10 & 11
New Horizons
Juno
Astronaut for scale reference
Voyager 1 & 2
Cassini
Galileo
HistoricSpacecraft.com

Exploring Space – How Far Have We Gone?

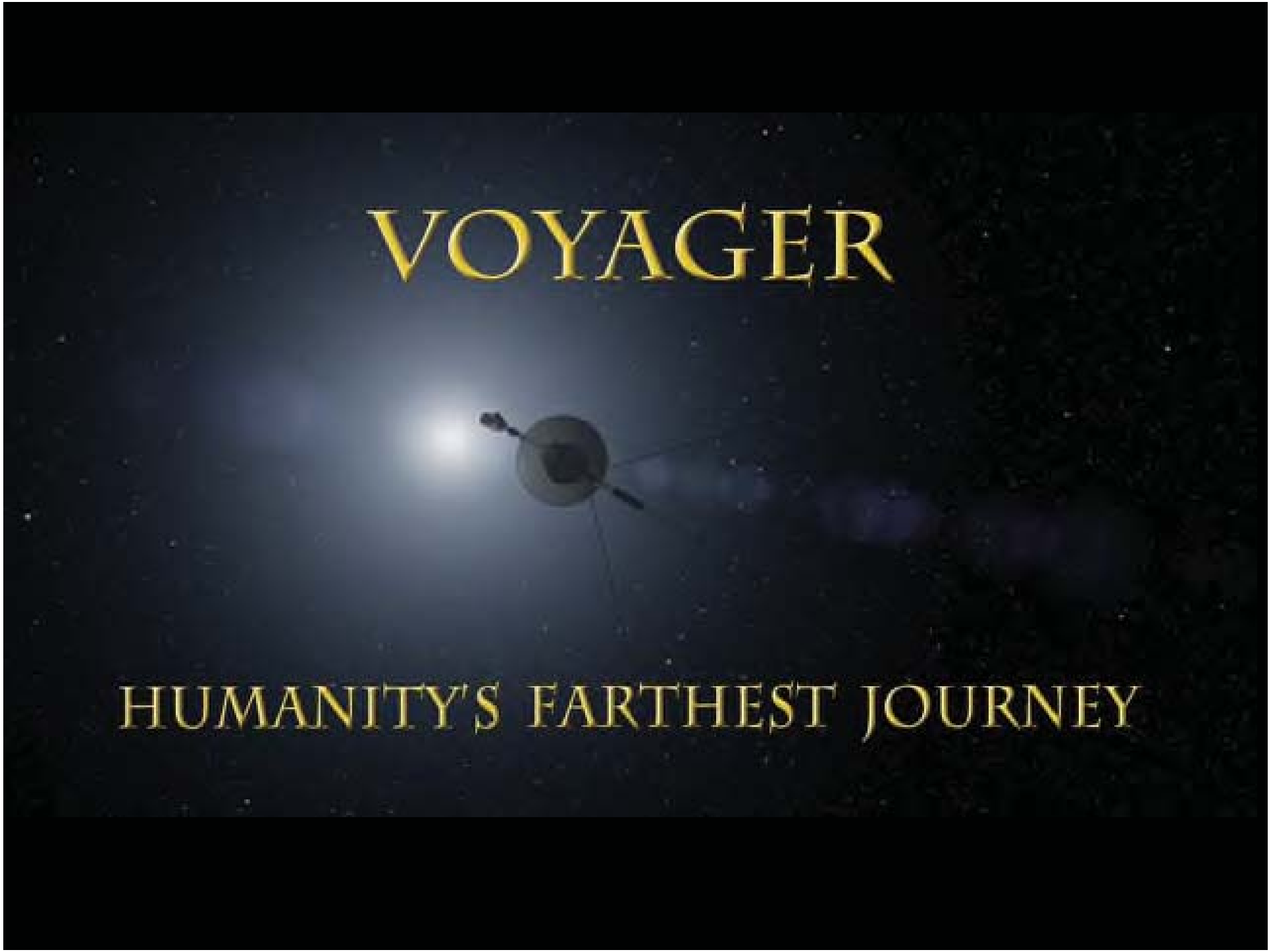
On 12 September 2013, Voyager 1 entered interstellar space



Voyager 1 and 2

Voyager 1
Distance from Earth: 19,396,005,663km
Distance from Sun: 35:56:36 light hours

Voyager 2
Distance from Earth: 15,863,430,047km
Distance from Sun: 29:23:49 light hours


VOYAGER
HUMANITY'S FARTHEST JOURNEY

HUMAN EXPLORATION

NASA's Path to Mars

EARTH RELIANT

MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS

Mastering fundamentals aboard the International Space Station

U.S. companies provide access to low-Earth orbit

PROVING GROUND

MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS

Expanding capabilities by visiting an asteroid redirected to a lunar distant retrograde orbit

The next step: traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft

MARS READY

MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS

Developing planetary independence by exploring Mars, its moons and other deep space destinations

Space Launch System - Launch

Expansion and the Future – YOUR TURN

Space Launch System

Orion

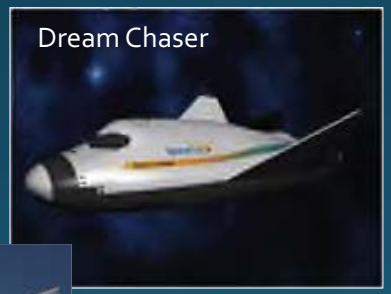
Asteroid Retrieval

Mars Missions

Lynx

XCOR Aerospace/Mike Massee

Dream Chaser



Space Ship Two

Boeing and SpaceX

Expansion and the Future – YOUR TURN

Science, Engineering, Biology, and Technology are the building blocks of our expansion into space, they give YOU the tools…..YOU will make our expansion into space possible

Look at how fast and far we have come…

the first airplane flew 37m at 10.9 km/h…

and in 66 years we were standing on the moon 384,400km away looking back at the earth, that is less than one generation,

think of what you can do and what you will see

You are the generation that will take people farther and faster than ever before

Each generation builds and expands on what was done before

And the next generation will do even more

Thank you for your time and attention

It Has Been My Honor to Talk to You Today