United Launch Alliance

Advanced Launching Learning Program

United Launch Alliance (ULA)

Two world-class launch systems operating as a single provider to the U.S. Government

Over 100 years combined experience in Expendable Launch Systems

1300+ launches starting from 1950

The largest, most experienced and reliable launch service provider IN THE NATION!

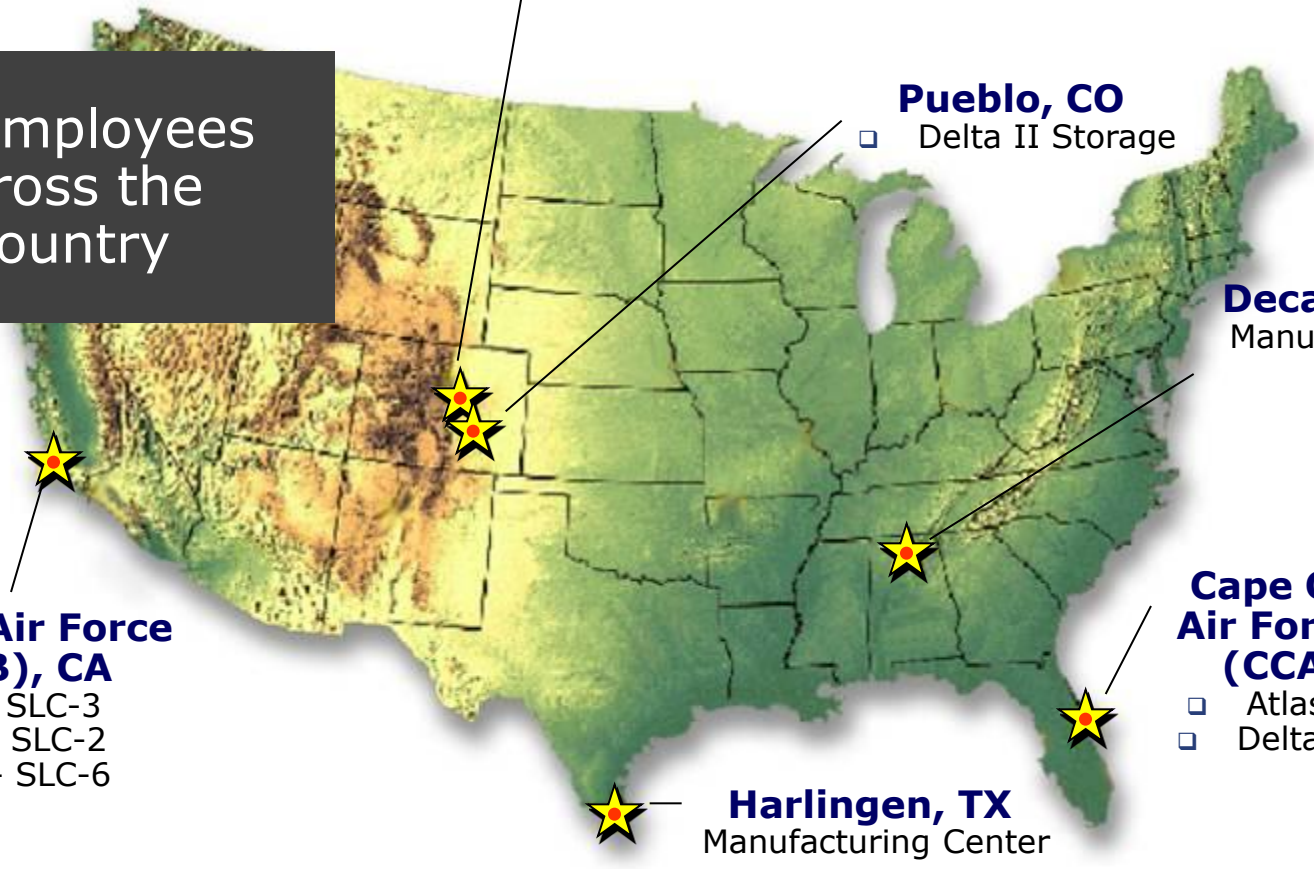
Where Can You Find Us?

Denver, CO
ULA Headquarters

3000 Employees Across the Country

Pueblo, CO
- Delta II Storage

Decatur, AL
Manufacturing Center



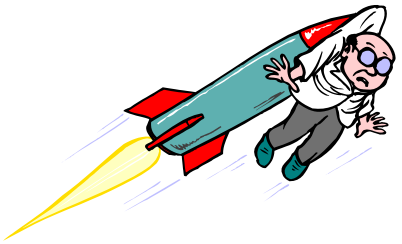
Vandenberg Air Force Base (VAFB), CA
- Atlas V – SLC-3
- Delta II – SLC-2
- Delta IV – SLC-6

Cape Canaveral Air Force Station (CCAFS), FL
- Atlas V – SLC-41
- Delta IV – SLC-37

Harlingen, TX
Manufacturing Center

What do ULA employees do?

Product
Development Engineer



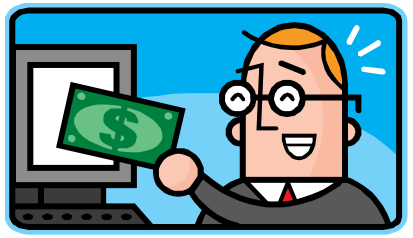
Mission Manager

Production Technician

Launch
Processing Technician

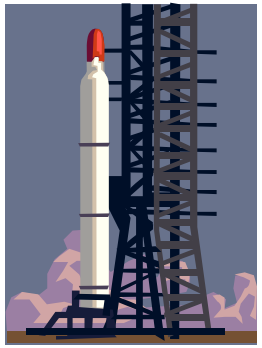
Production/Launch Manager

Finance &
Accounting



Procurement

Human
Resources



Facilities
Management

And many others…

Where Do We Build Rockets?

Decatur, AL

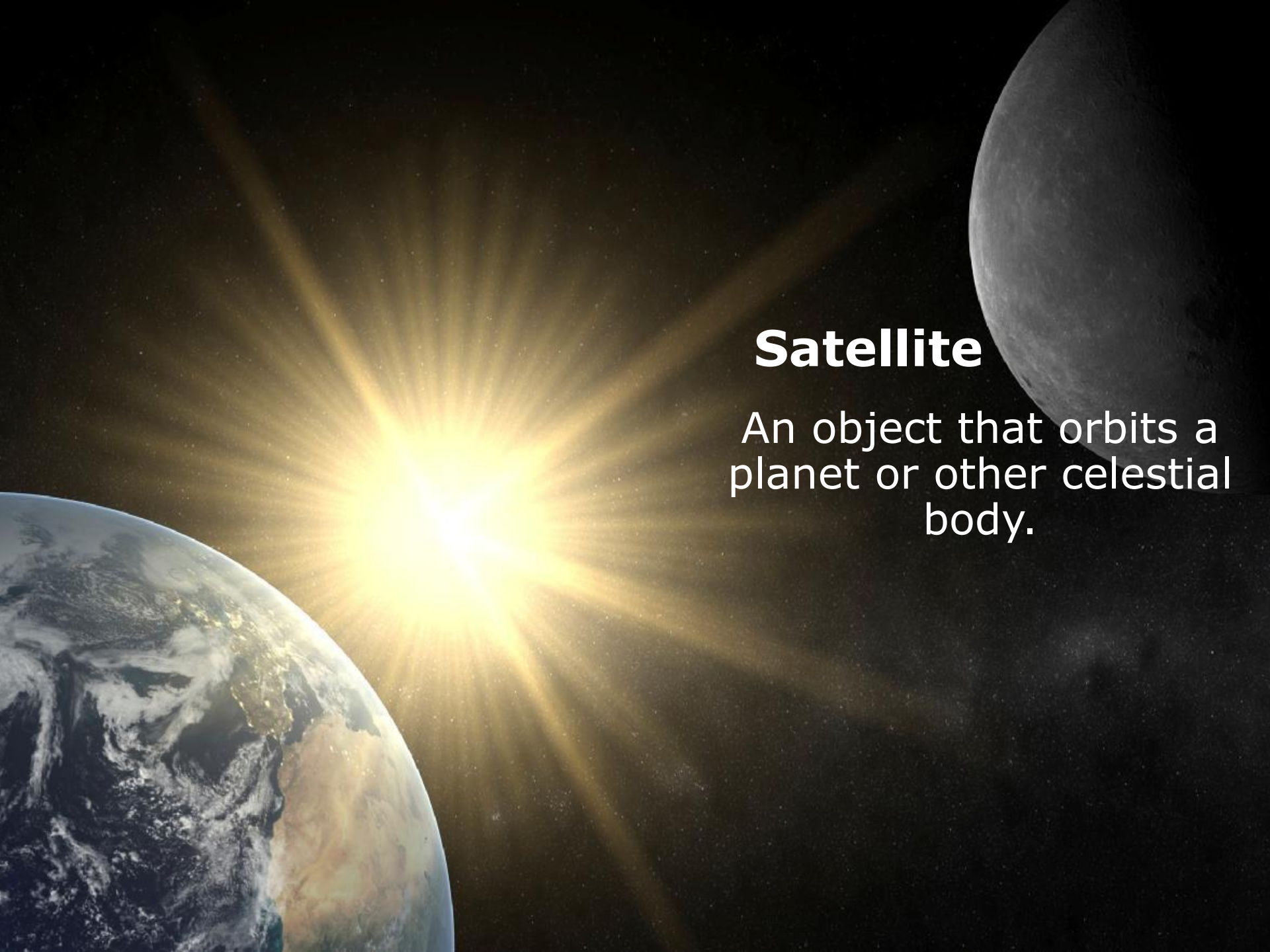
Plant Fun Facts

- 1/2 mile long x 1/4 mile wide
- >36 football fields
- entire campus is ~300 acres

The plant can manage 20 rocket builds at one time

Delta IV Space Launch Complex-37 CCAFS, Florida

Delta IV Space Launch Complex-6
VAFB, California



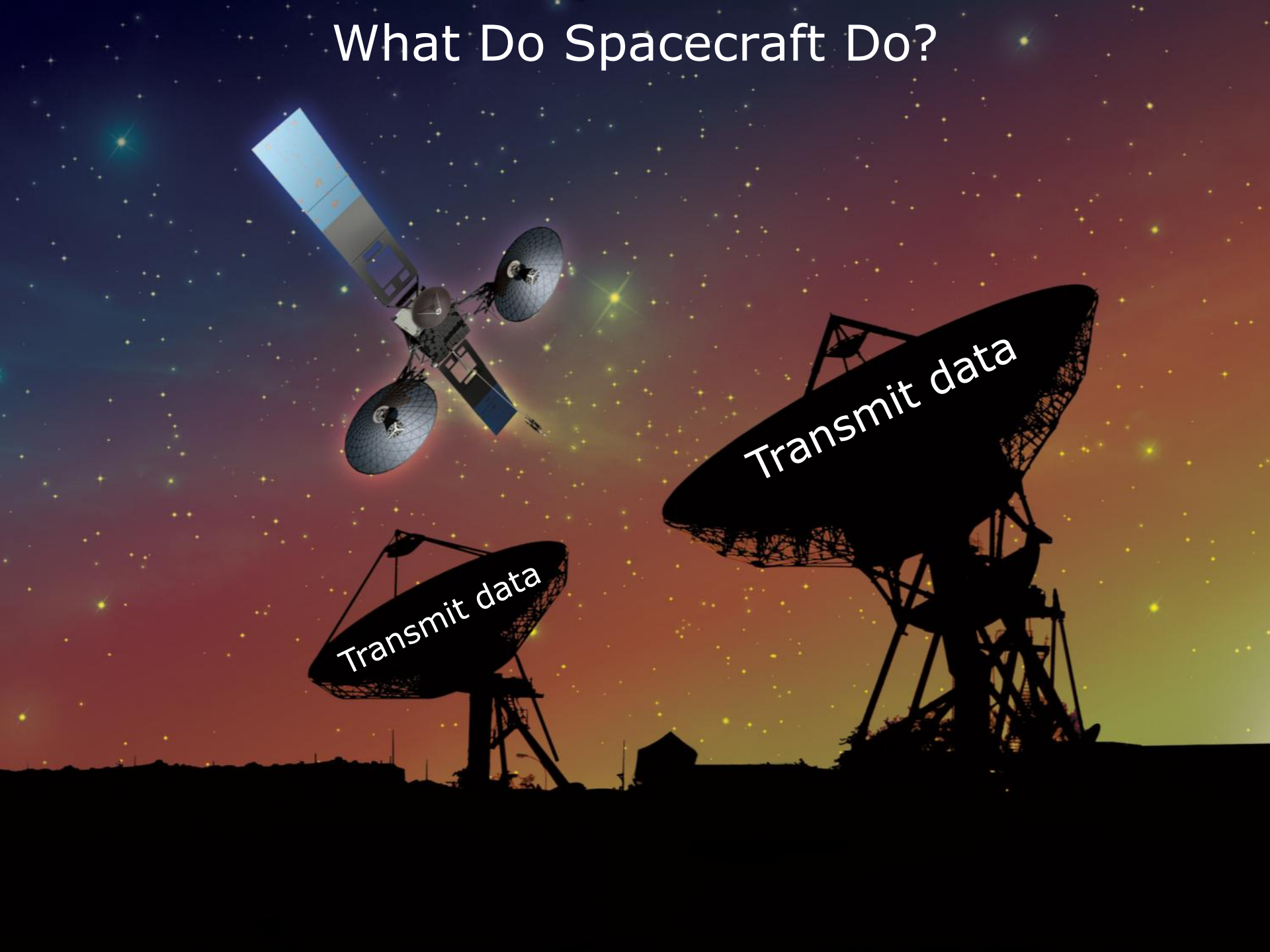
Satellite

An object that orbits a planet or other celestial body.

Spacecraft

A machine designed to operate in space (i.e. a man-made satellite).

What Do Spacecraft Do?



What Do Spacecraft Do?

TV & Radio Communication

What Do Spacecraft Do?

Study the Earth

What Do Spacecraft Do?

Map our planet

What Do Spacecraft Do?

What Do Spacecraft Do?

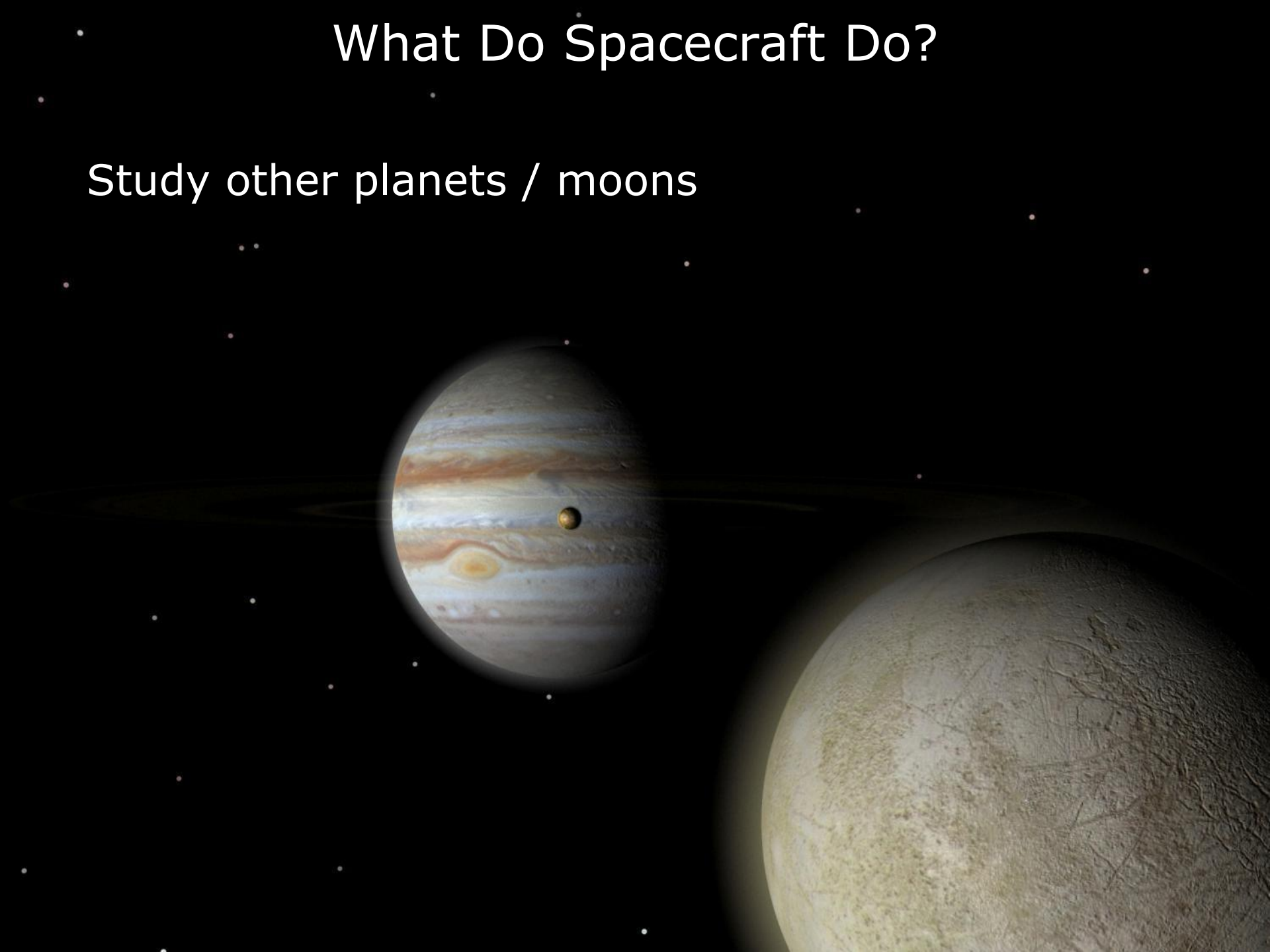
Navigation

What Do Spacecraft Do?

Track enemy missile launches

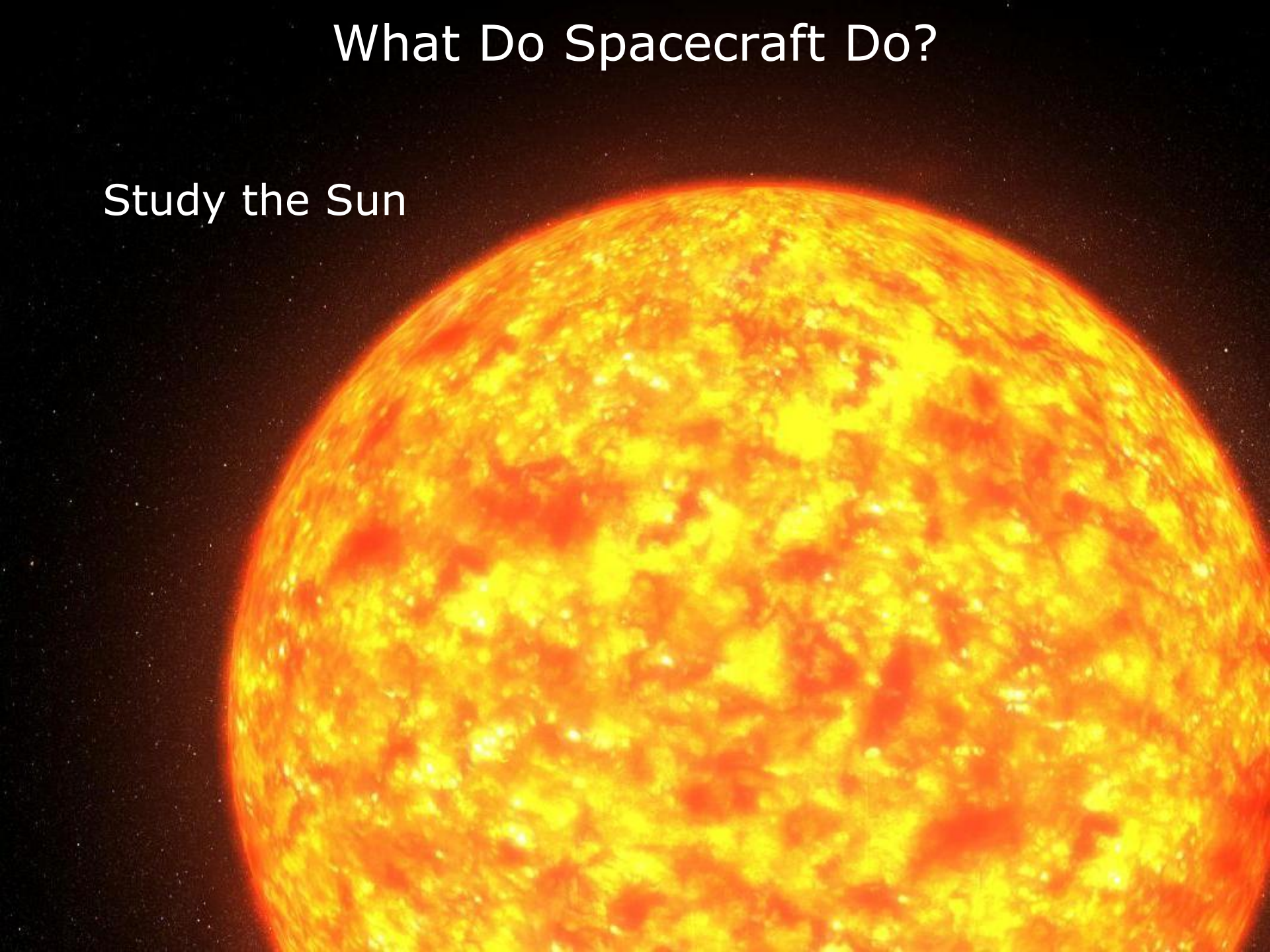
What Do Spacecraft Do?

Study other planets / moons

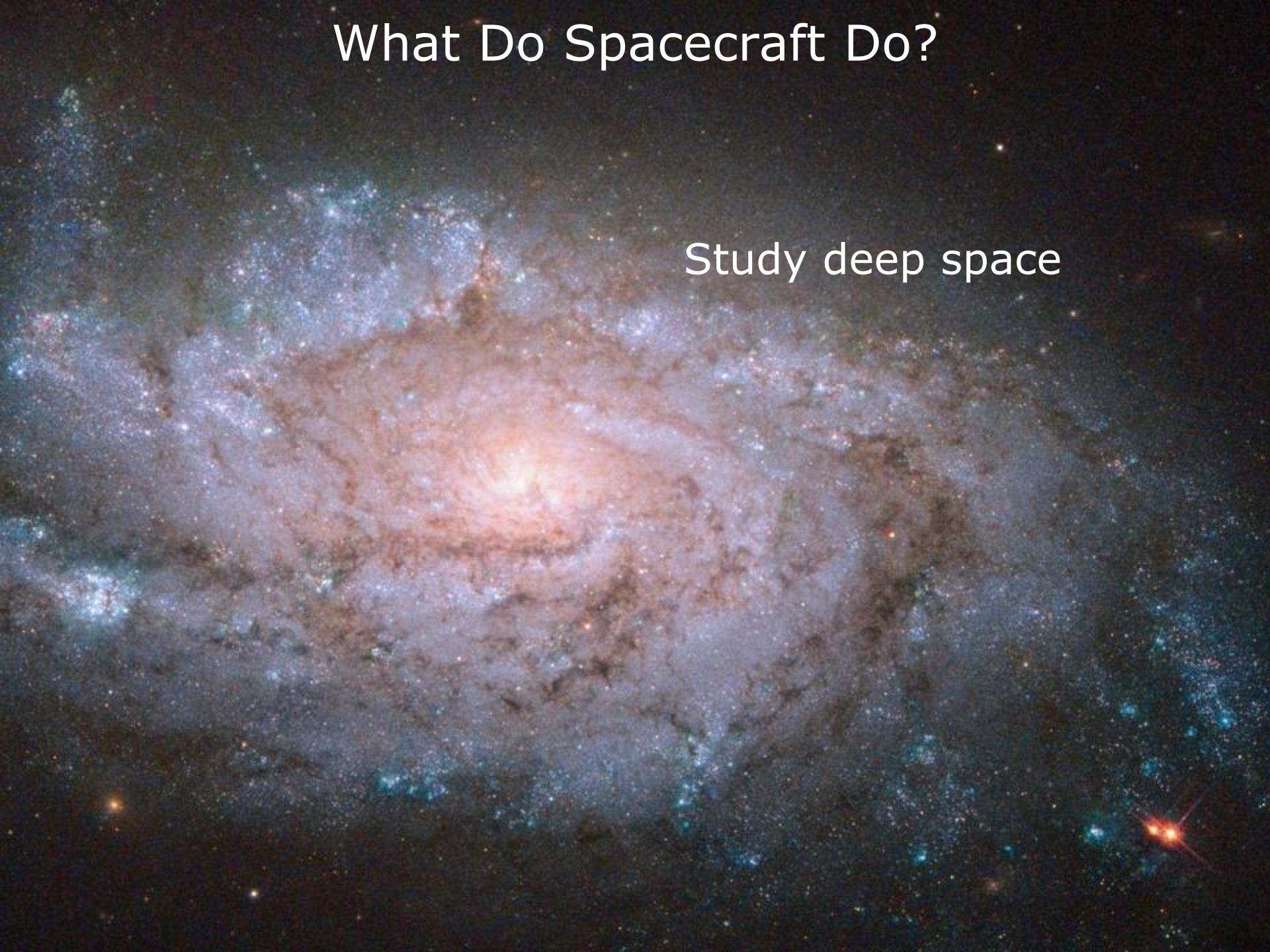


What Do Spacecraft Do?

Study the Sun



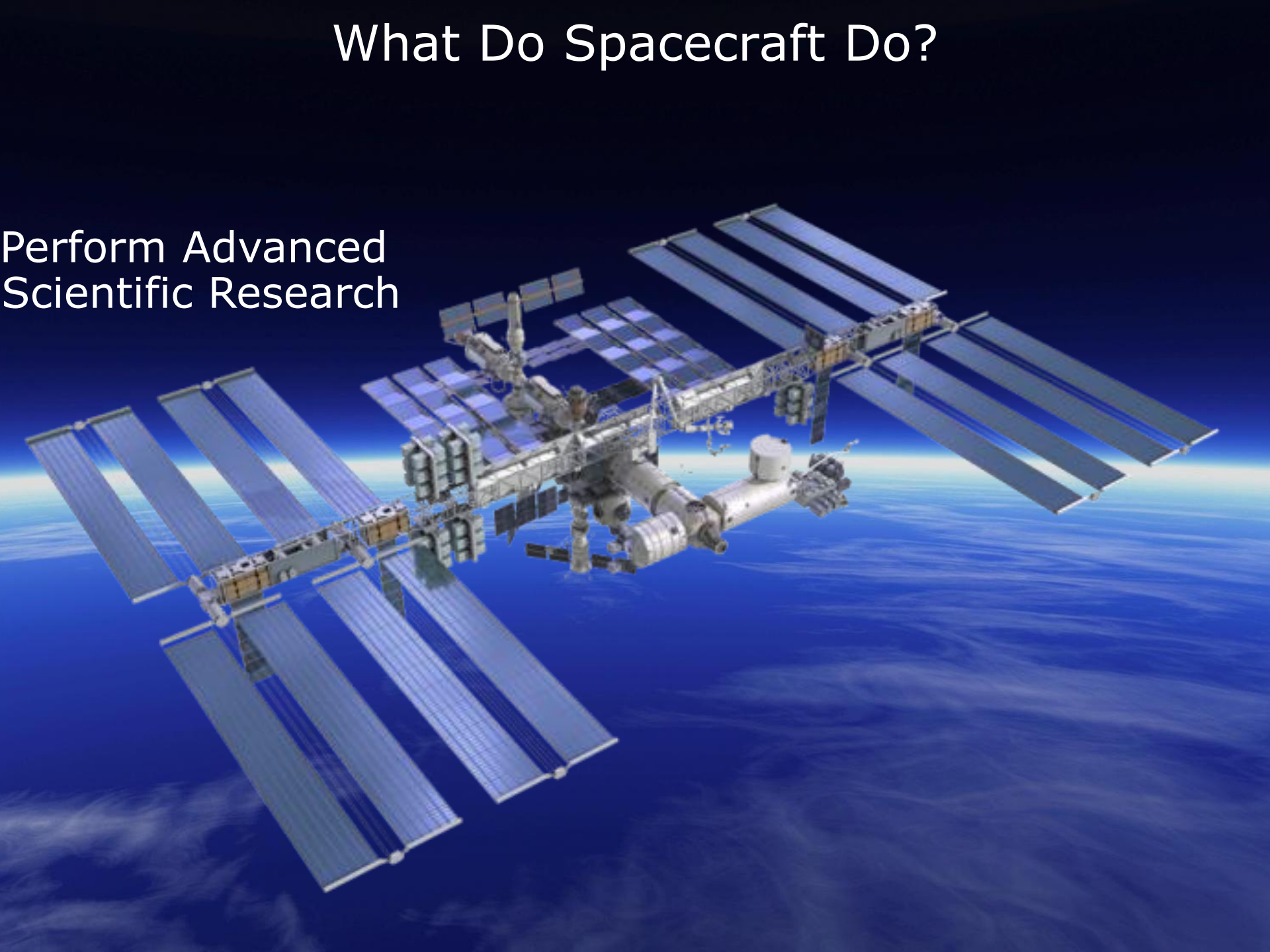
What Do Spacecraft Do?



Study deep space

What Do Spacecraft Do?

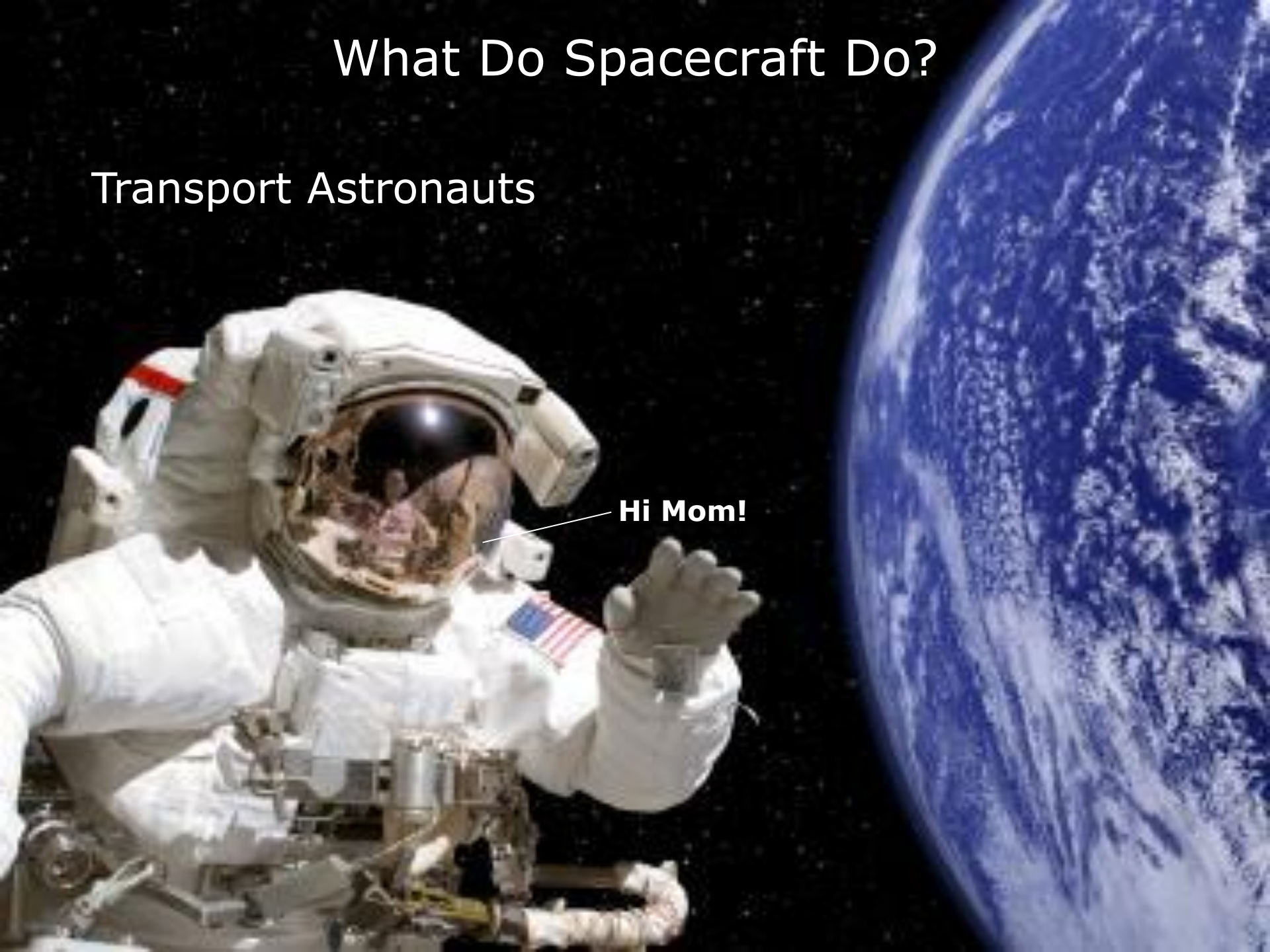
Perform Advanced Scientific Research



What Do Spacecraft Do?

What Do Spacecraft Do?

Transport Astronauts



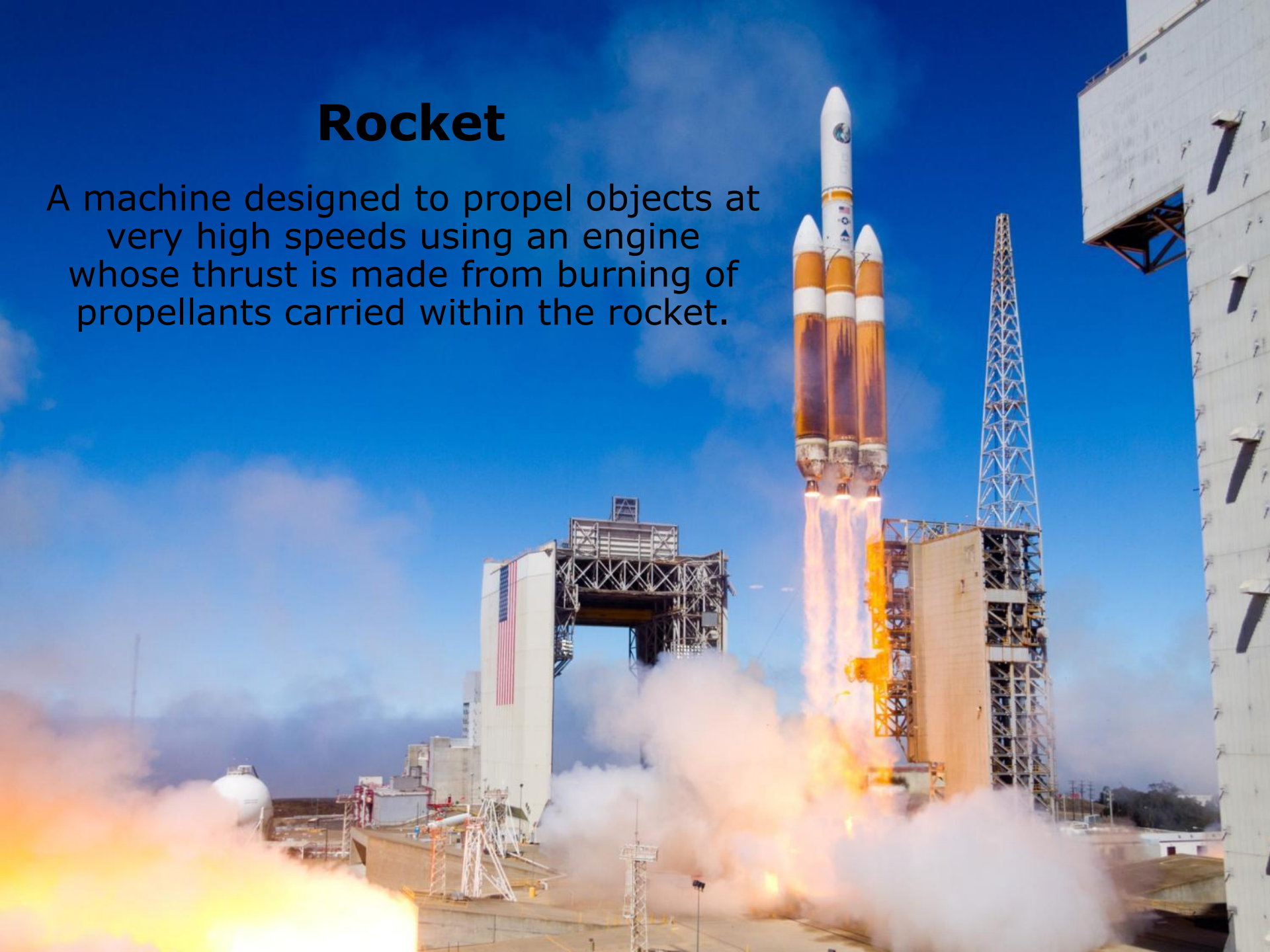
What Do Spacecraft Do?

Roam Around Other Planets

Rocket Basics

Rocket

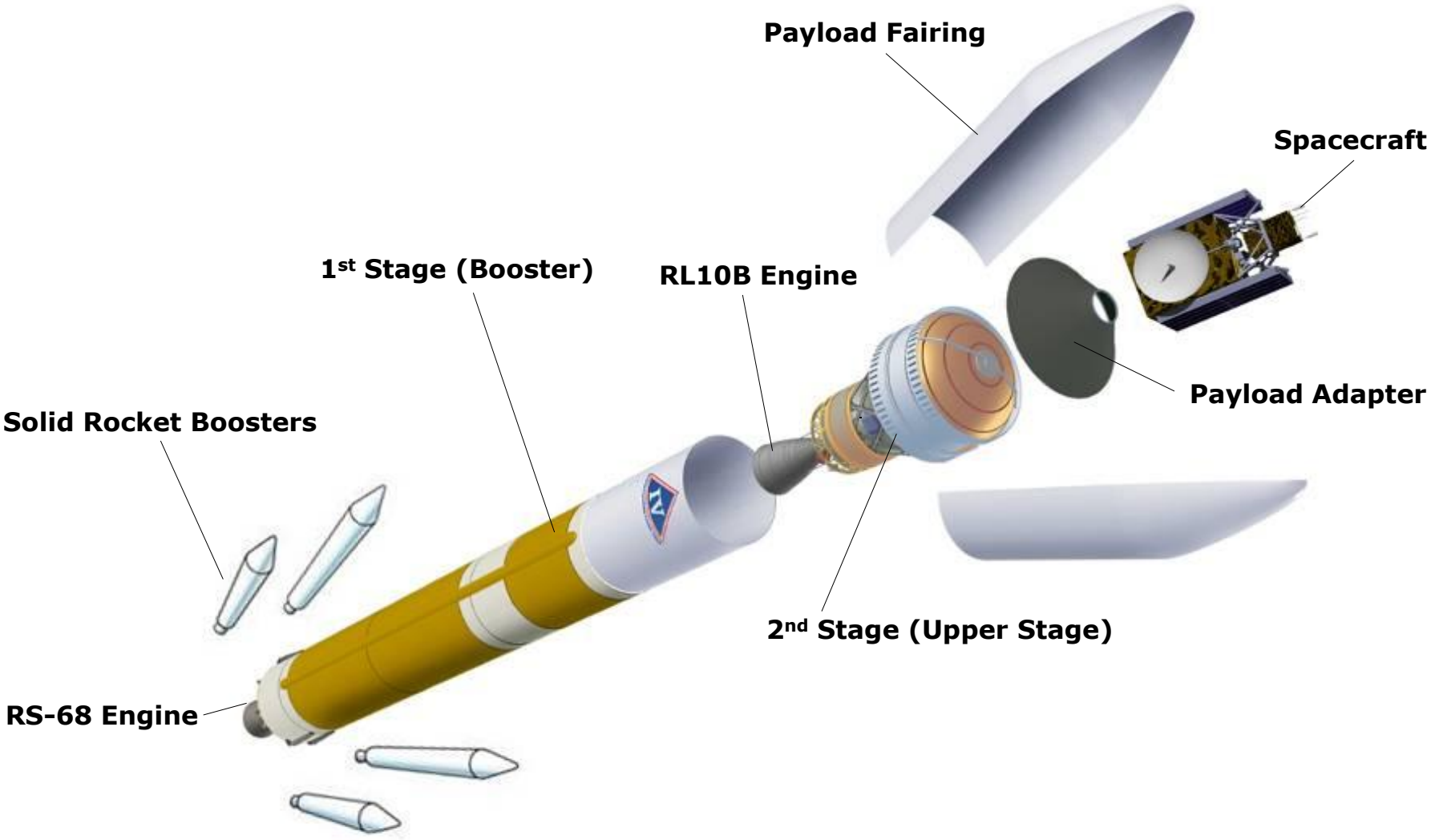
A machine designed to propel objects at very high speeds using an engine whose thrust is made from burning of propellants carried within the rocket.



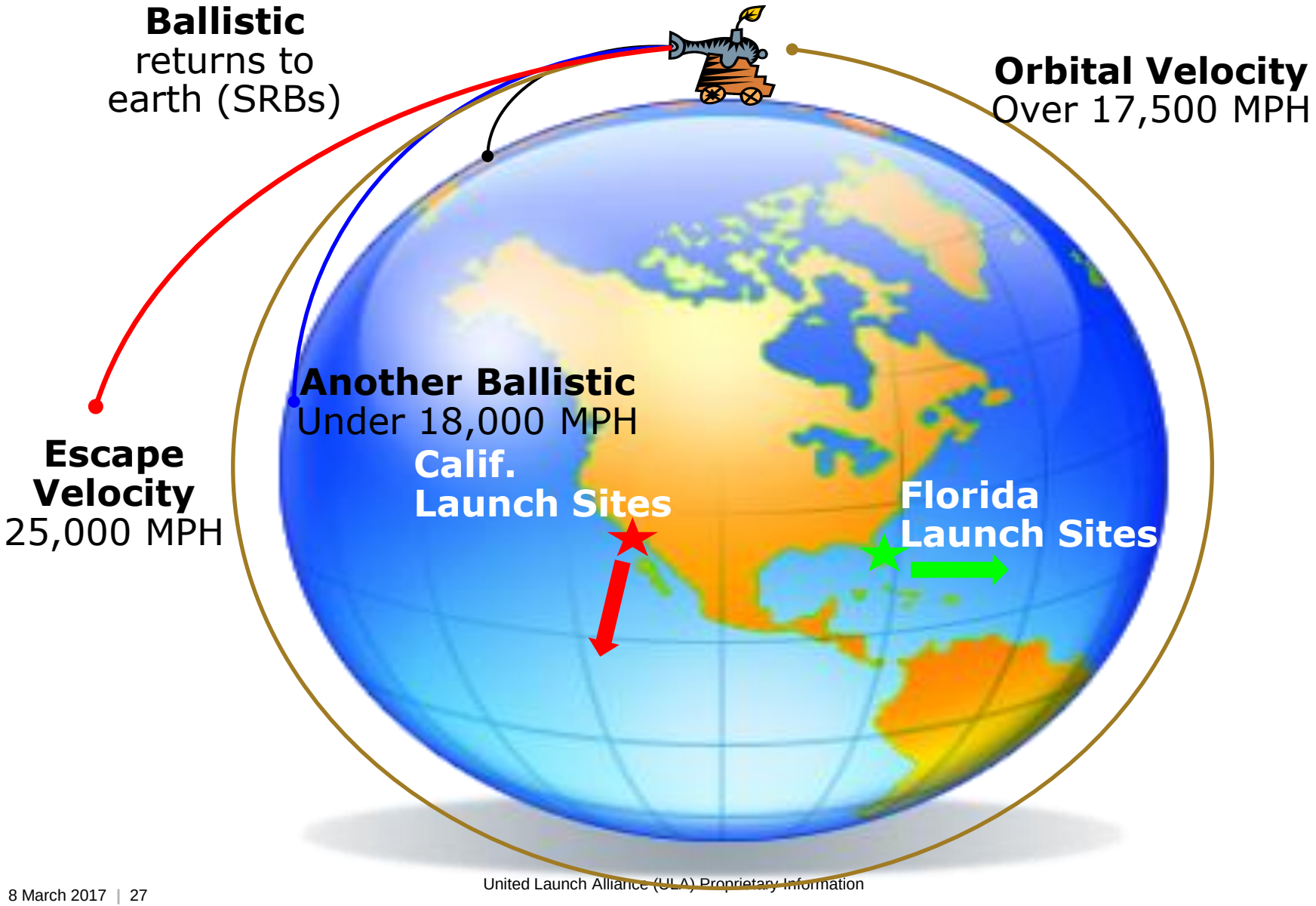
Launch Vehicle

A rocket used to carry a spacecraft into space.

Parts of a Rocket
Delta IV Launch Vehicle



Physics of a Rocket Launch



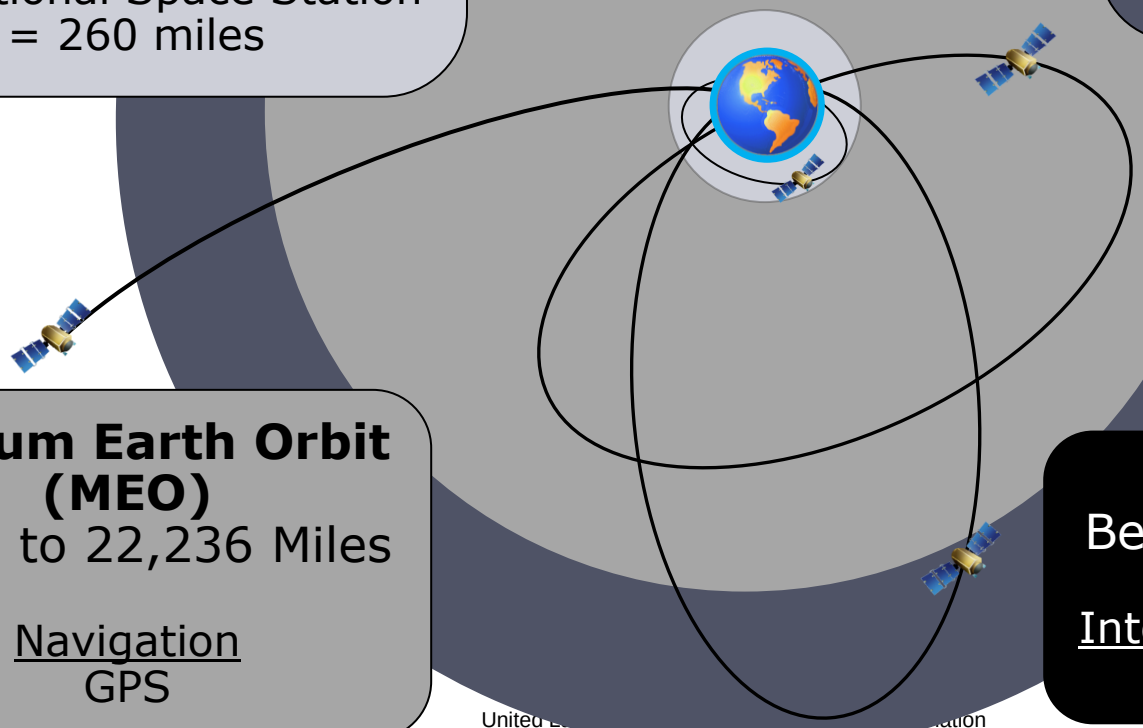
What are the Types of Orbits?

Low Earth Orbit (LEO)
99 to 1200 Miles

Earth Observation
Weather surveillance,
Earth imaging
International Space Station
= 260 miles

Geosynchronous Earth Orbit (GEO)
22,236 Miles

Communications
Dish Network,
Sirius XM



Medium Earth Orbit (MEO)
1,200 to 22,236 Miles

Navigation
GPS

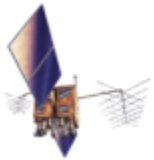
Inter-Planetary
Beyond Earth's Gravity

Interplanetary Exploration
Mar's Rovers

How Heavy are Satellites?

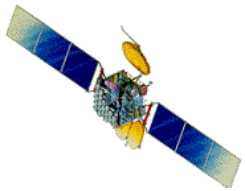
United Launch Alliance

GPS



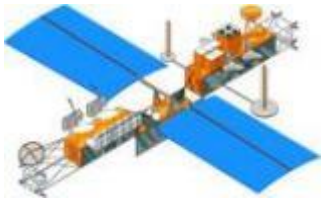
~4,500 lbs

Communication



~12,000 lbs

National Security



~13,000 lbs to 40,000 lbs

Family Sedan: ~4,500 lbs

2 Humvees: ~6,000 lbs each

School Bus: ~23,000 lbs

Delta II

Atlas V & Delta IV

Delta IV Heavy

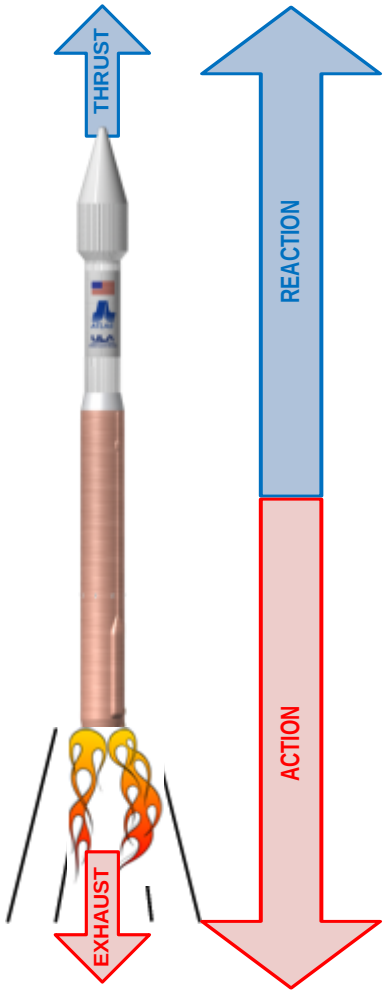
Rocket Engines 101

May the Force be with you: Thrust

- What is thrust?
  - The amount of push the rocket engine provides
- How does a rocket create thrust?
  - The engine creates thrust by burning rocket fuel in the opposite direction the rocket is heading

Force = Mass x Acceleration

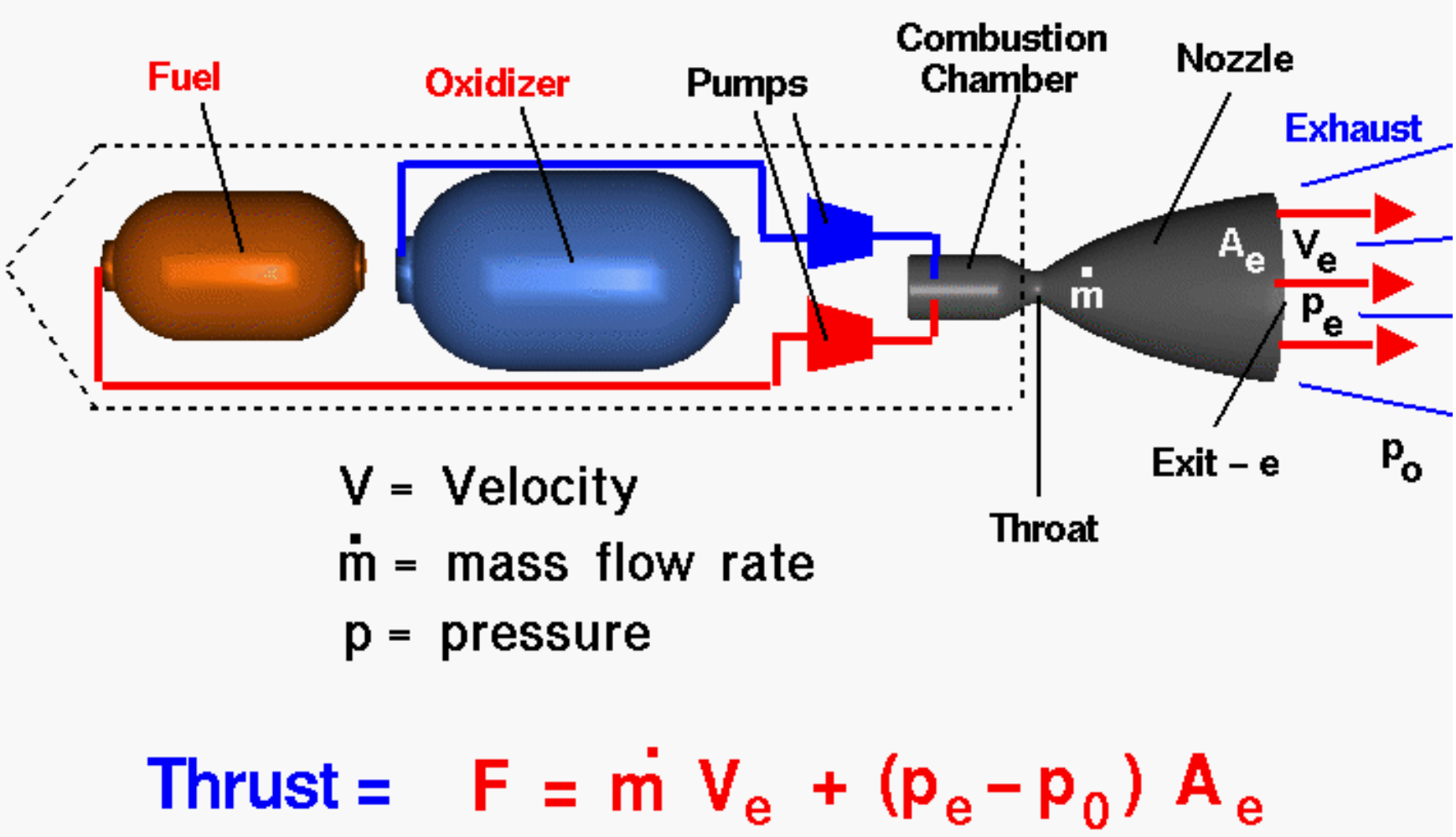
Newton



NEWTON'S THIRD LAW

"For every **ACTION**, there is an equal and opposite **REACTION**"

Liquid Rocket Engine Equation

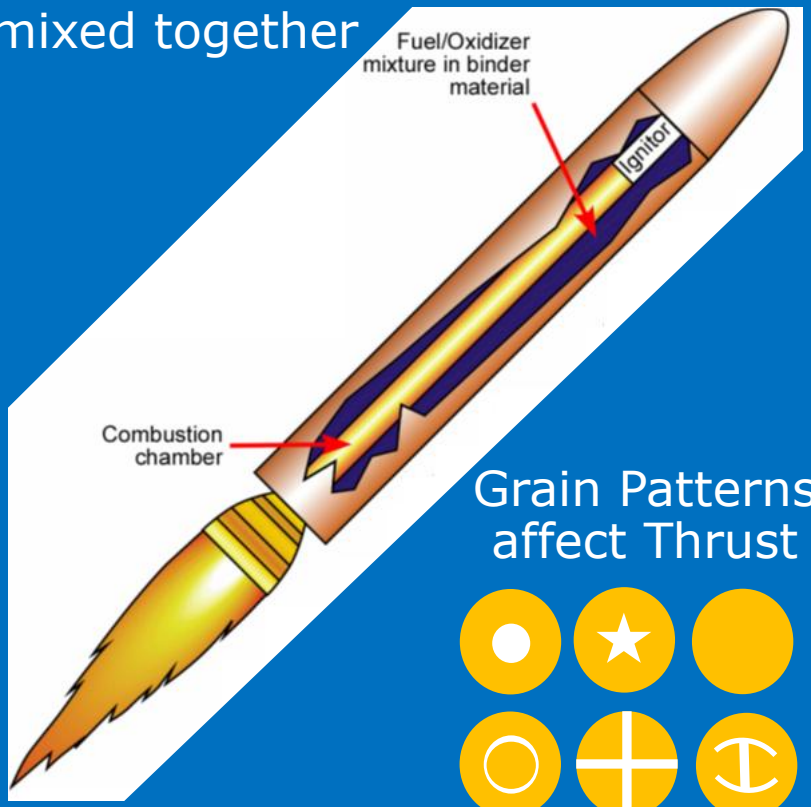


Force = mass flow*exit velocity + area of the exit *(pressure at the exit – ambient pressure)

How Rocket Engines Make Thrust

Solid Rockets

Fuel and Oxidizer mixed together



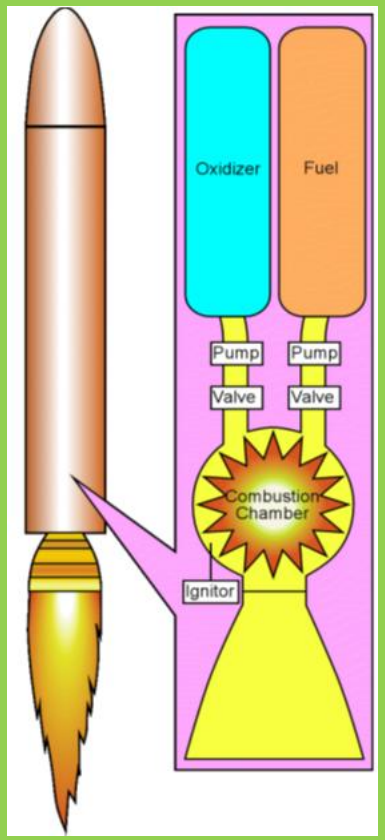
Grain Patterns affect Thrust

Liquid Rockets

Fuel and Oxidizer stored separate

Combust when mixed together in engine

Pump speed used to control Thrust



There are two main types of rocket engines

Solid Rocket

Advantages:

1. Simple
2. Low Cost
3. Safe
4. Easy to store

Disadvantages:

1. Thrust not as controllable
2. Cannot be stopped or restarted

Liquid Rocket

- **Advantages:**
  1. Can be controlled
  2. can be started and stopped
- **Disadvantages:**
  1. complex
  2. expensive
  3. Must be kept cold
  4. Complicated mechanics

Atlas V Booster Engine

RD-180

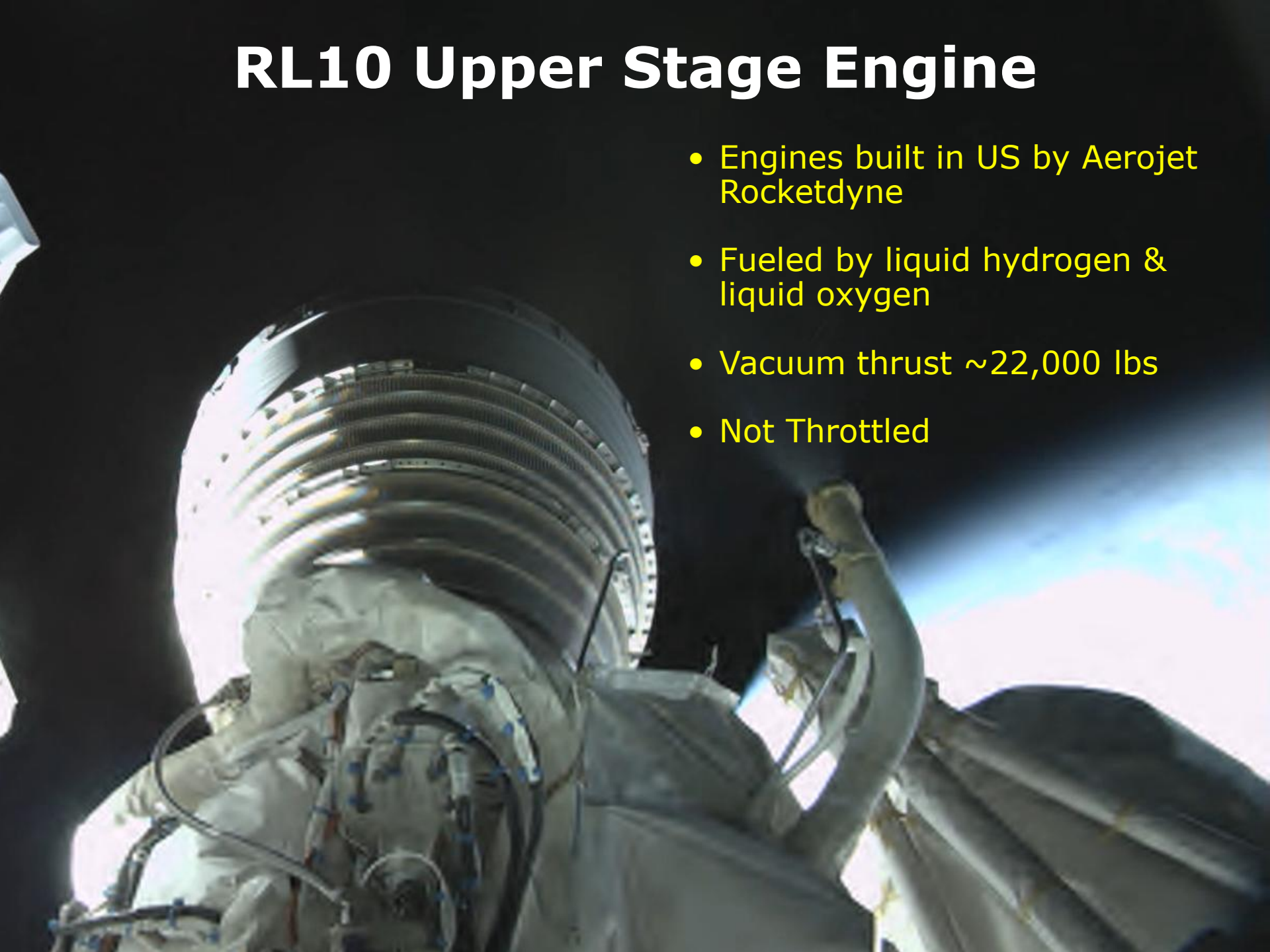
- Engines built in Russia
- Fueled by kerosene & liquid oxygen
- Vacuum thrust ~1,000,000 lbs
- Throttle from 40% to 100%

Delta IV Booster Engine

RS-68

- Engines built in US by Aerojet Rocketdyne
- Fueled by liquid hydrogen & liquid oxygen
- Vacuum thrust ~758,000 lbs
- Two throttle settings: Full and Half

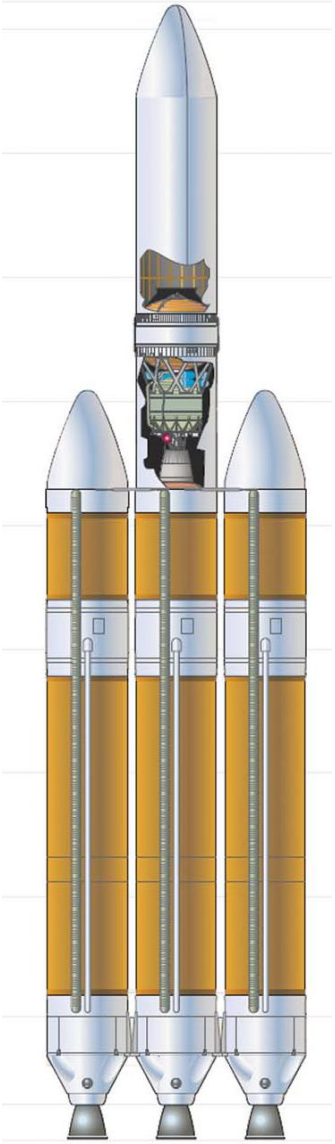
RL10 Upper Stage Engine



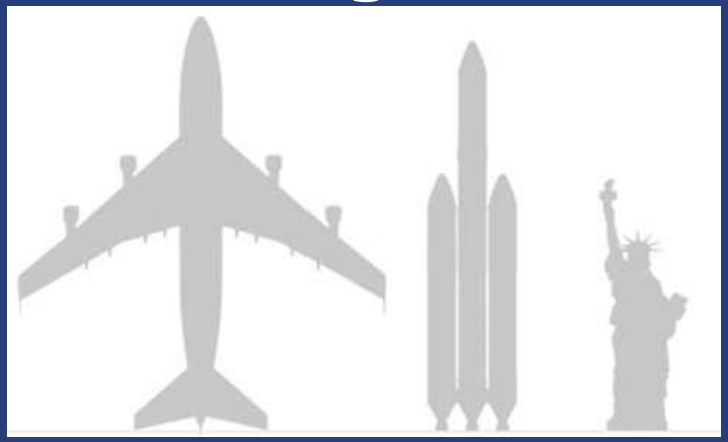
- Engines built in US by Aerojet Rocketdyne
- Fueled by liquid hydrogen & liquid oxygen
- Vacuum thrust ~22,000 lbs
- Not Throttled

Delta IV Heavy Fun Facts

United Launch Alliance



Height



Boeing 747-8 / ULA Delta IV / Statue of Liberty

250 ft **235 ft** **151 ft**

Performance

Thrust generated by
Delta IV Heavy
equivalent to
ten 747 airplanes

Speed

	DELTA IV HEAVY
0 TO 60 MPH	15 SECONDS
0 TO 100 MPH	25 SECONDS
0 TO 700 MPH	80 SECONDS
0 TO 17,500 MPH	5 MINUTES

Fuel

DELTA IV HEAVY

483,500 GALLONS

Stage 1
132,000 Gallons LOX
330,000 Gallons LH2

Stage 2
5,000 Gallons LOX
16,500 Gallons LH2

COST TO FILL UP	$600,000
MILES PER GALLON	0.00087 MPG**

Opportunities for You!

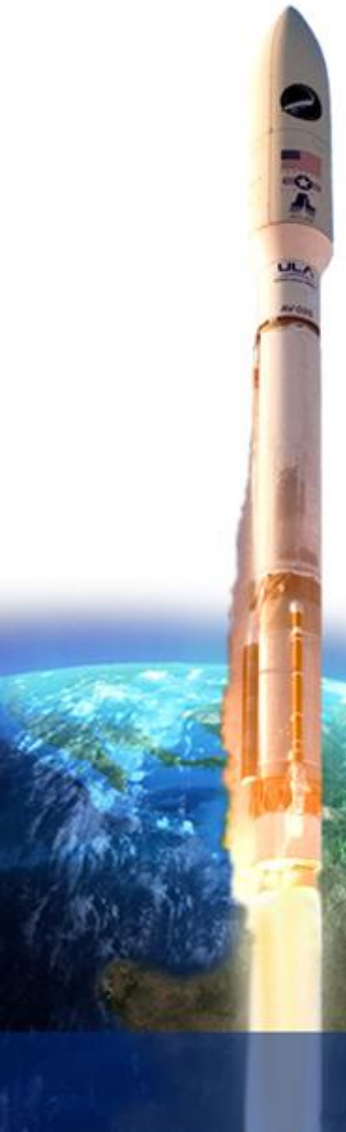
- **ULA hires more than 70 interns per year across all sites**
  - paid summer internships!
  - internships are available after your first year in college
  - job training in a business career or as a rocket scientist
  - hands on experience

Look for job postings at **www.ulalaunch.com** in the fall semester of college

United Launch Alliance

QUESTIONS?

United Launch Alliance

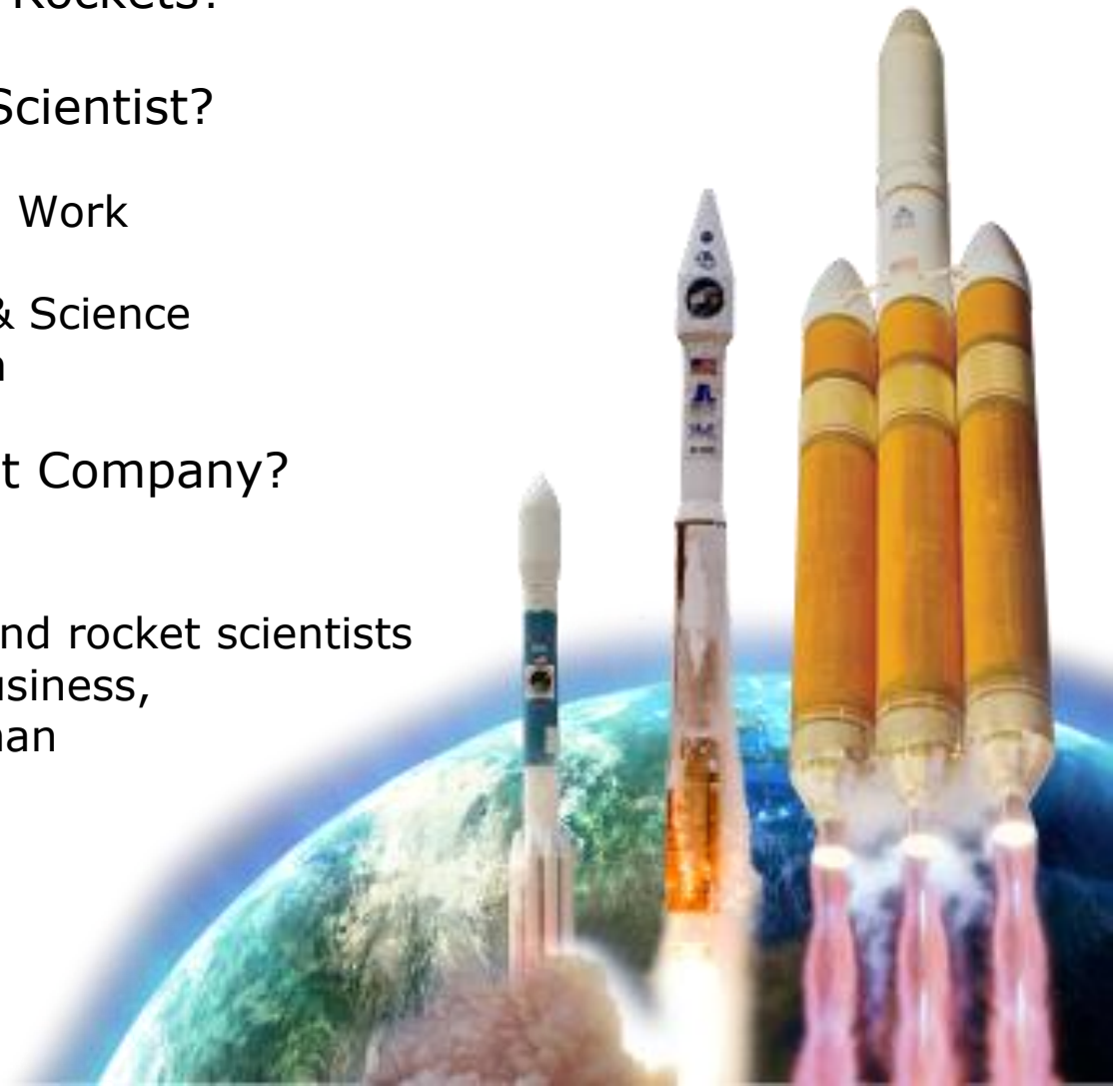


BACKUP

What Do Spacecraft Do?

Math, Science & Space

- Who Would Like to Design Rockets?
- Who Can Be an Engineer/Scientist?
  - Curious About How Things Work
  - Technology is Fun
  - Love to Tinker with Math & Science
  - Enjoys Working as a Team
- Who Can work for a Rocket Company?
  - YOU CAN!
  - ULA is not just engineers and rocket scientists
  - People who specialize in business, finance, procurement, human resources, etc.



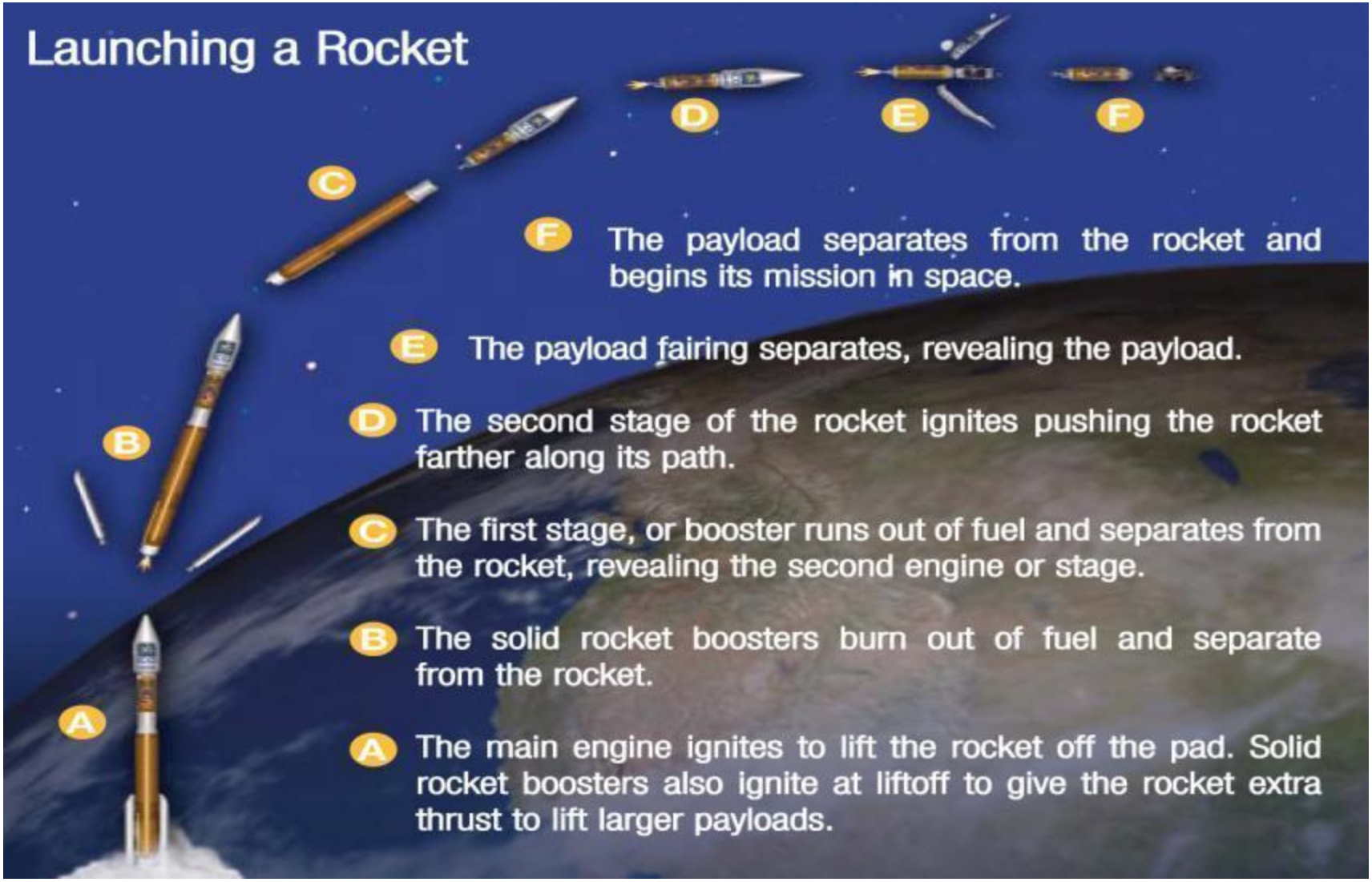
Fastest Man Made Machine

January 2006, Atlas V set a WORLD RECORD for the fastest spacecraft leaving Earth's atmosphere

- Leaving the atmosphere at over 35,800 miles per hour, the New Horizon mission reached the moon in nine hours on it's way to Pluto. *(We'll get to Pluto July 2015)*

- It reached a speed of 47,000 miles per hour
  Denver to New York City in 2 minutes and 16 seconds

- **How did we do it?!**
  - 5 solid rocket boosters
  - Added a third stage



Typical Launch Profile: Atlas V