Tones from Deep Space

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October 4, 2007: "Beep… beep… beep...." That's the sound that marked the beginning of the Space Age fifty years ago. It was a simple radio tone transmitted by the first satellite, Sputnik 1, as it orbited Earth in October 1957.

Since then communication with spacecraft has advanced tremendously. Yet a modern probe on the way to the edge of the solar system is using Sputnik-like tones to send messages back to Earth.

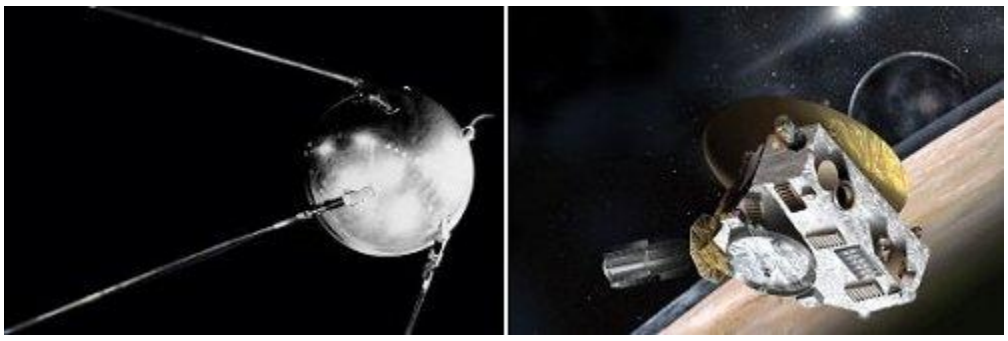
Right: In Oct. 1957, ham radio operator Roy Welch of Dallas, Texas, tunes in to the 20 MHz radio tones of Sputnik. [More] [Larger image]

Why the retro technology? It solves a modern problem: multiplication. Sputnik has so many descendants! There are robots on Mars; spacecraft circling Saturn, Mars and the Sun; probes en route to Mercury, the asteroid belt and even Pluto. All of these missions are trying to talk to Earth, creating a cacophony that threatens to overtax NASA's Deep Space Network. If only these probes could learn to communicate with greater brevity as Sputnik once did.

Enter Beacon Monitor--a device onboard NASA's New Horizons spacecraft that communicates with Earth using only eight simple tones. It leverages the fact that New Horizons doesn't have much to do during its 9-year voyage to Pluto other than report its status to Earth. "I'm okay," sums up a typical weekly transmission.

New Horizons is capable of complex communication. It can transmit detailed images and data streams rich in numerical information. "But when we only need a basic status check, a few simple tones are fine," says Henry Hotz an engineer at NASA's Jet Propulsion Laboratory who helped develop the technology.

Despite its seeming simplicity, the beacon is sophisticated. New Horizons has many systems and all of them must be checked. Onboard software boils down the entire situation into a succinct "diagnosis." The system then uses a low-power antenna to transmit the diagnosis as one of eight simple radio tones. One means *I'm okay* while the other seven signify calls for help ranging in urgency from *Help me soon* to *Help me now* to *Red Alert! I'm in big trouble.*



Above: Sputnik (left) and New Horizons (right).

This approach has many advantages. "Simple tones from a distant probe are much easier to detect on Earth than an ordinary data transmission," explains Hotz. "If you miss part of a complex data stream the information is lost, but any part of a simple tone can tell you its frequency, thus revealing the message." The simpler transmission means that the beacon can use less of the probe's limited power (New Horizons operates on less power than a pair of 100-watt household light bulbs), and mission scientists can use smaller dishes to receive the signal. "Both of these advantages cut costs and make a mission more feasible."

Beacon Monitor was first tested onboard Deep Space 1, an experimental spacecraft flown in 1998 by NASA's New Millennium Program. The *raison d'etre* of Deep Space 1 was to test a suite of cutting-edge technologies (e.g., an ion engine, a smart autopilot, super-solar arrays and a back-to-the-future status monitor) for possible use on future missions. "Beacon Monitor passed with flying colors and was later installed on New Horizons."

So, as the Space Age began, it continues, to Pluto and beyond. Close your eyes. Can you hear the tones?

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