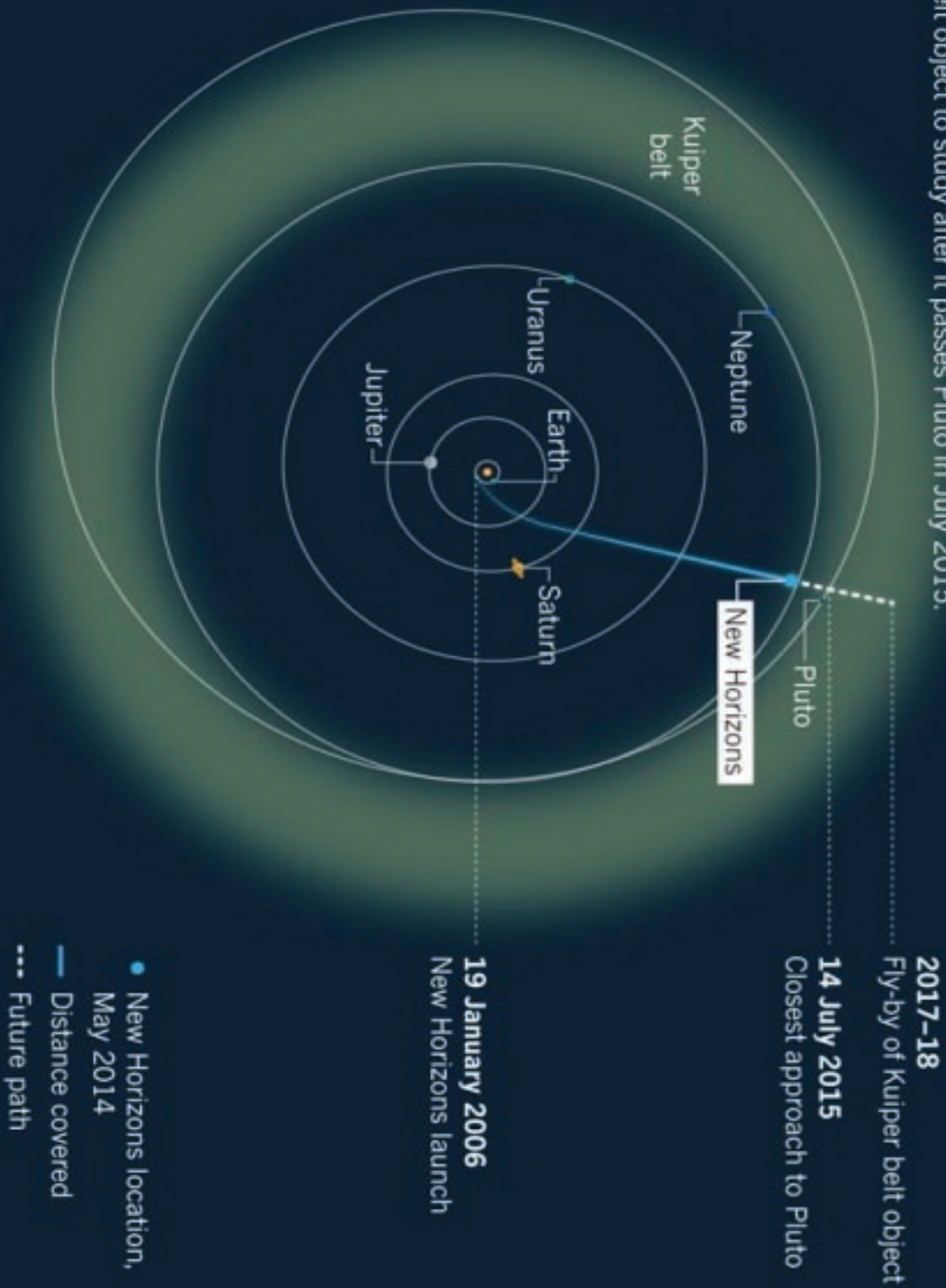


The Amazing Journey to Pluto

FAR HORIZONS

NASA's New Horizons probe has struggled to identify a Kuiper belt object to study after it passes Pluto in July 2015.



The Amazing Journey to Pluto

Our solar system is so vast that it is almost impossible to think about its scale in terms of miles or kilometers. One way we can bring these enormous distances 'down to Earth' is to think in terms of travel times.

In a commercial jet liner, you could travel once around Earth in about 50 hours (not including stops for refueling!). It would take about 500 hours to get to the moon in the same plane. The much faster Apollo spacecraft made the trip in about 80 hours. The fastest spacecraft trip to Mars, made by Mariner 7 launched in 1969, took 128 days. The Soviet Venera 1 spacecraft made it to Venus in 97 days, and Mariner 10 took 147 days to get to Mercury. To get from Earth to the outer solar system takes years. To measure such vast distances, scientists use the Astronomical Unit or AU, which is the distance between Earth and the sun (150 million km or 93 million miles).

The slowest methods of interplanetary travel use gravity assists to save fuel and cost. The fastest methods use a very large launch vehicle to boost a spacecraft into an interplanetary trajectory at a high velocity. The spacecraft then coasts the rest of the way!

Starting from launch on January 19, 2006, and with a gravity assist from Jupiter along the way, NASA's New Horizons spacecraft took 9 years and 5 months to get to Pluto, 39 AU from the Sun. It traveled at an average speed of 4.1 AU/year.

Deep-space missions can take up to 10 years from development to launch. For New Horizons, it took close to 20 years from the time that scientists conceived of the mission to the time it reached its destination!

Spacecraft	Cost	Launched	Distance	Time	Speed
Pioneer 10	\$350 million	1972	30 AU	10 yr 10 mo	2.8 AU/yr
Pioneer 11	\$350 million	1973	86 AU	39 yr 5 mo	2.2 AU/yr
Voyager 1	\$450 million	1977	69 AU	20 yr 8 mo	3.3 AU/yr
Voyager 2	\$450 million	1977	108 AU	37 yr 10 mo	2.9 AU/yr
New Horizons	\$700 million	2006	39 AU	9 yr 5 mo	4.1 AU/yr

Space Math Challenge!

If 1 AU/year equals 4.8 km/sec (11,000 mph) how fast was the fastest spacecraft traveling in km/sec and mph? **Now try this:** Like light, radio signals in space travel at a speed of 300,000 km/sec. If it takes 8.5 minutes for a signal to travel 1 AU, what will be the round-trip time, in hours, for a radio signal to travel from Earth to each spacecraft and back to Earth at the distances shown in the table?

Answers: New Horizons was the fastest at a speed of $4.1 \times 4.8 \text{ km/s} = 20 \text{ km/sec}$ or 45,000 mph.

Now try this: Pioneer 10: $30 \text{ AU} \times (8.5 \text{ min/AU}) = 255 \text{ minutes one-way}$, and so 8.5 hours round-trip. Pioneer 11: $86 \text{ AU} \times (8.5 \text{ min/AU}) \times (1 \text{ hr}/60 \text{ min}) \times 2 = 24.4 \text{ hrs}$; Voyager 1: $69 \text{ AU} \times (8.5 \text{ min/AU}) \times (1 \text{ hr}/60 \text{ min}) \times 2 = 19.6 \text{ hrs}$; Voyager 2: $108 \text{ AU} \times (8.5 \text{ min/AU}) \times (1 \text{ hr}/60 \text{ min}) \times 2 = 30.6 \text{ hrs}$; New Horizons: $39 \text{ AU} \times (8.5 \text{ min/AU}) \times (1 \text{ hr}/60 \text{ min}) \times 2 = 11.1 \text{ hrs}$.