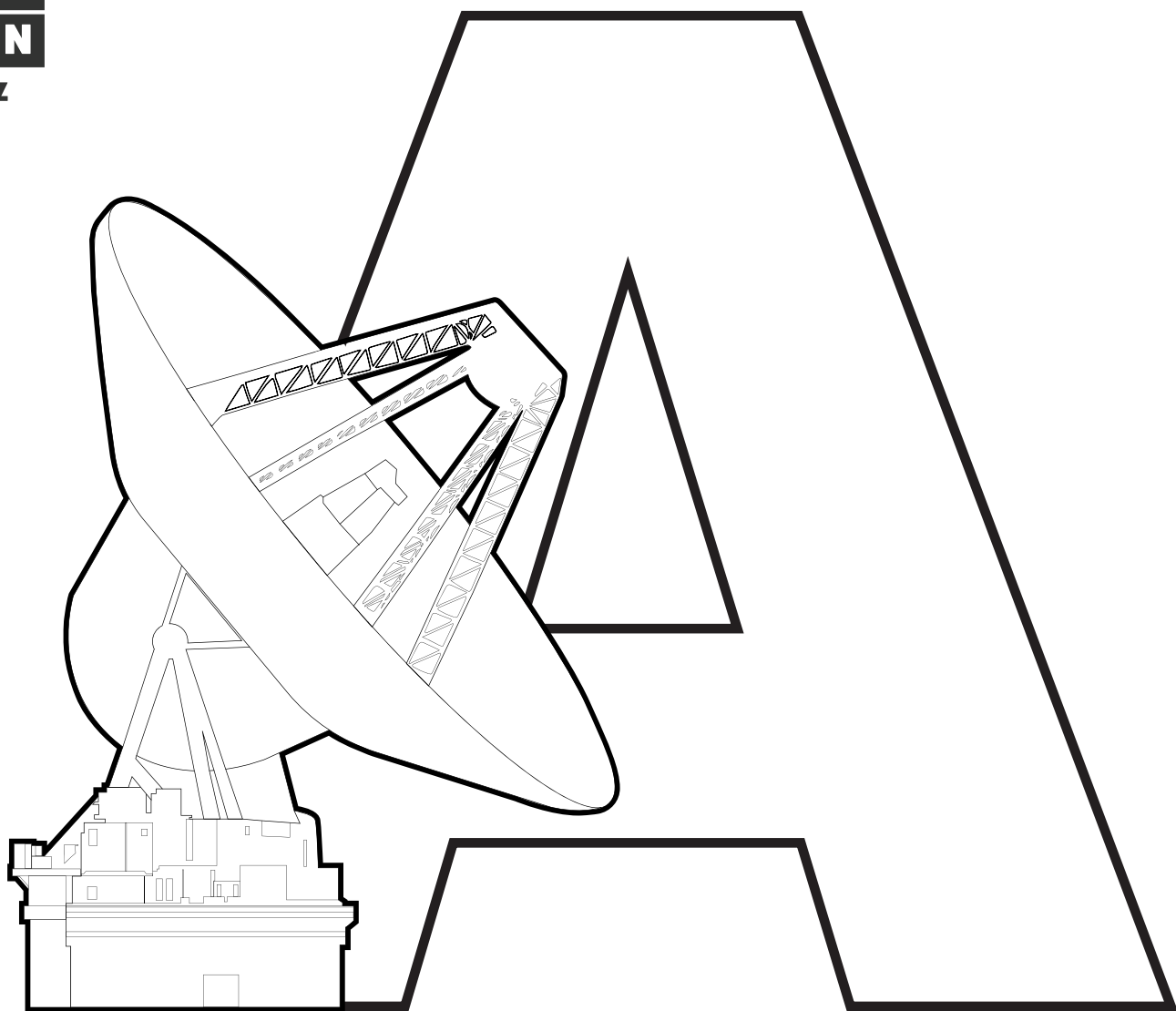


# A to Z Coloring Book

## Out of This World Alphabet

Space Communications and Navigation



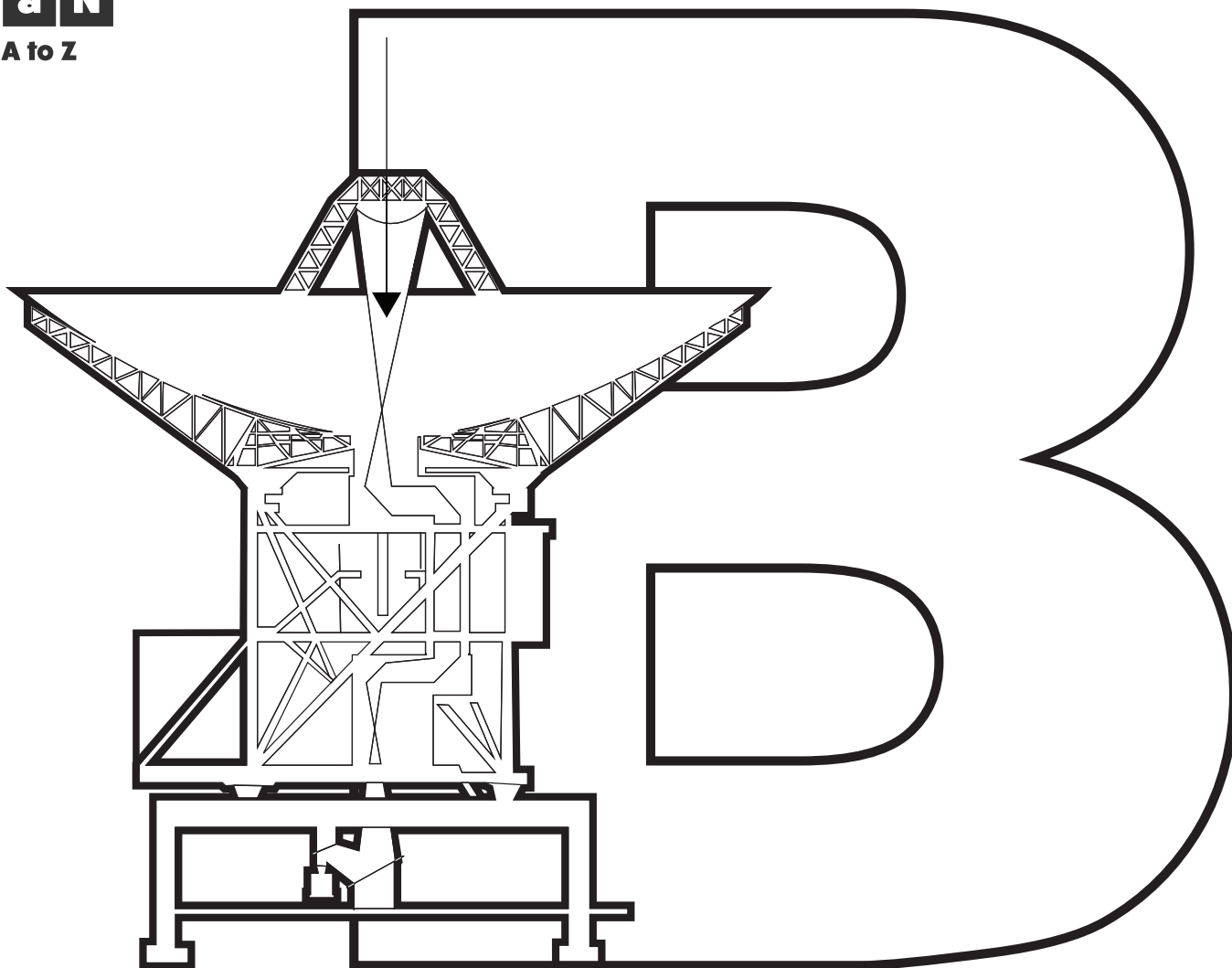
# Antenna

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An antenna is a structure that captures or sends electromagnetic waves.

Antennas come in all shapes and sizes, from little ones that can be found on your roof for watching television, to really big ones that capture signals from satellites in outer space millions of miles away!

SCaN has more than 65 antennas that help capture and transmit data to and from satellites in space.

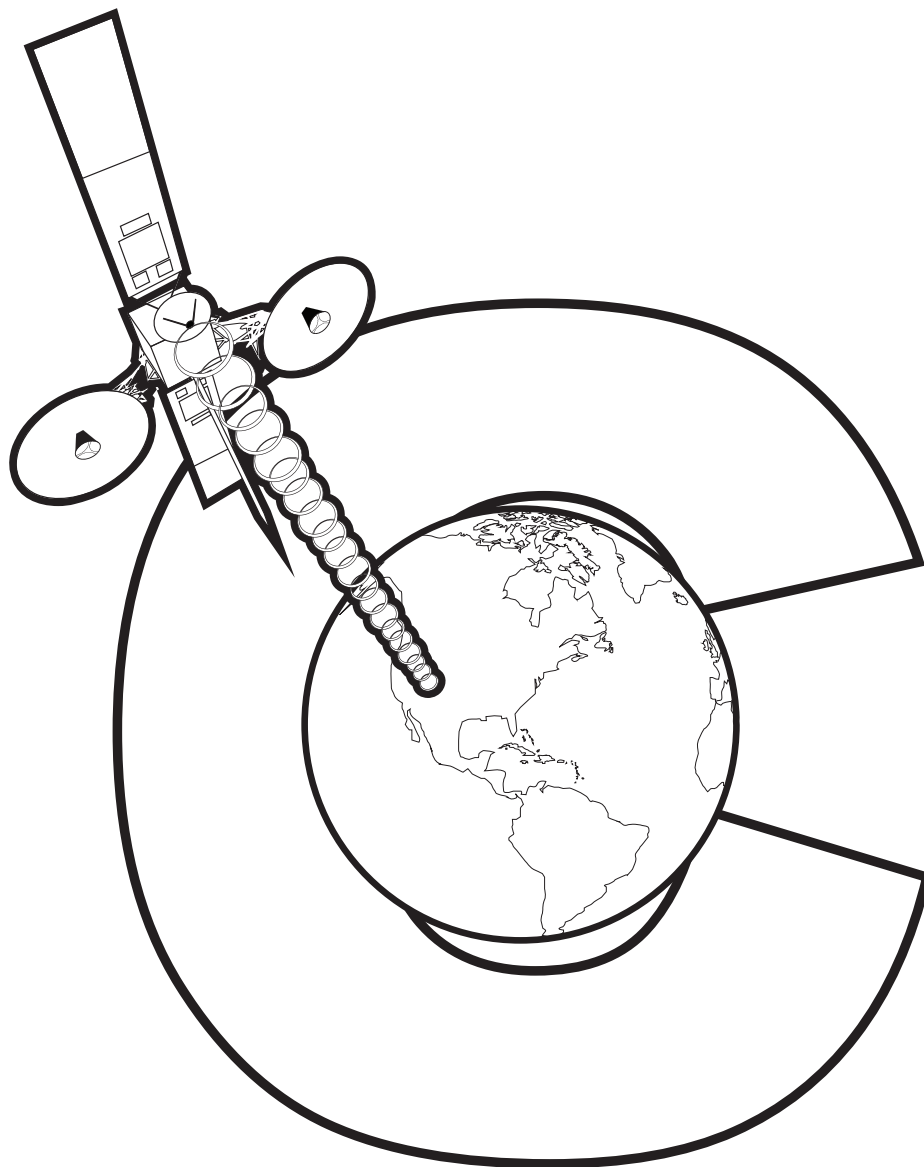


## Beam Waveguide Antenna

SCaN uses a variety of antennas for space communication. A beam waveguide antenna is a large steerable curved antenna.

The antenna has five mirrors that reflect radio signals from space and sends the signals down the antenna to the pedestal room that is underground.

The pedestal room has radio receivers that allow computers to translate the signals into information humans can read and see.



# Communications

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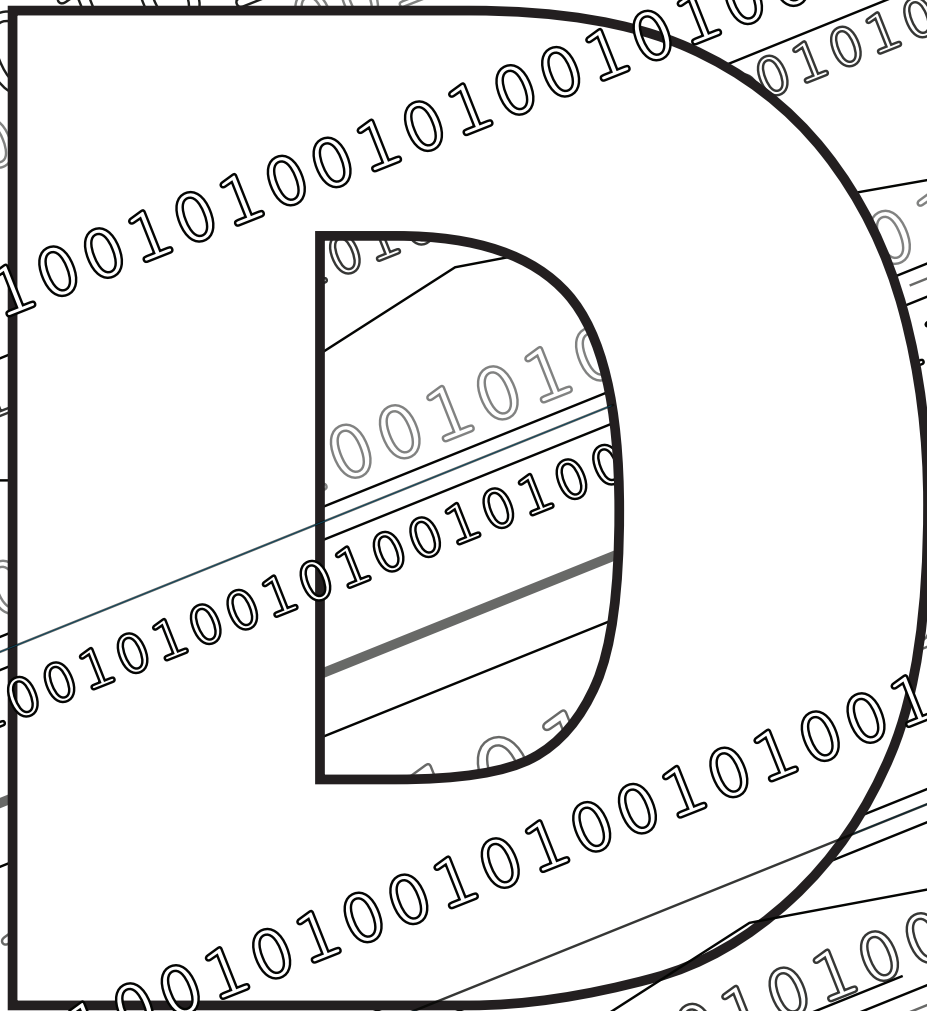
Communications is the exchange of information from one place or person to another.

SCaN uses antennas, satellites, and spacecraft to send information, or communicate, between Earth and outer space.

Every space mission requires communication to be successful—whether it is for astronauts on the International Space Station or the many spacecraft collecting data near Earth and also millions of miles away.



A to Z

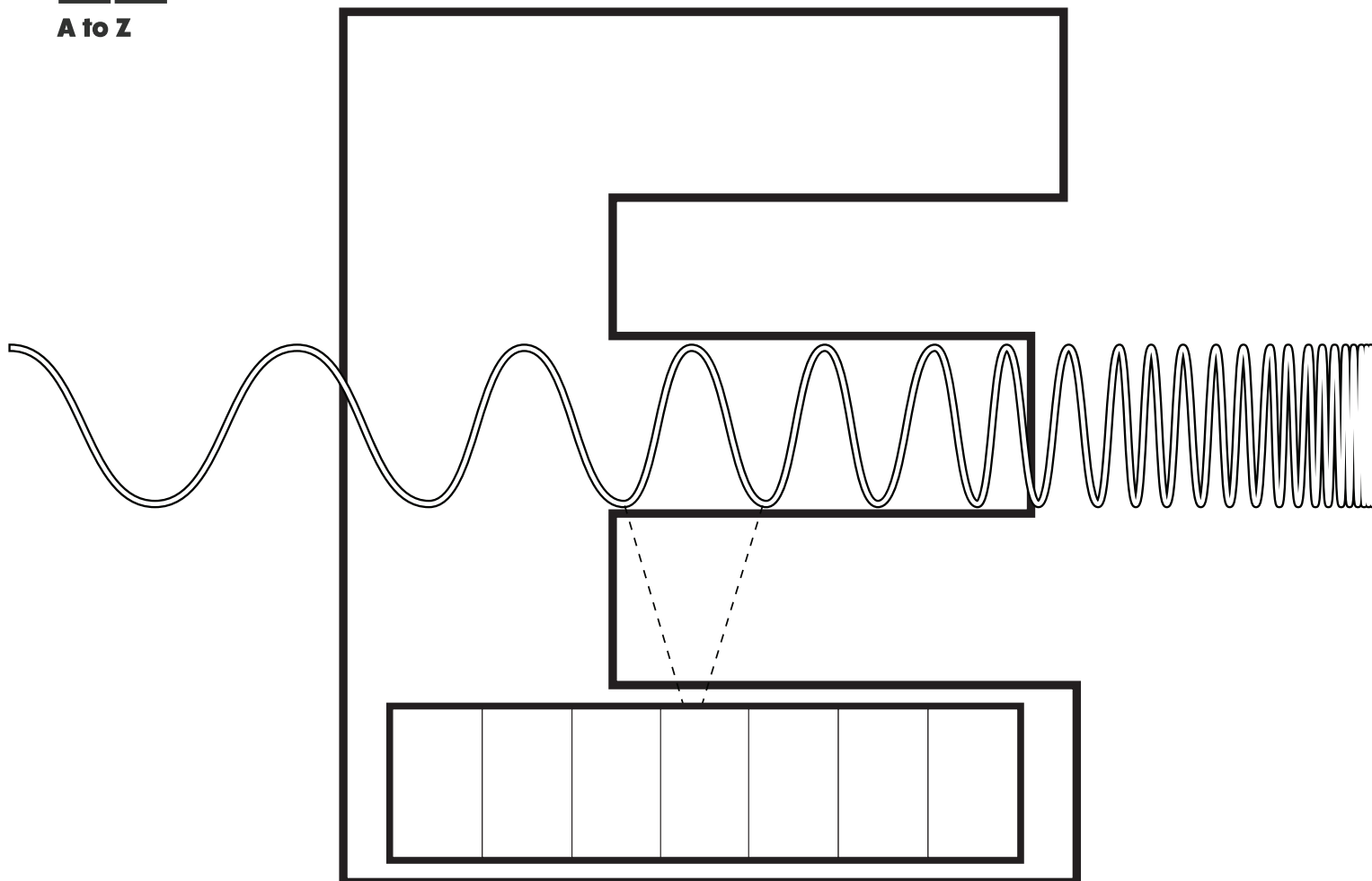


# Data

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SCaN collects various types of data from space. Data can be a collection of facts, numbers, measurements or observations. SCaN uses satellites and antennas to send data to and from space.

SCaN supports over 100 NASA and non-NASA missions. That means data is being collected from the Sun, all its planets and their moons, and objects (or perhaps, bodies) far beyond our solar system, to learn more about them and about the origin of the universe.

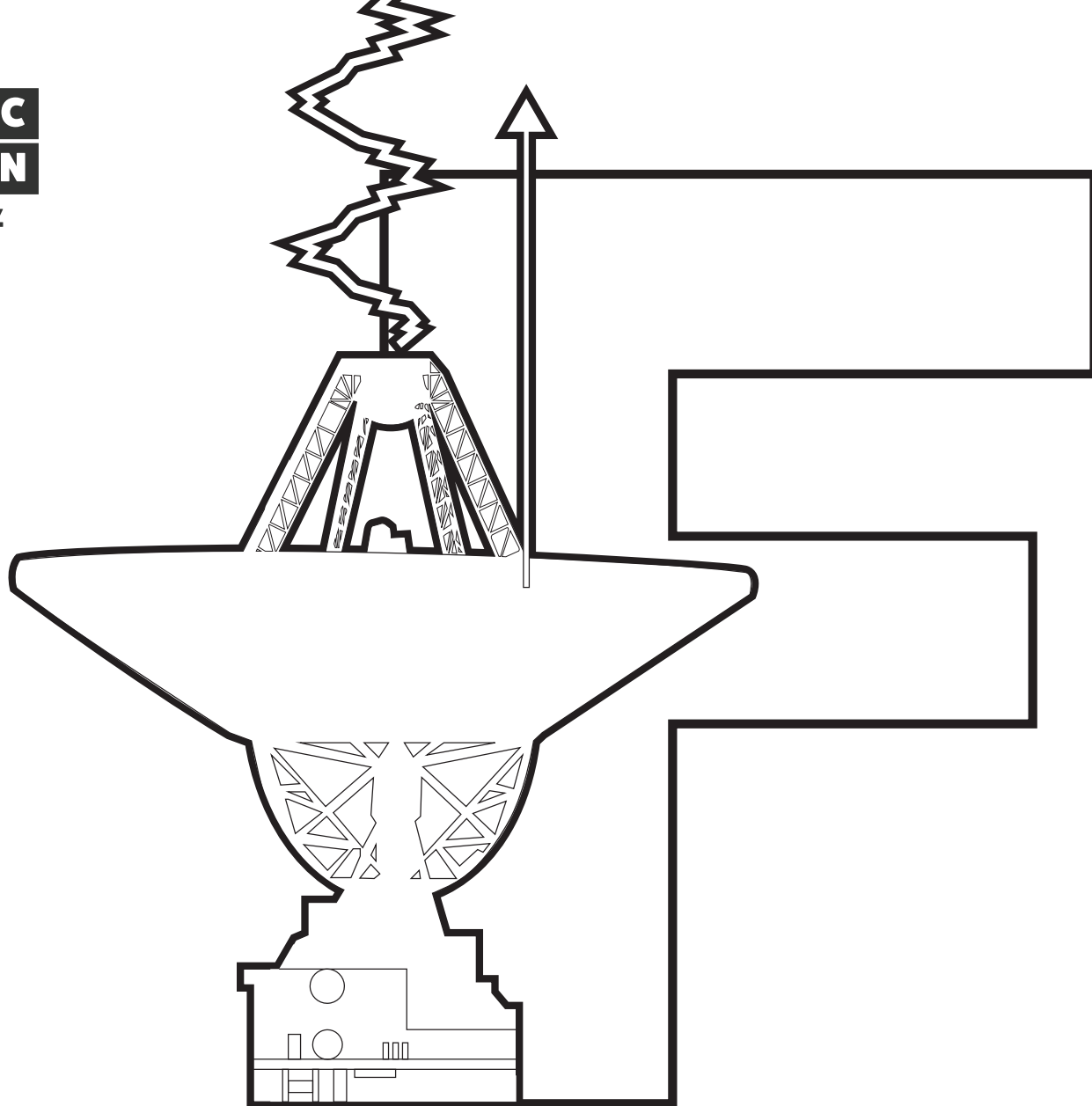


# Electromagnetic Spectrum

The electromagnetic spectrum is made up of all electromagnetic radiation frequencies that spread energy and travel through space in the form of waves.

People use the electromagnetic spectrum every day! Did you know the microwave oven you use to heat your food and the cell phone you use every day rely on the electromagnetic spectrum? Even the light we see with our eyes is part of the spectrum.

Longer wavelengths with lower frequencies are a part of the radio spectrum. Shorter wavelengths with higher frequencies are a part of the optical spectrum. Waves can be very big like a building or very small like an atom.



## Forward Link

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A forward link, also called an uplink, is the path data flows from the ground to a spacecraft or satellite in space.

A forward link is used when data needs to be relayed to a satellite or spacecraft, but not when it needs to be relayed in the opposite direction, from spacecraft to ground.



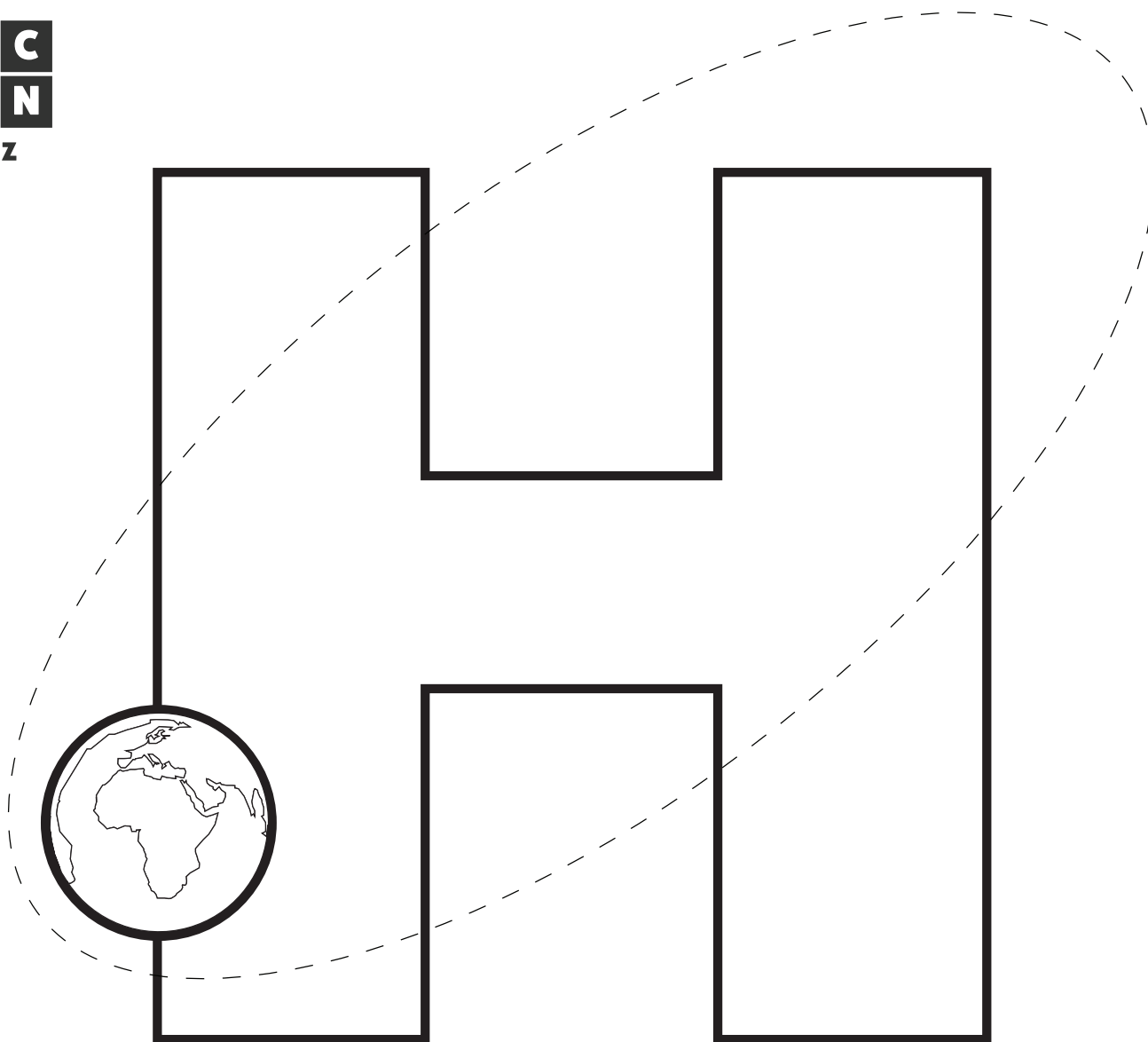
# Geosynchronous Orbit

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Geosynchronous orbit is a repeating path in which the satellite is always in the same area of the sky in respect to the rotating Earth.

Satellites in this orbit, such as the Tracking and Data Relay Satellite (TDRS), are about 22,300 miles above Earth.





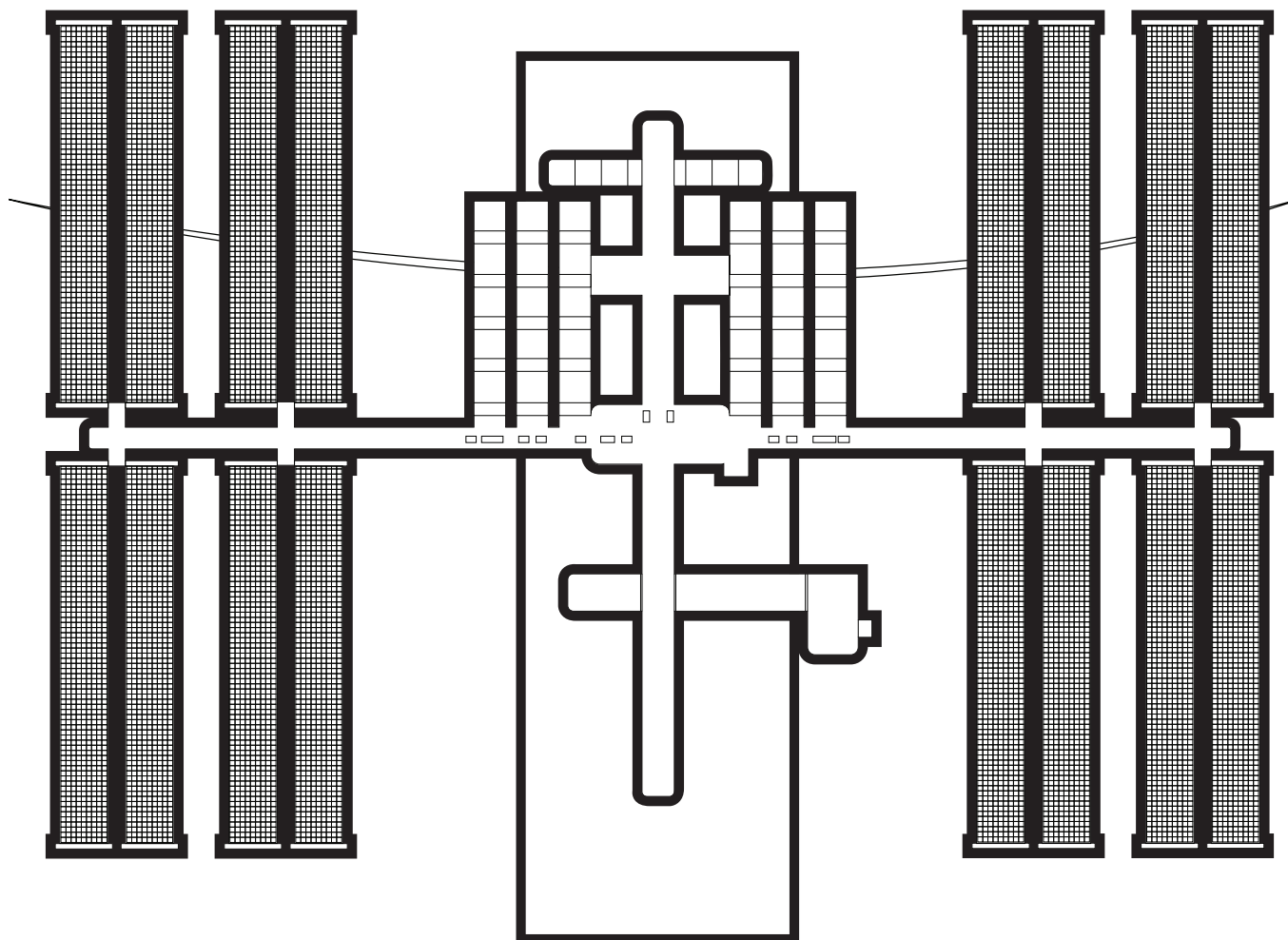
# Highly Elliptical Orbit

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Highly elliptical orbit is a high Earth repeating path that is above geosynchronous orbit.

The orbit is more of a long oval shape as compared to a circle.

The perigee (the point in the orbit that is closest to Earth) can be hundreds of miles above the Earth's surface and the apogee (the point in the orbit that is farthest from Earth) can be tens of thousands of miles above the Earth's surface.

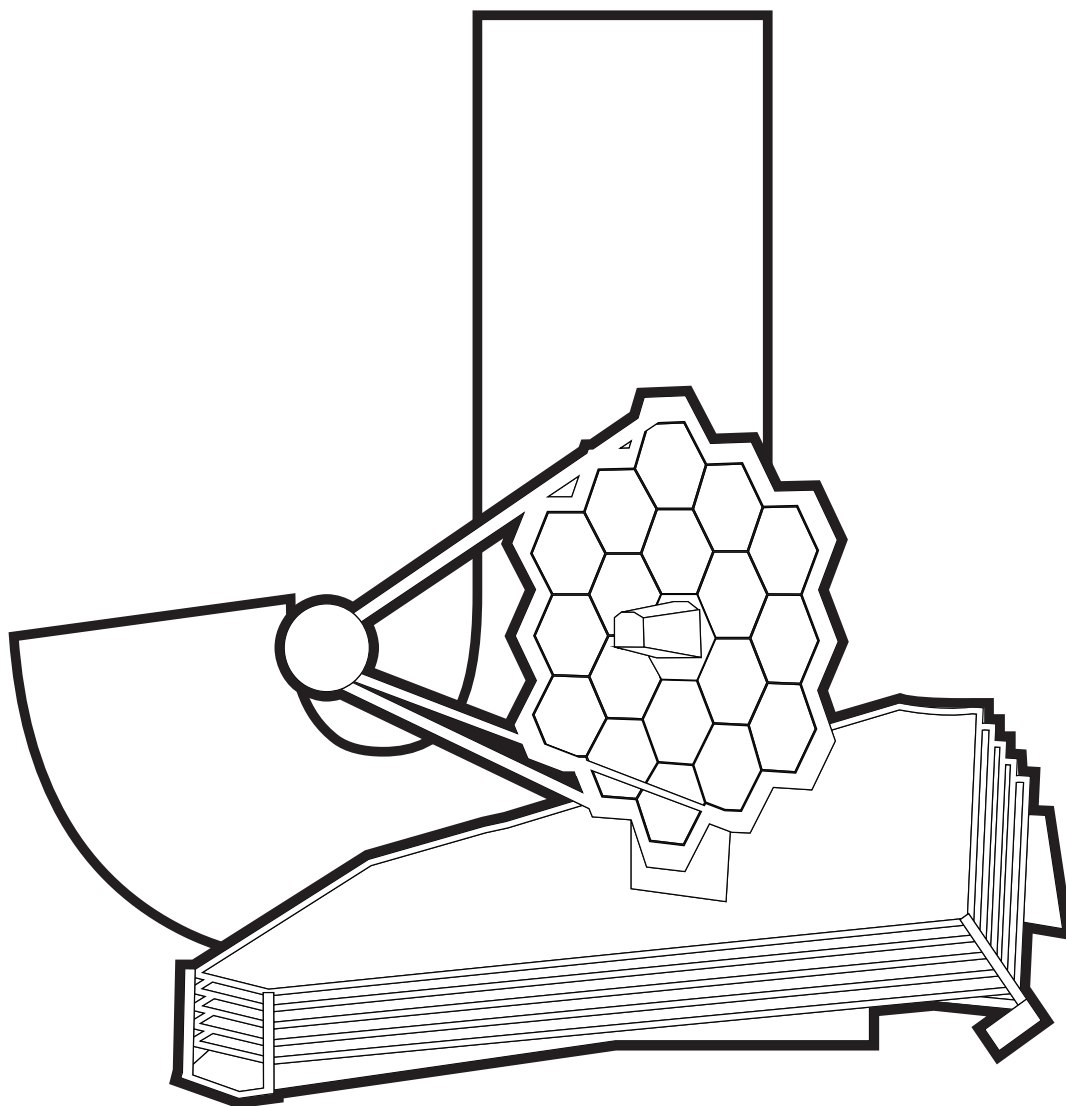


# International Space Station

The International Space Station is a large spacecraft that orbits around Earth and is home to astronauts.

The space station serves as a science lab and many countries worked together to build it and use it, including the United States, Russia, Canada, Japan, and the participating countries of the European Space Agency.

NASA sends data back and forth from Earth and the space station every day.



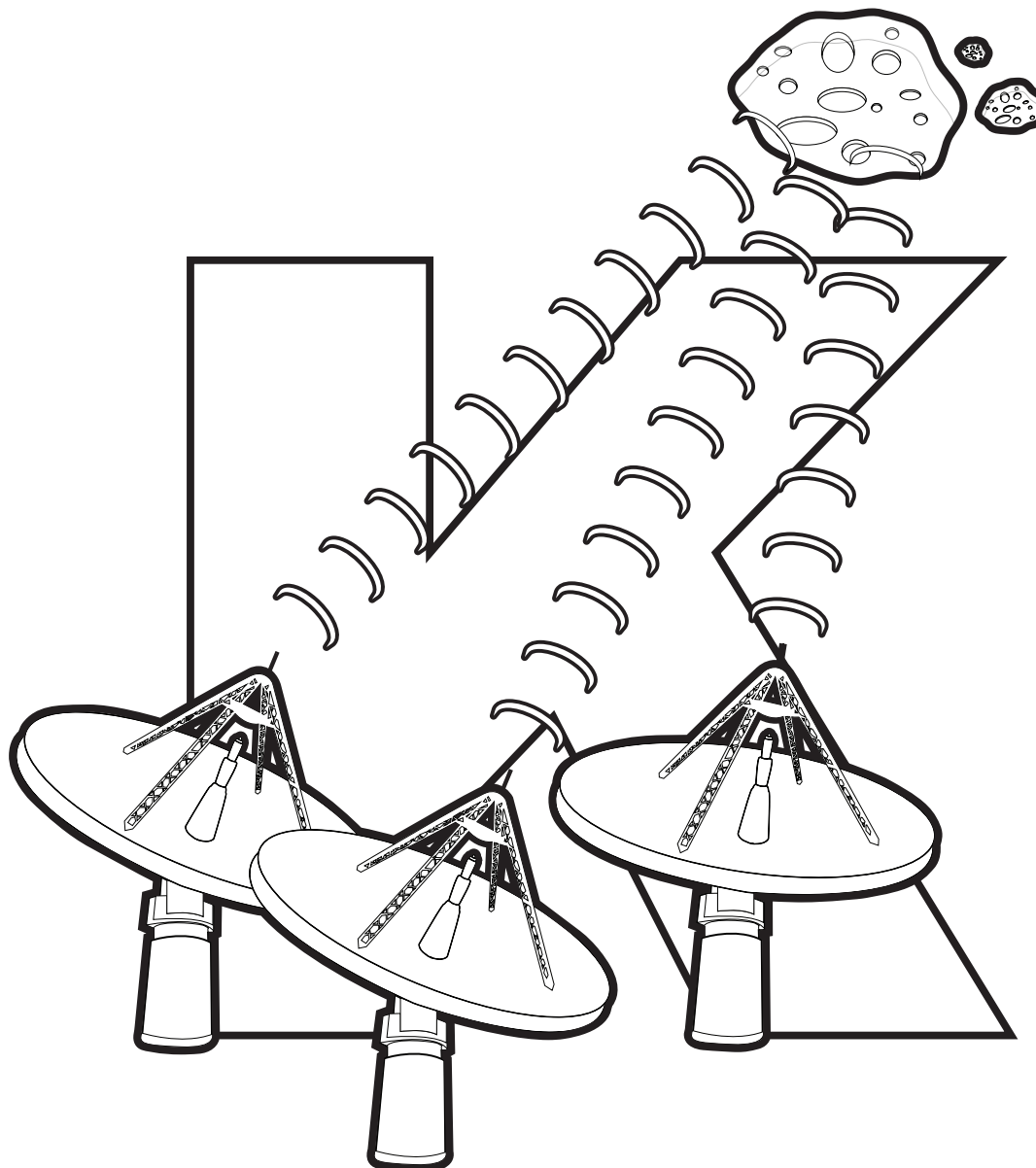
# James Webb Space Telescope

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The James Webb Space Telescope (also known as Webb) is an orbiting telescope that will complement the discoveries of the Hubble Space Telescope.

The Hubble Space Telescope sends back images and data to Earth that has led to many discoveries about outer space. Webb will have even more capabilities to capture and send data back to Earth.

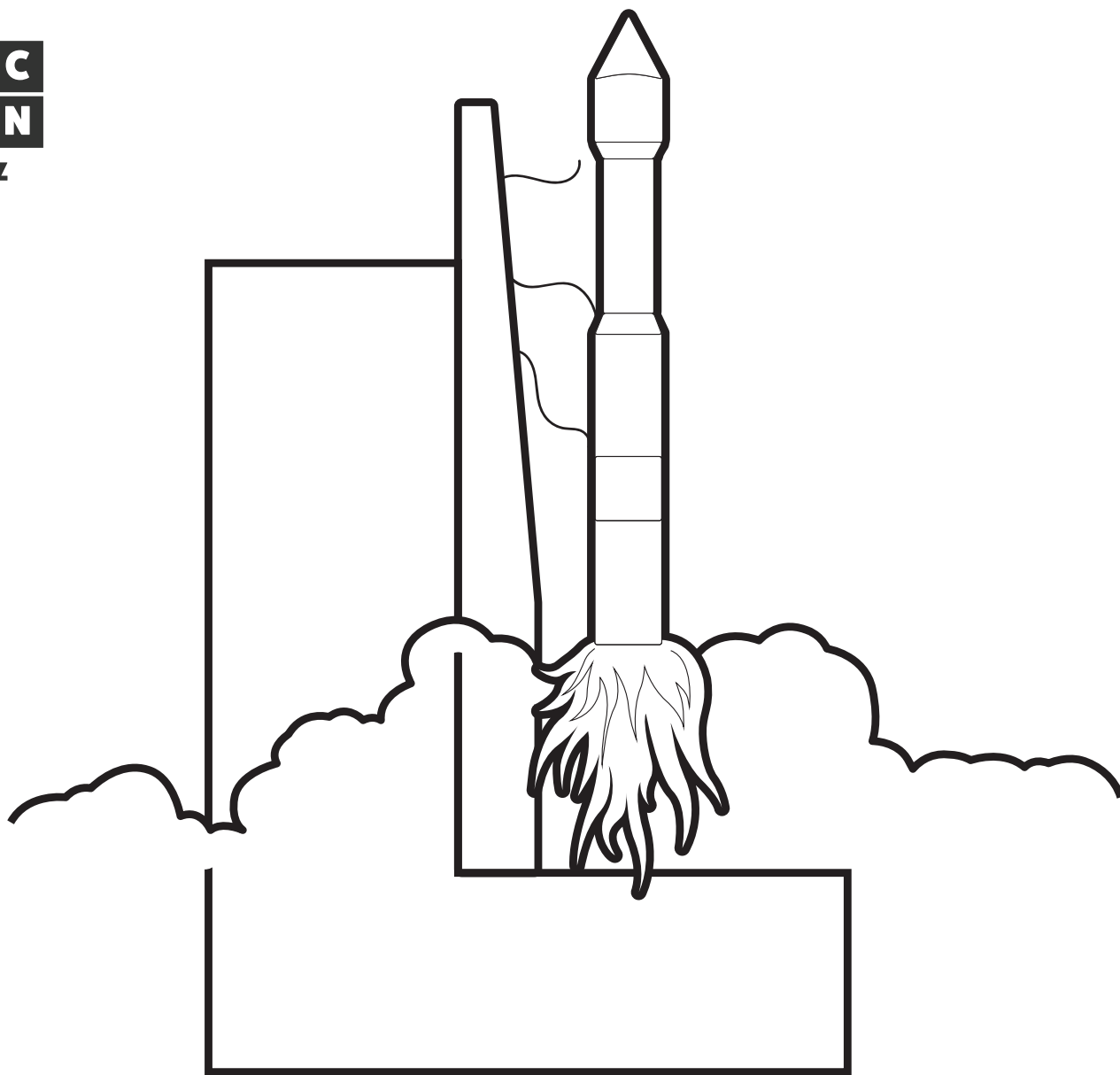
Webb will observe dust clouds where stars and planets are forming today. It will look much closer to the beginning of time to hunt for the unobserved formation of the first galaxies.



# KaBOOM

KaBOOM stands for Ka-Band Objects Observation and Monitoring.

KaBOOM is a high-power Ka-Band radar system using three antennas that tracks and characterizes the size, shape, spin and surface composition of near-Earth objects like asteroids.



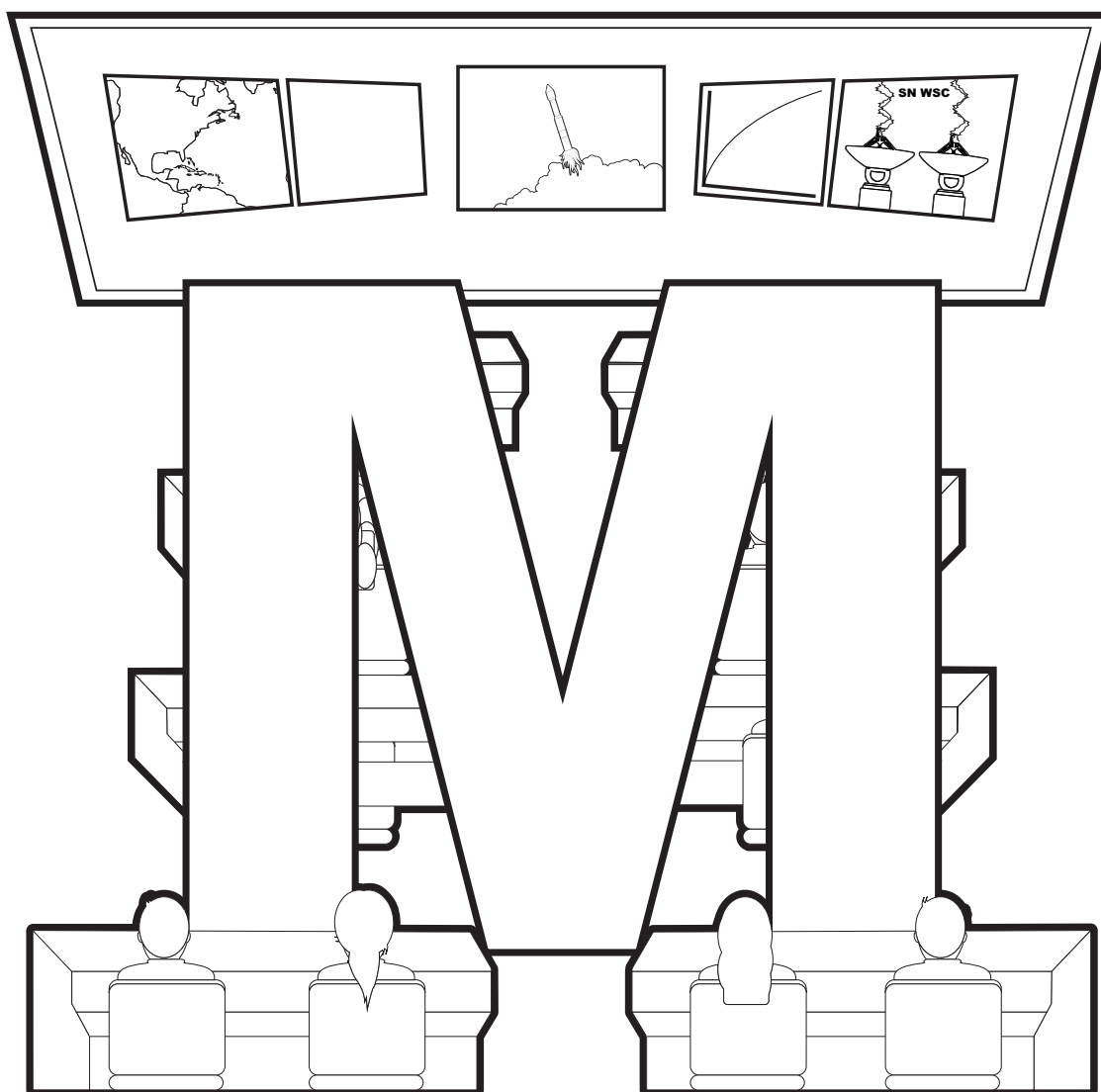
# Launch

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A launch occurs when an object pushes off the Earth’s surface and is sent on its course or into orbit in space. NASA uses rockets to help launch satellites, spacecraft, and astronauts into space.

SCaN provides communication and tracking services during launches. This means that a lot of data is being collected during the launch to help ensure it is successful.

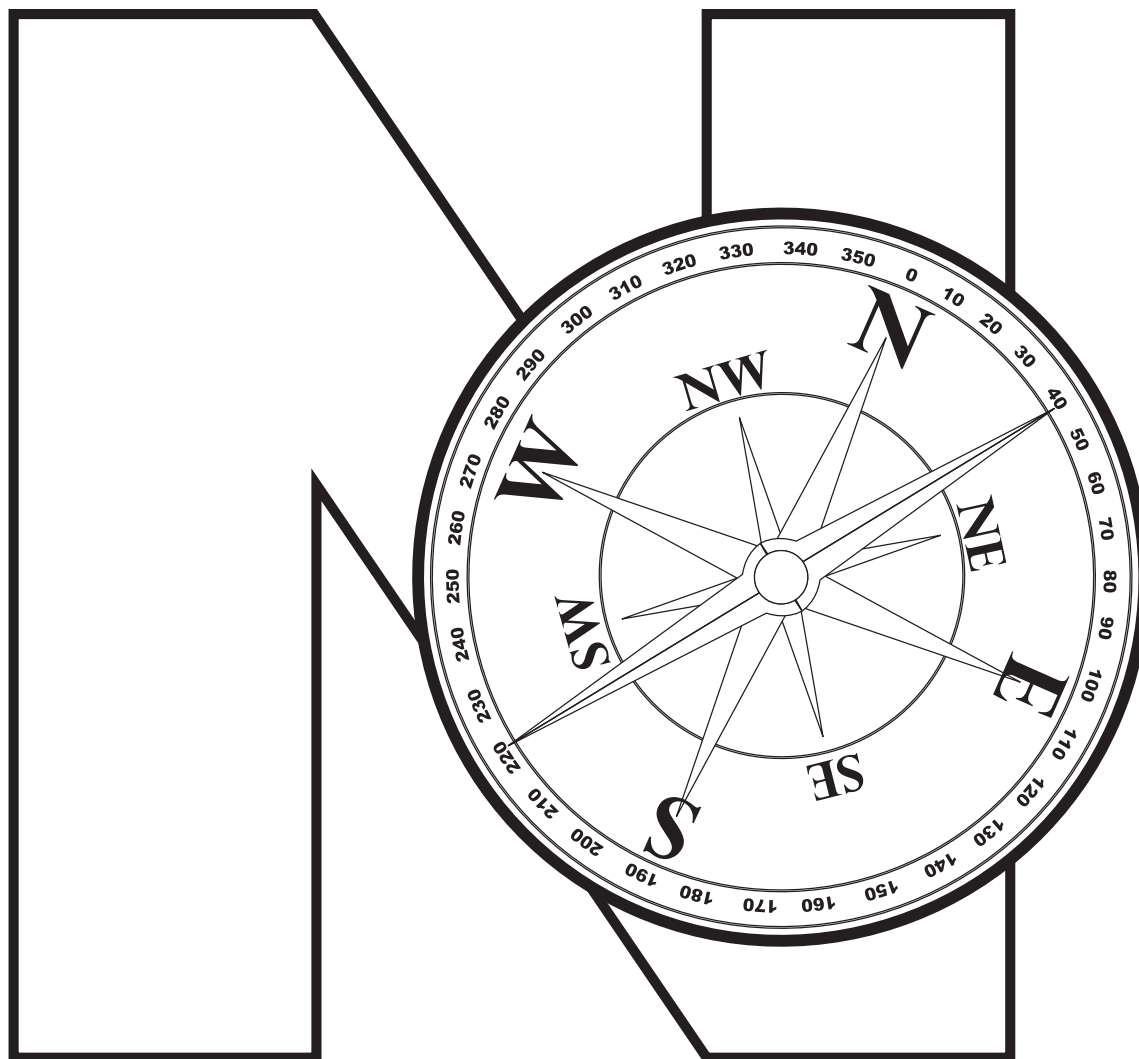
Antennas from the Deep Space Network and Near Space Network may be used to receive and relay data during a launch. Each launch requires different SCaN services.



# Mission

A mission is an accomplishment of a specific science objective over the course of many years and observations.

SCaN enables over 100 NASA and non-NASA missions. Some missions look down at the Earth and observe changes; others observe the sun’s influence on Earth; some study the moon and the planets, while others study the origin of the universe.

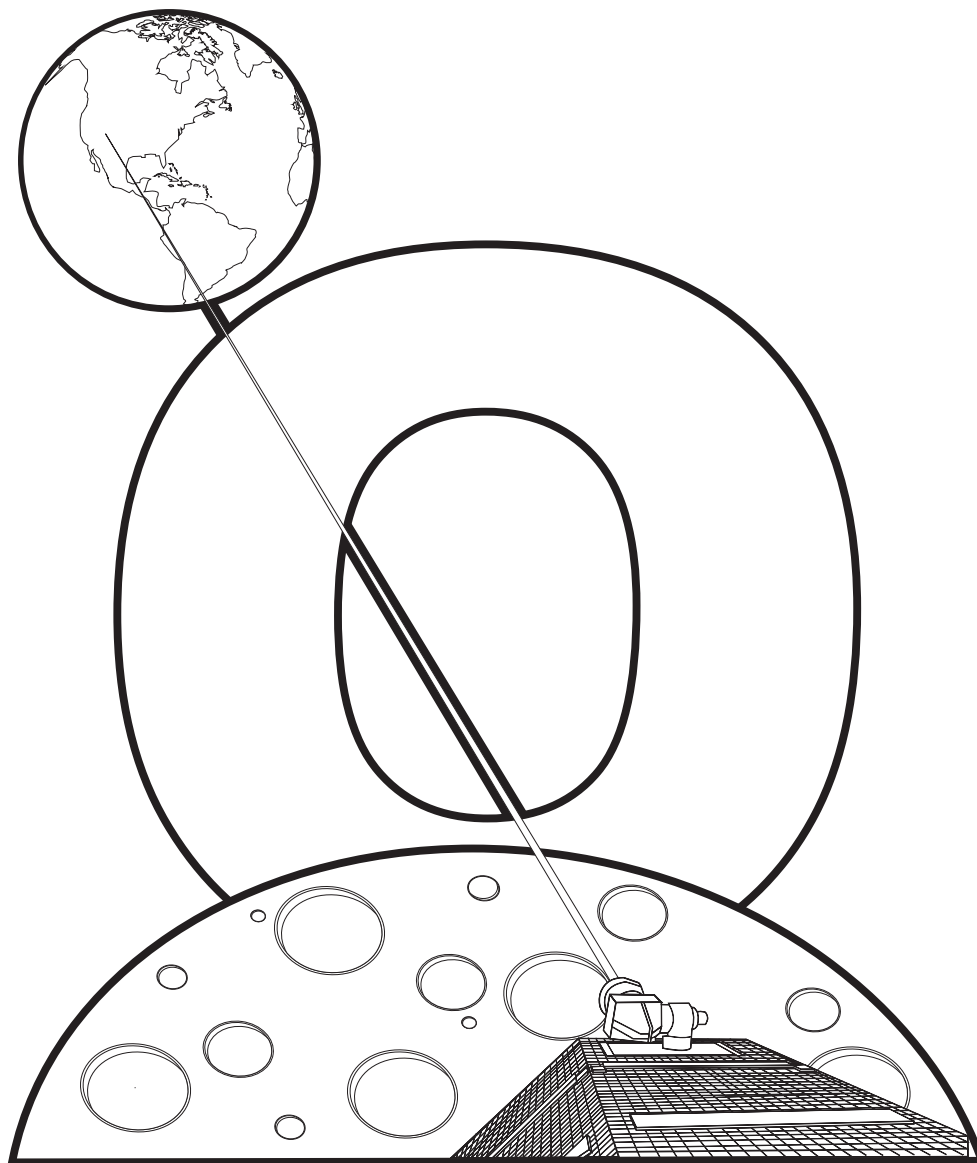


# Navigation

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Navigation is the ability to determine a current or specific position or location of an object in space in relationship to a fixed object.

Some spacecraft closer to Earth are able to use Global Positioning System (GPS) to navigate around the Earth.



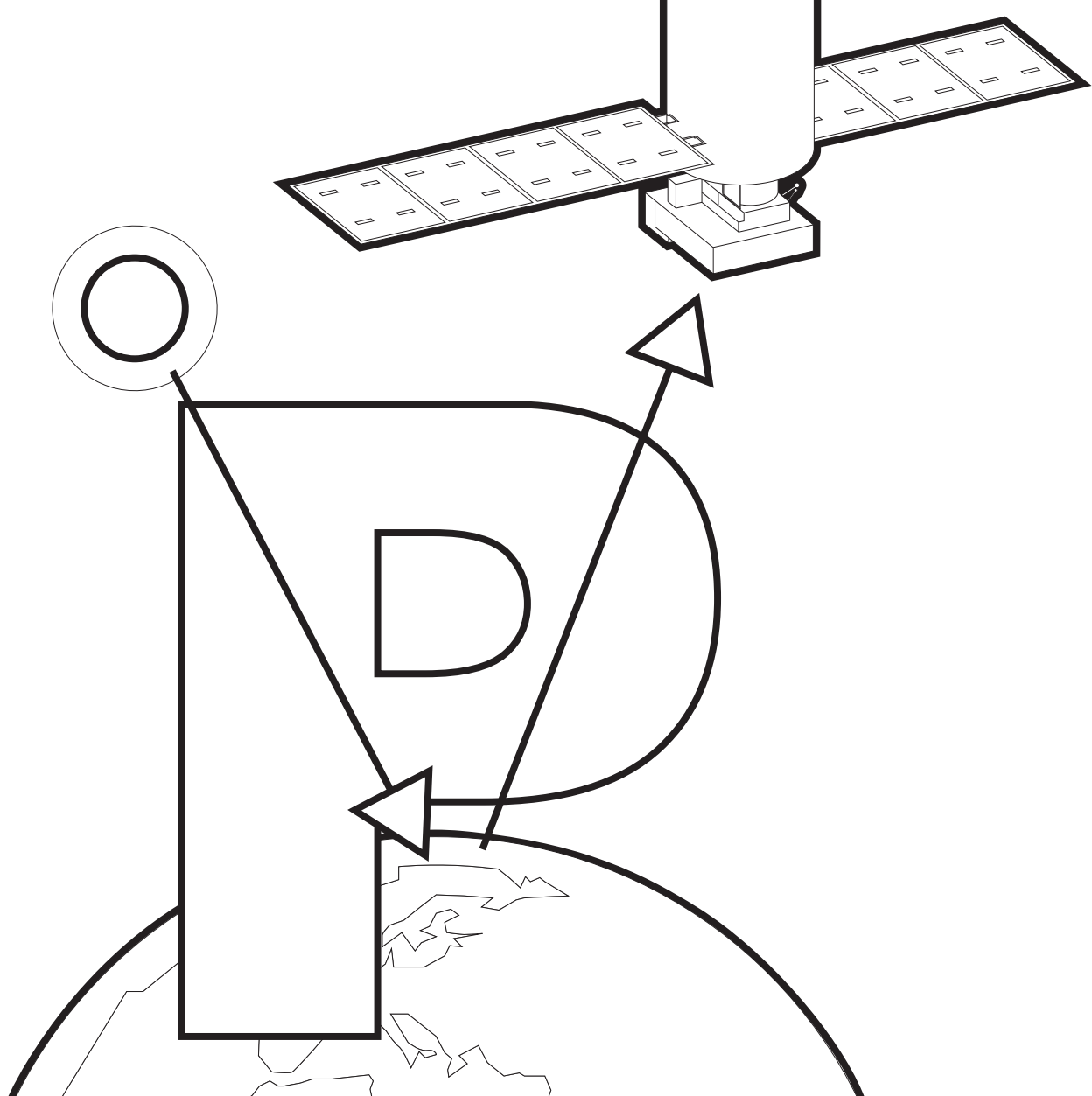
# Optical Communications

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Optical communication is an exciting new communication technology that uses lasers to send data at much higher rates compared to current capabilities.

SCaN's first demonstration in optical communications was in 2013 from the Earth's moon. SCaN is moving forward with the Decade of Light for the future of space communication.

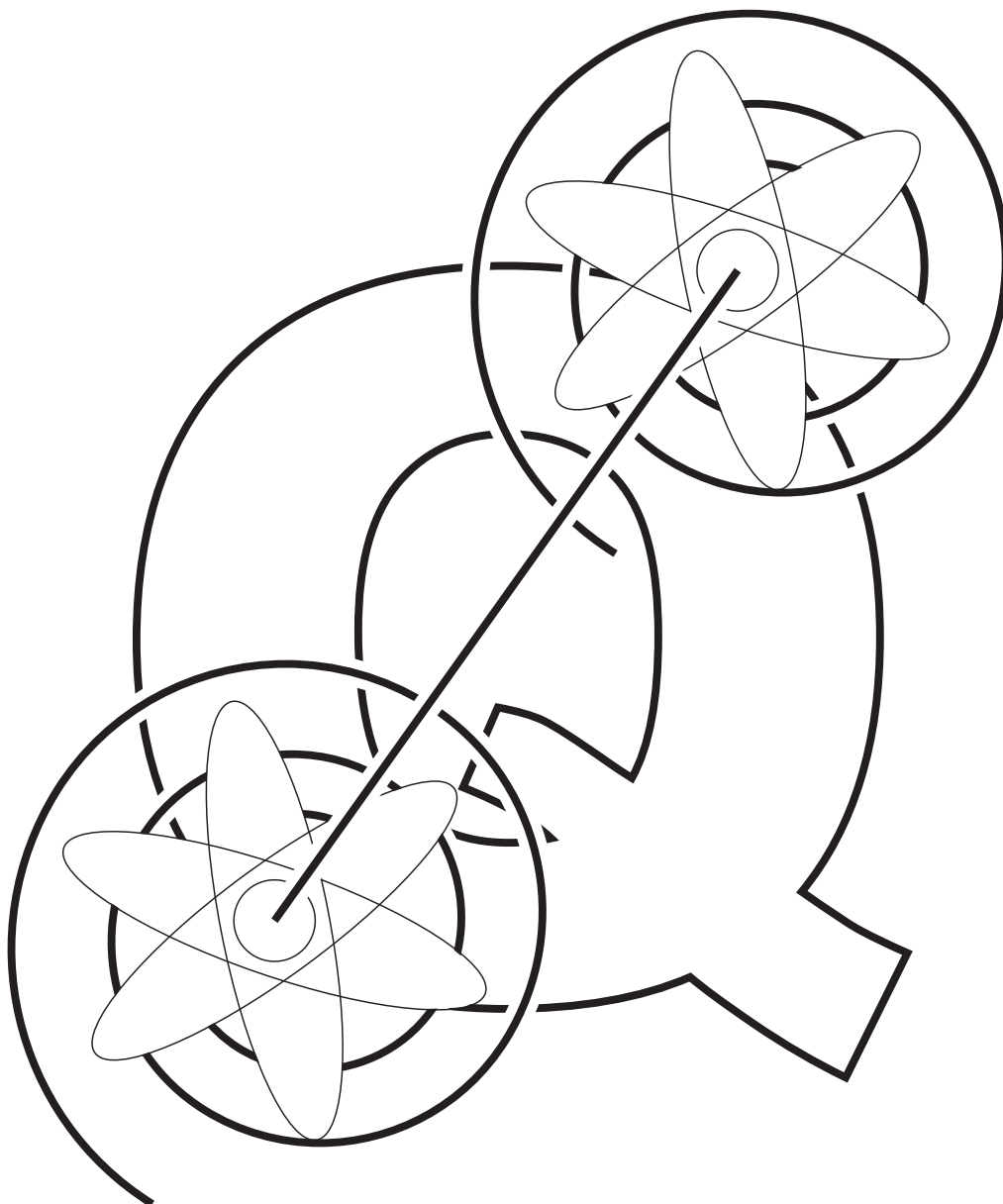




## Passive Sensor

A passive sensor is a type of radio sensor located on a spacecraft that produces no energy.

Instead, it measures natural emissions from the Earth and its atmosphere at specific frequencies in order to provide a description of the Earth's environment.

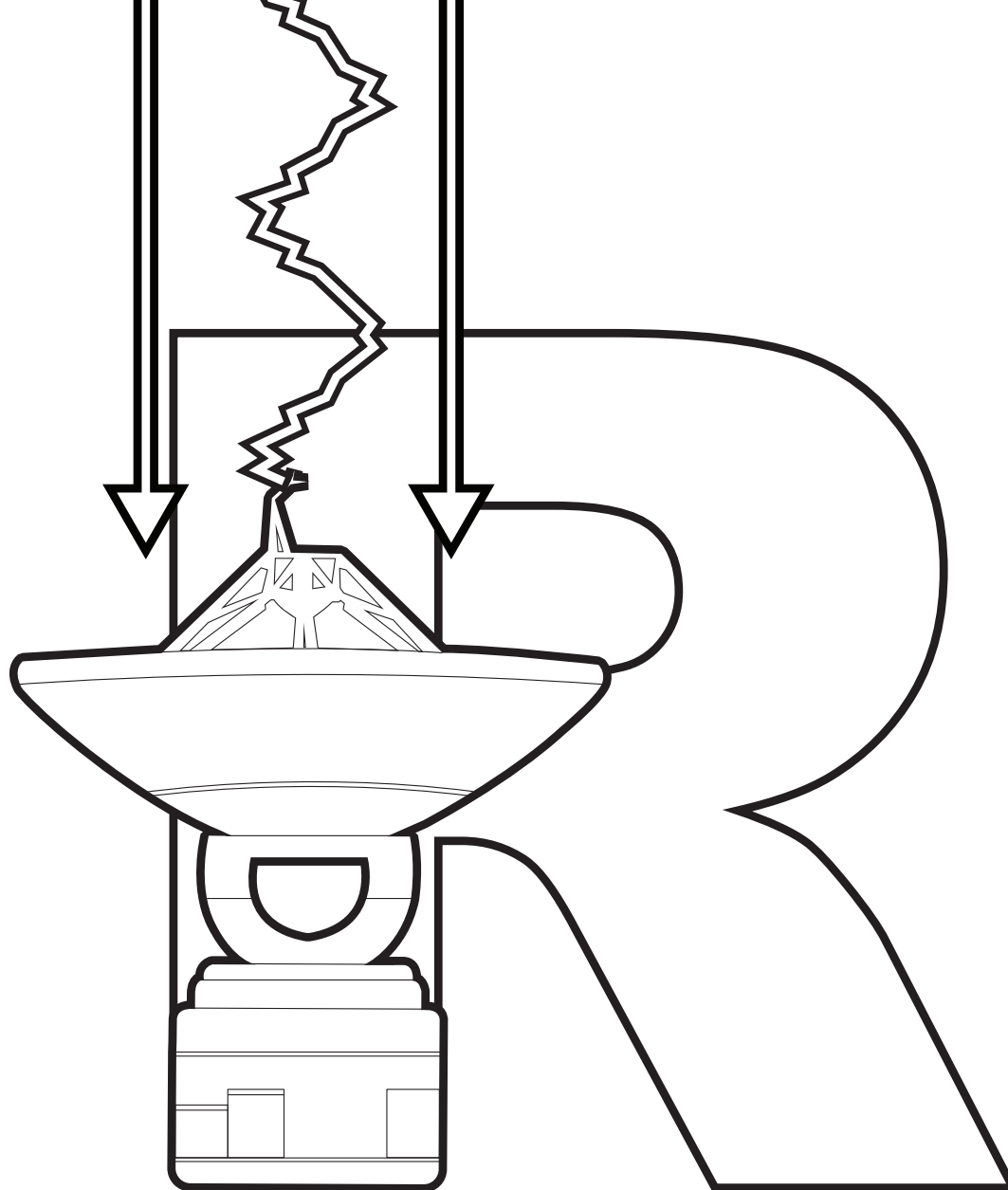


# Quantum Entanglement

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Quantum entanglement occurs when linked particles of light begin to affect one another, even when they are very far apart.

When these particles are linked, more data can travel via these particles back to Earth.

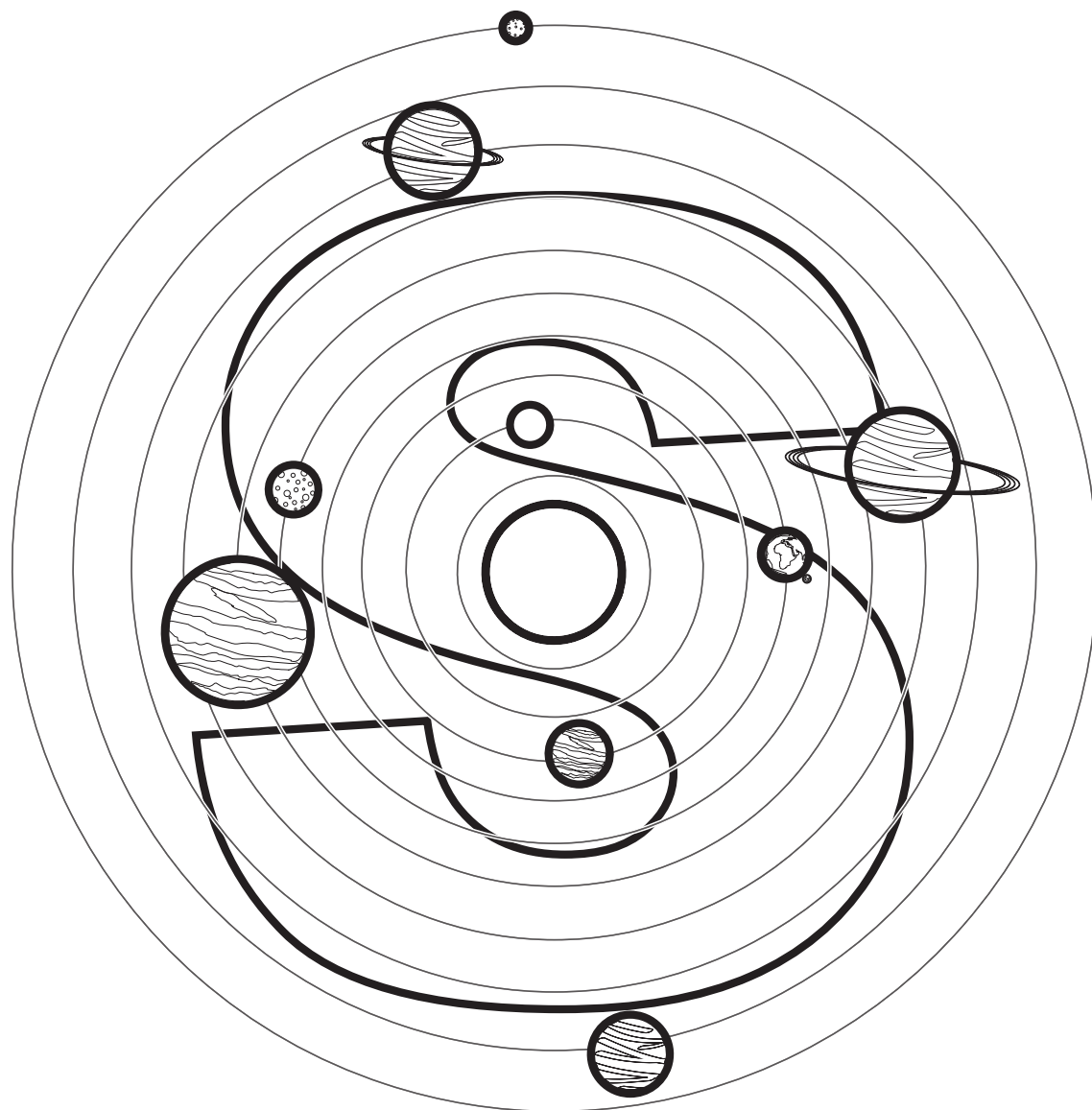


## Return Link

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A return link, also known as a downlink, is the communication path for data from spacecraft to ground.

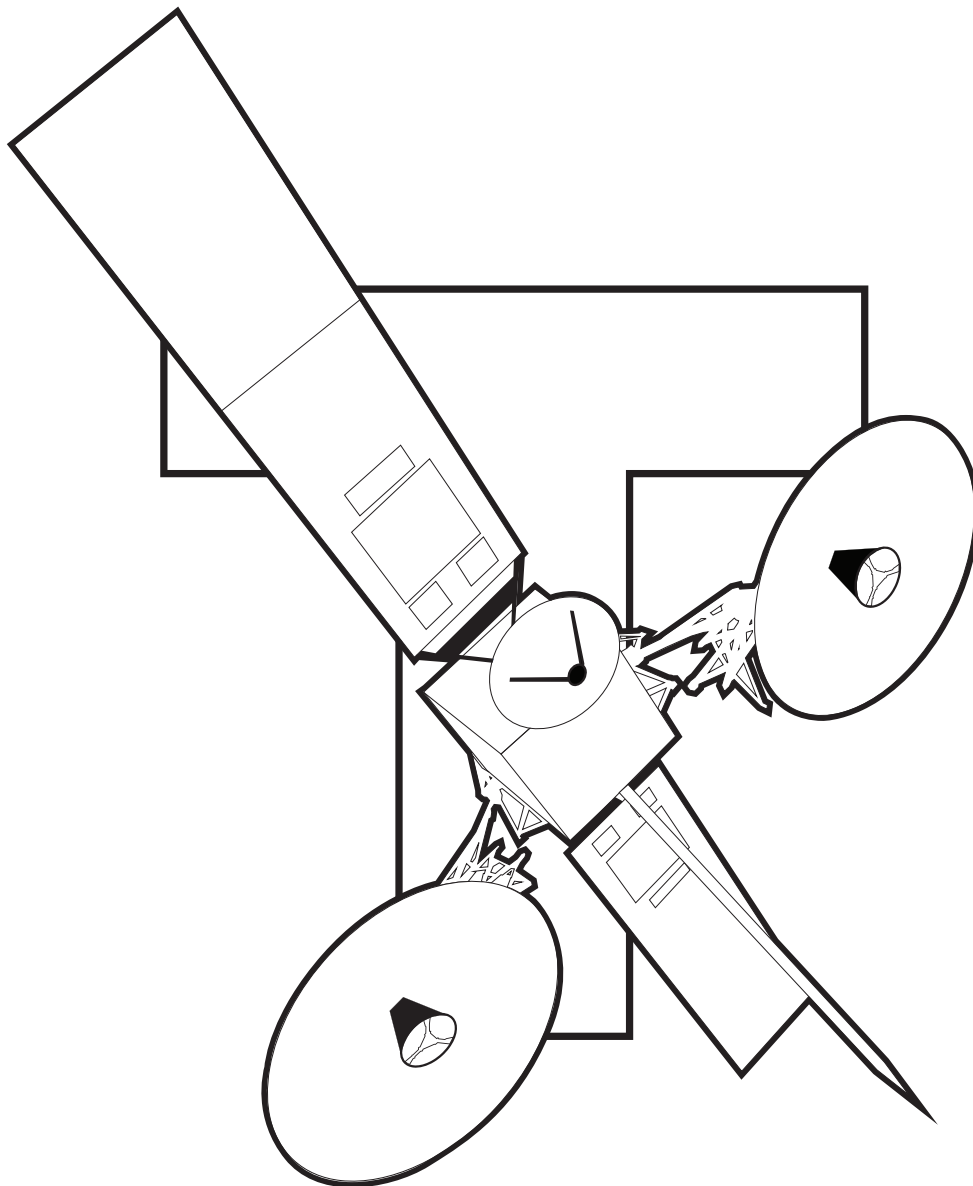
A return link is used when data needs to be relayed to Earth from space, but not when it needs to be relayed from the Earth to a satellite or spacecraft.



# Solar System

A solar system is a star and all of the objects that travel around it — planets, moons, asteroids, comets, and meteoroids.

SCaN supports missions that aim to better understand the interaction between Earth and the sun in our solar system.

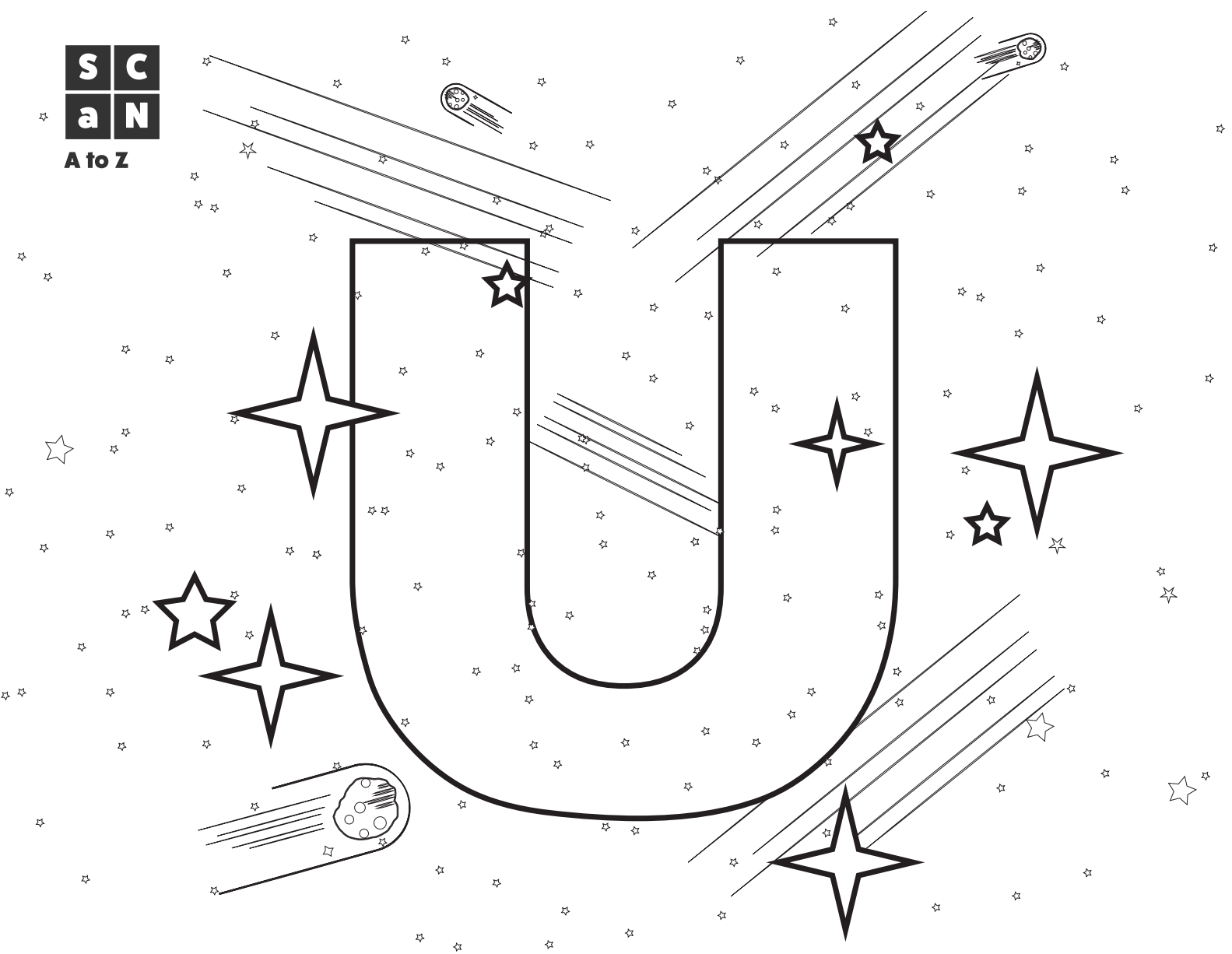


## **Tracking and Data Relay Satellite**

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A Tracking and Data Relay Satellite (TDRS) is a communications satellite that sends information to and from spacecraft such as the International Space Station.

The group or fleet of TDRS sit in geosynchronous orbit around Earth. This fleet serves as part of the relay segment of NASA's Near Space Network.



# Universe

The universe consists of all matter and energy, including Earth, the galaxies, and the contents of space.

Scientists use spacecraft to study the universe to learn more about the history of the universe and how its galaxies and solar systems were formed.

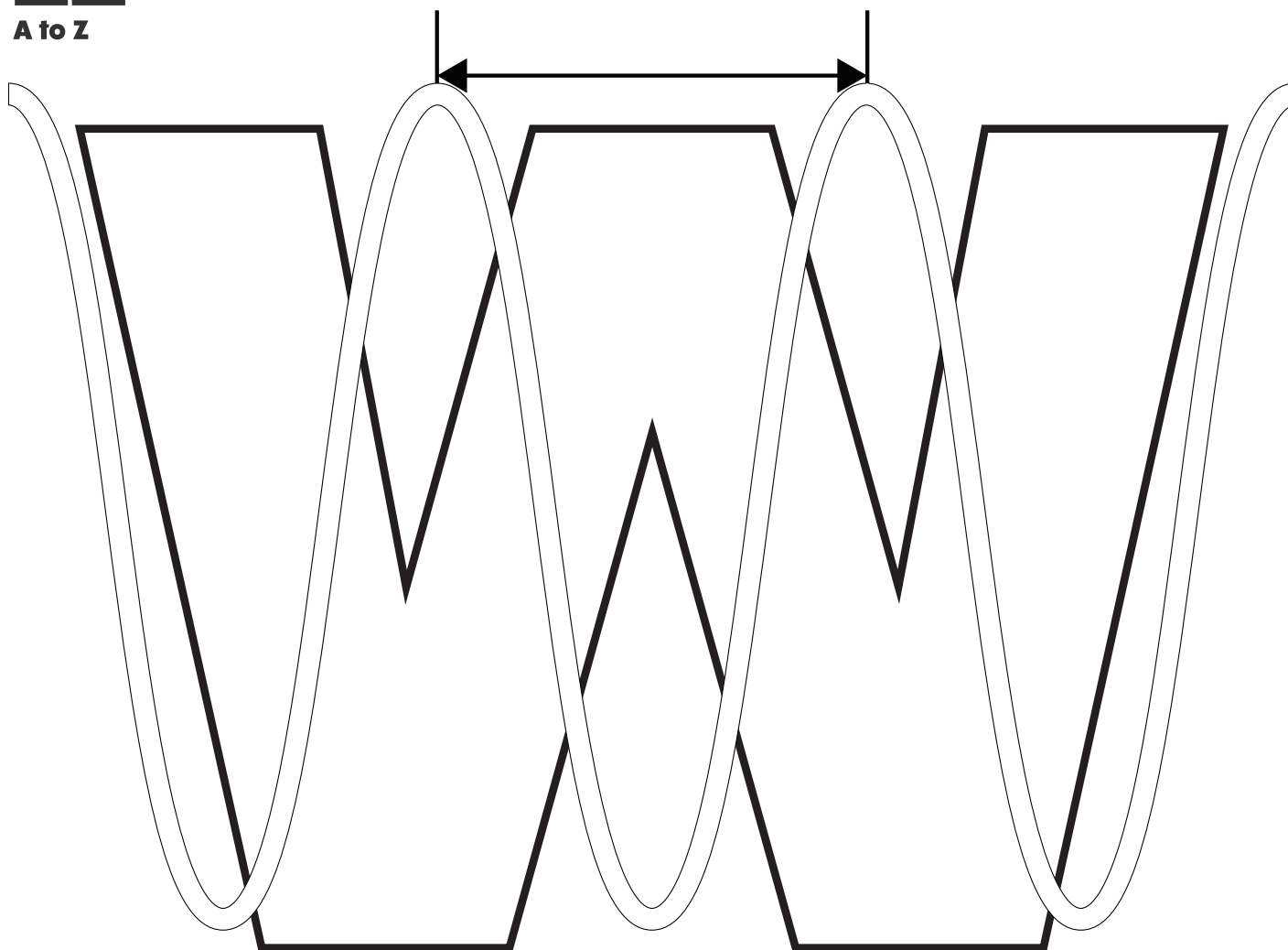


# Velocity

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Velocity is the speed of an object in a specific direction.

Velocity is important when NASA wants to launch satellites to space on a rocket. The rocket needs to go fast enough so that it can escape the gravitational force of Earth to reach its desired orbit in space.



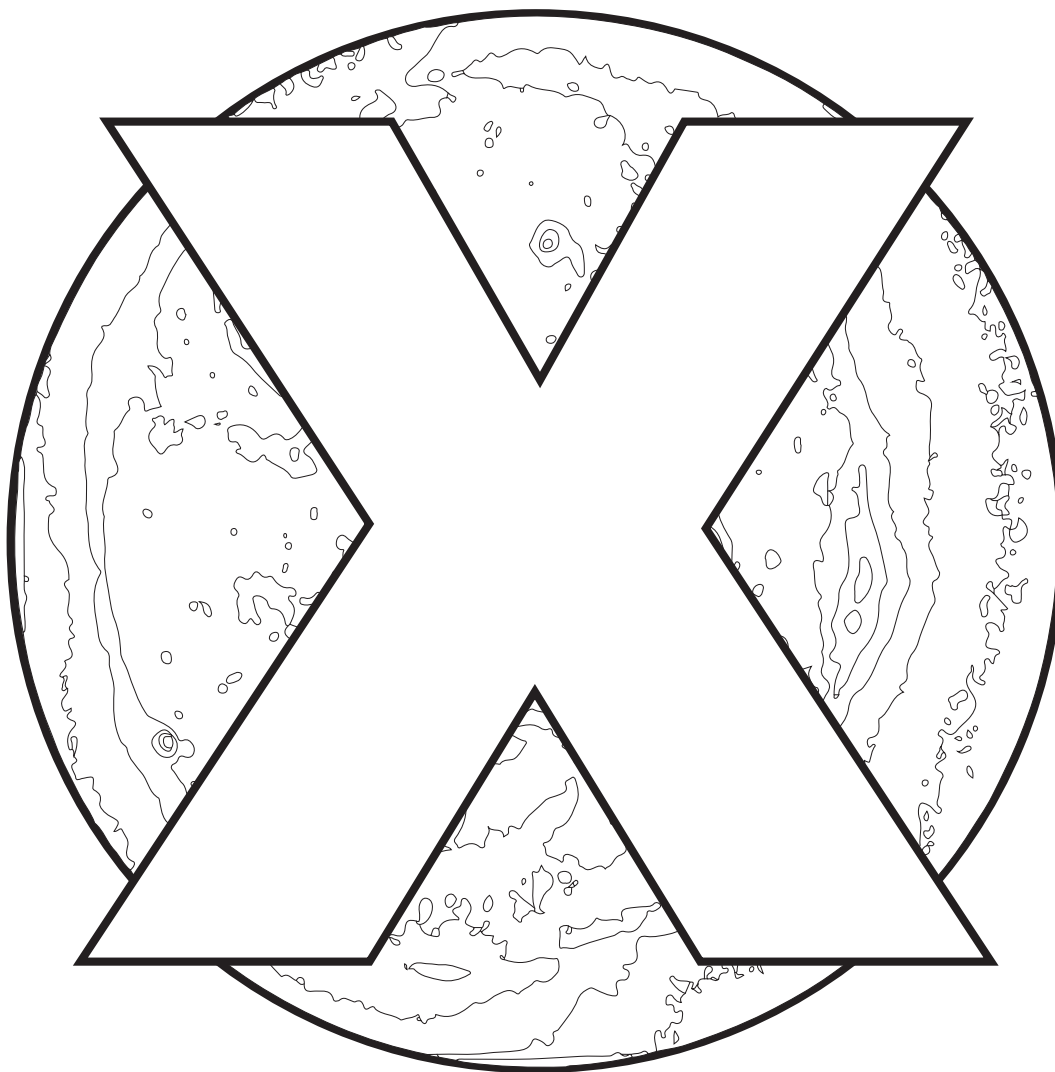
# Wavelength

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The distance between one peak or crest of a wave of light, heat or other energy, and the next peak or crest.

Wavelengths that SCaN currently uses for space communications are between the size of a building and the size of a pinhead.





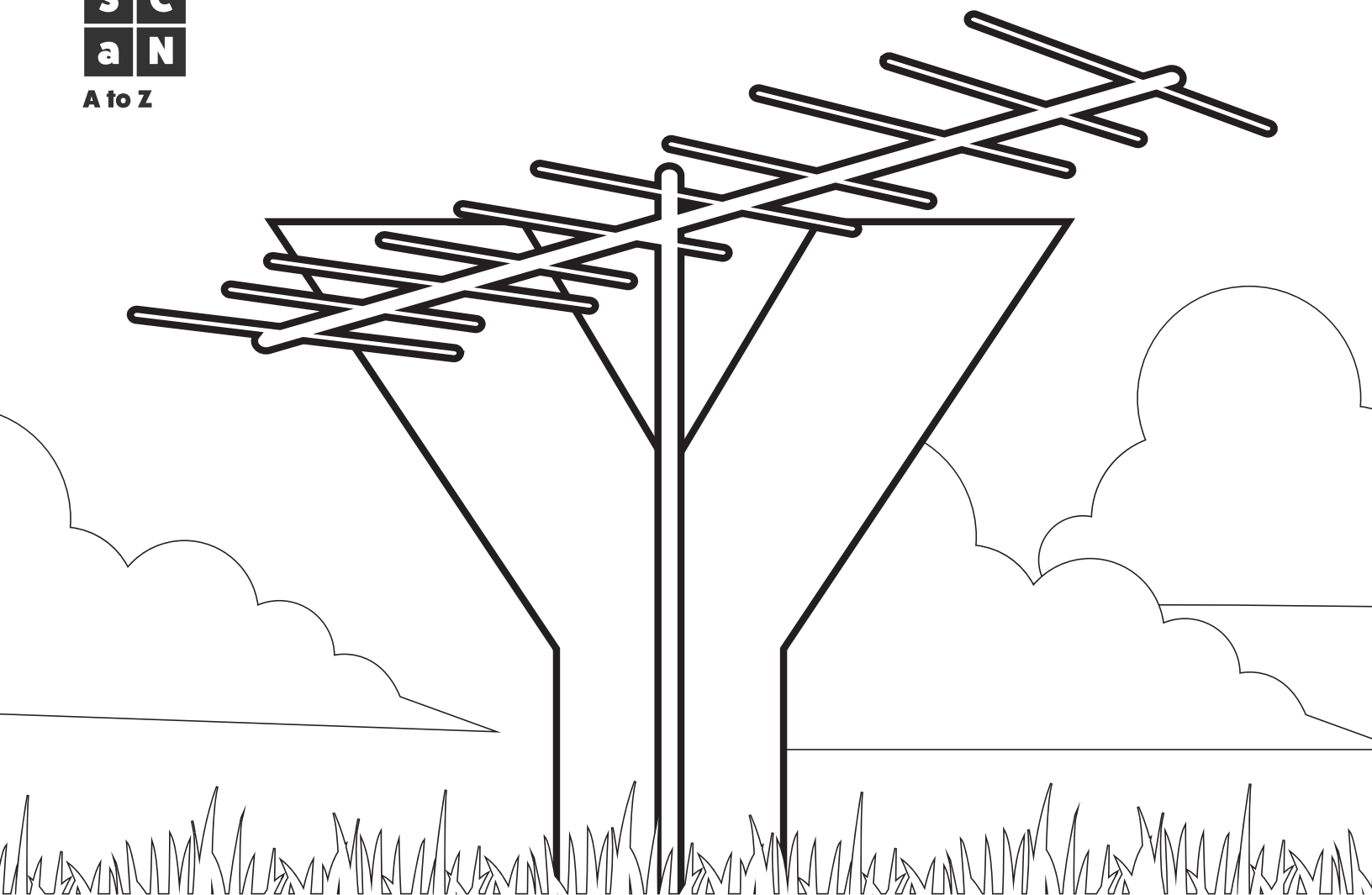
## **X-Ray**

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X-ray is an electromagnetic radiation of very short wavelength and very high energy.

X-rays have shorter wavelengths than ultraviolet light but longer wavelengths than gamma rays.

Spacecraft use X-ray to view galaxies and other items in the universe.

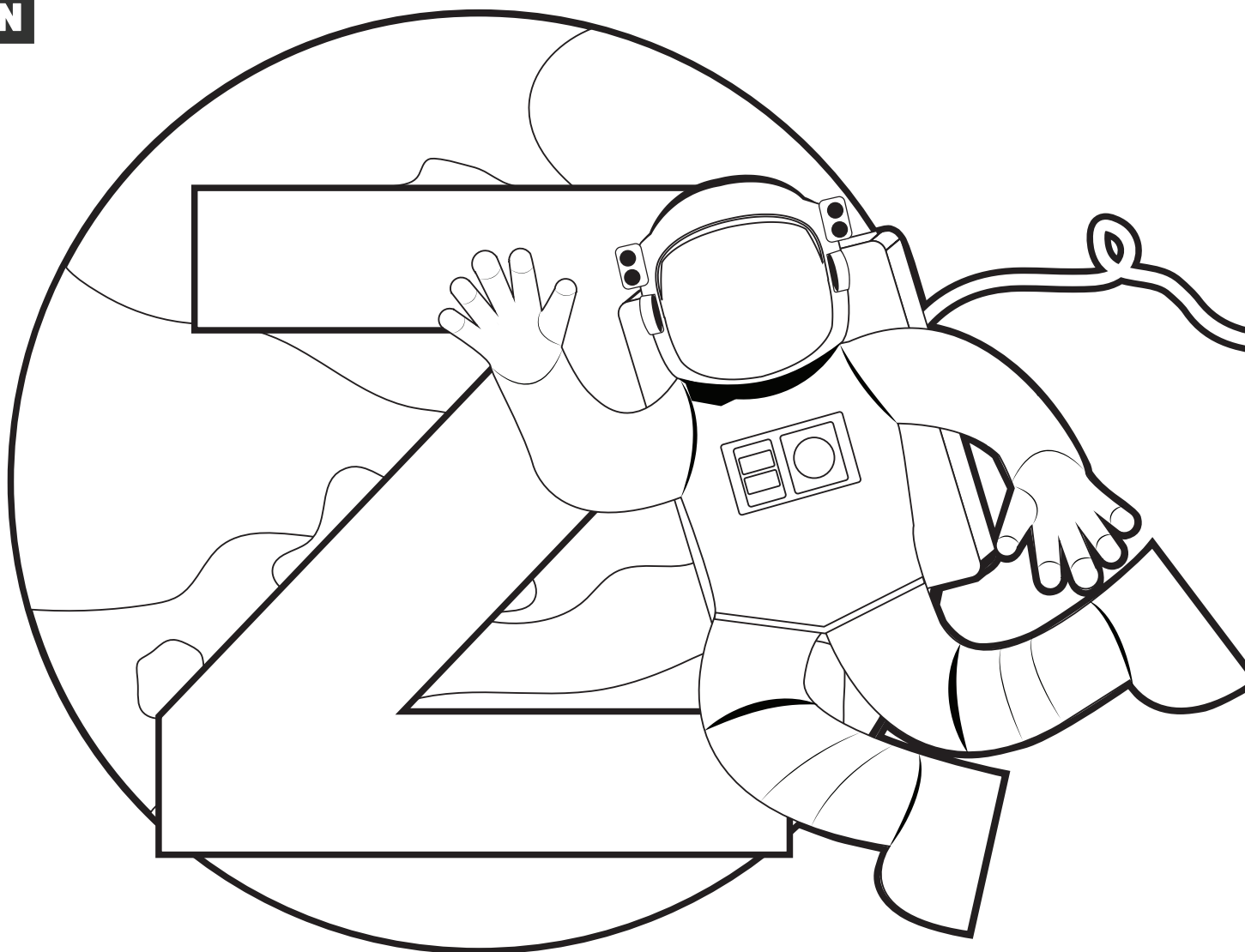


# Yagi Antenna

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A Yagi antenna is a directional antenna made up of parallel thin rod elements in a line.

These antennas were used in the early days of space communications.



# Zero Gravity

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Zero gravity is also referred to as microgravity. It is the condition in which people or objects appear to be weightless.

The name may be misleading, however, as there is a small amount of gravity in space.



National Aeronautics and Space Administration

**Space Communications and Navigation**

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