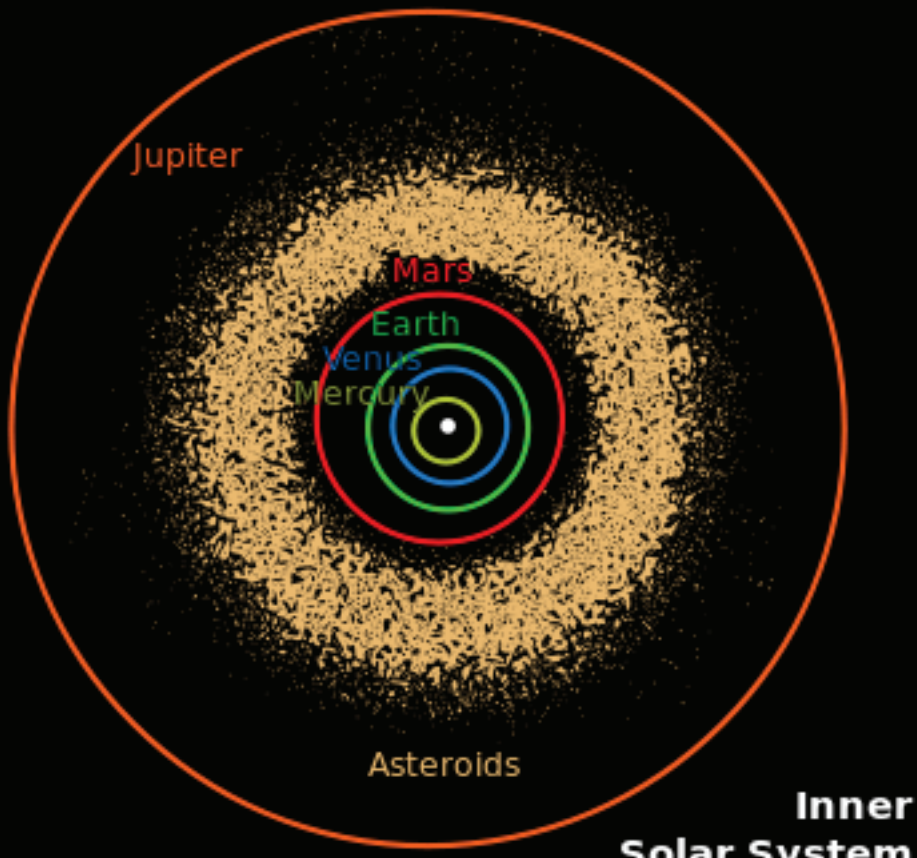
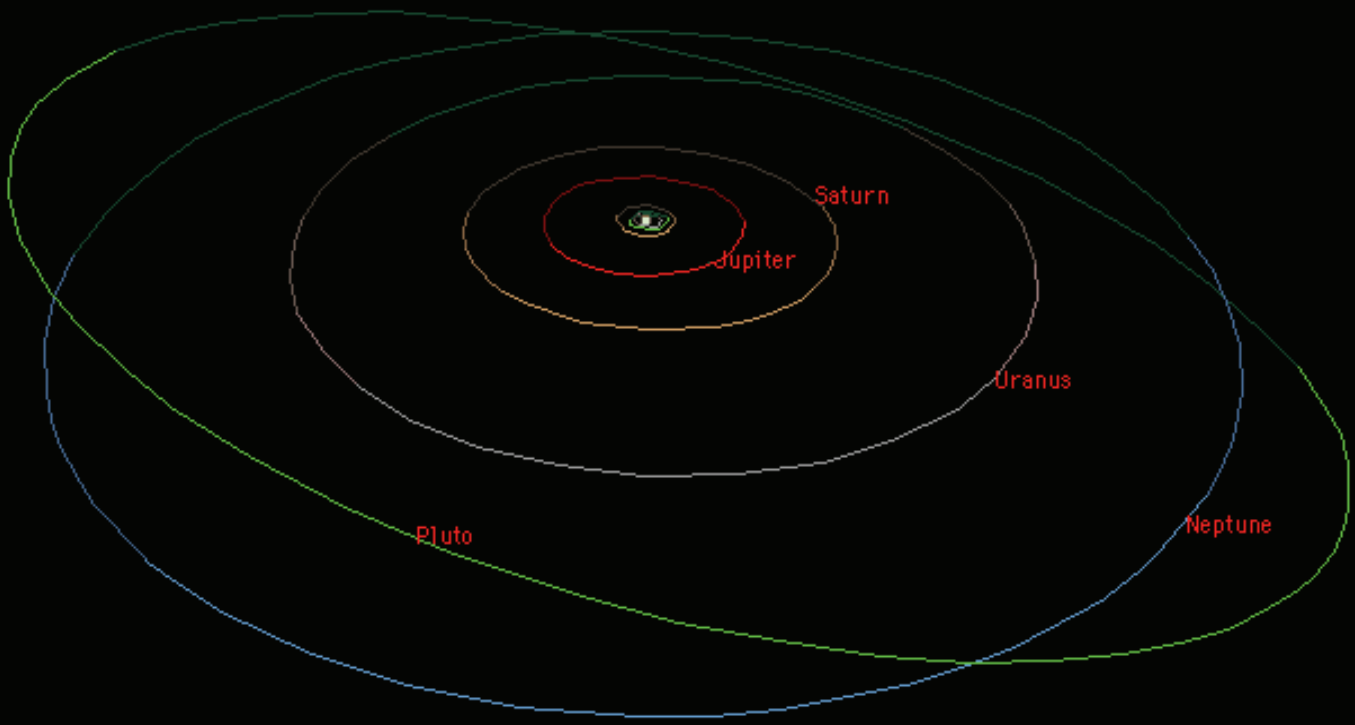
Exploring Interplanetary Communication





Courtesy of NASA / JPL-Caltech / R. Hurt

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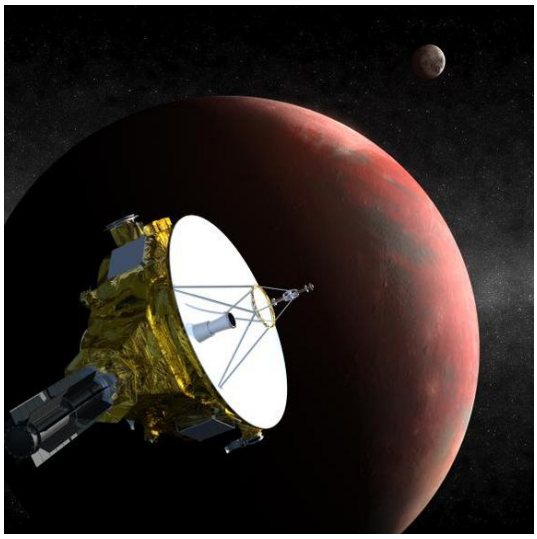
It is almost impossible for us to understand the vastness of our solar system. Most of us have some mental idea of what a kilometer looks like on a human scale. But when we start talking about millions of kilometers, all of our normal ways of thinking about distances completely fall apart…even for astronomers and rocket scientists!

This problem becomes particularly annoying when we start thinking about communicating across interplanetary distances by light and radio waves. These waves travel at 300,000 kilometers per second (670 million mph). Over a distance of a few meters – say, across a room – travel time is about 3 billionths of a second, a fraction of time that only precision instruments can measure. But when scientists communicate with spacecraft orbiting Mars, travel time for a radio signal can be nearly an hour or more round-trip!

A lot of bad things can happen to a spacecraft over the course of an hour. A rover on Mars can drive into a ditch or over a cliff. NASA spacecraft use some form of artificial intelligence so they can figure most problems out for themselves without waiting for commands from someone on Earth.



Artist rendering of New Horizons near Pluto (NASA)

On July 14, 2015, NASA's New Horizons spacecraft reaches dwarf planet Pluto and begins sending data back to Earth. At that time, the distance from Earth to Pluto is 4.8 billion kilometers. At the speed of light, one-way radio-signal travel time is 16,000 seconds or 4 hours and 27 minutes.

New Horizons makes its closest approach to Pluto at 7:50 am EDT on July 14. Scientists will not get data or images about that event until 4 hours and 27 minutes later or around 12:17 pm EDT, just after lunch!

Space Math Challenge!

For New Horizons, which event do you think we should celebrate? The one at 7:50 am when it arrives at Pluto, or the one at 12:17 pm when we first receive the signal at Earth? **Now try this:** On the same day New Horizons reaches Pluto at a distance of 4.8 billion kilometers, the Voyager 2 spacecraft is 16.1 billion kilometers from Earth. The round-trip radio-signal travel time between Earth and Pluto is 8h 54m. If a radio signal were to be sent to both the New Horizons and Voyager 2 spacecraft on July 14, 2015, at 8:00 am EDT, at what time would the radio signals reach each spacecraft?

Answer: Either time is important to know, but for different reasons!
Now try this: The one-way trip to Pluto takes 4h 27m. Voyager 2 is at a distance 16.1/4.8 = 3.35 times farther than Pluto, so it will take (4h 27m)x 3.35 = (267m)x 3.35 = 894 min or 14 hours and 54 minutes to get from Earth to Voyager 2. The signal would reach Pluto at 8:00 am + 4h 27m = 12:27 pm. It would reach Voyager 2 at 8:00 am + 14h 54m = 22:54 or 10:54 pm on July 14.