THE PAST, PRESENT AND FUTURE OF SETI

The Search for Extraterrestrial Intelligence has heard nothing for 50 years. We ask: what next?

WORDS: STUART CLARK

Fifty years ago this month, young radio astronomer Frank Drake hooked up a receiver to the 85ft dish at Green Bank, West Virginia, and began the modern Search for Extraterrestrial Intelligence (SETI) beyond Earth. It's an inspiring story but it wasn't the first time radio had been used to look for life.

Thirty-six years before Drake made his study, the US military conducted its own search for extraterrestrial radio messages. On 22 August 1924, Mars drew closer to Earth than at any time since 1804, and both Army and Navy radio units listened in for messages. Neither of them heard any. But 25 years earlier, in 1899, the radio pioneer Nikola Tesla was convinced that he had actually heard an intelligent signal from space. He predicted that the greatest discovery of the 20th century would be the uncovering of proof of extraterrestrial signals crossing space. It wasn't.

A century is a lot of time to be searching without finding a thing. You might think SETI enthusiasts would be downhearted. They're not. If anything, more people are now thinking about the subject than ever. The recent surge of interest comes from the fact that searches for planets around other stars are starting to bear fruit. Many astronomers think 2010 could be the year the first habitable planet is identified. Habitable, however, is not the same thing as actually being inhabited.

To be habitable means that the planet has a solid surface and exists in an orbit around its parent star that makes it sufficiently warm to allow surface water to exist. In other words, it has the potential to be an Earth-like planet. There are two space telescopes currently in orbit looking for such worlds. The French-led mission with ESA participation, CoRoT (COnvection, ROtation & planetary Transits) and the NASA mission, Kepler. Both detect planets by looking for the drop in starlight caused by the silhouette of a planet as it passes in front of its parent star.

Red dwarf worlds

The first habitable planets will probably not be found around Sun-like stars. Rather, they'll be found around smaller stars called red dwarfs. These celestial minnows are cooler than the Sun, possessing surface temperatures of around 4,000°C. As a result, habitable planets would have to be closer in; probably so close that the star's gravity would prevent the planet spinning independently. In other words, the planet would always present the same face to the star, much as our Moon does to Earth. This means that the planet would have one hemisphere permanently in sunlight and one in permanent darkness. Winds blowing between the heated and unheated hemispheres would likely be fierce but temperatures could nonetheless be clement.

Any habitable planets that CoRoT and Kepler do find will provide compelling targets for SETI searches, and the radio telescopes available now are better than any that have existed in the past. In ►

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► particular, there's the Allen Telescope Array (ATA), built by astronomers from the privately funded, nonprofit SETI Institute.

Construction began in March 2004, after a four-year development period. It was made possible by a donation of $25 million by Paul Allen, the co-founder of Microsoft. Some 42 of its 6m-diameter dishes are now in place at Hat Creek Observatory, California. When further funding can be raised, the total number of dishes will be increased even further to 350.

In its final configuration, the ATA will be capable of surveying 4 billion stars for SETI emissions, and one million of those to highly sensitive levels. In addition to its SETI goals, ATA will map gas in nearby galaxies and star-forming regions, look for distant black holes and search for the as-yet-undetected gravitational waves predicted by general relativity.

> "Three photons: that's all you need to change history forever" FRANK DRAKE

As well as radio SETI, there is a newer variety: Optical SETI (OSETI). The idea itself isn't new. Way back in 1961, the inventor of the laser, Charles Townes, pointed out that extremely large lasers would make efficient beacons for interstellar communications. However, the idea was slow to catch on. A NASA-funded report into strategies for SETI all but dismissed the idea in 1971. But times have changed. Frank Drake, one of the authors of that report, now admits that he was too hasty, and at a recent meeting of the Royal Society in London he advocated the search for laser pulses.

The power of the laser is such that the beam does not diverge as much as normal light sources, and so remains bright even over celestial distances. Laser beacons from extraterrestrials would momentarily appear brighter than their host star by around a thousand times. OSETI telescopes now look for particularly bright signals, and need very few photons of light to make positive detections. "Three photons: that's all you need to change history forever," Drake told the Royal Society.

There are more SETI searches taking place now than ever before, but on the flip-side there are also compelling reasons for believing that the search will still come back empty handed. It is not that extraterrestrial civilisations are absent, but rather that they cannot, or do not, use radio technology. One reason may be because they have yet to develop such gadgets. Another reason, from our history, would be that the window in which radio is used is short. Omnidirectional antennae that blast television and radio programmes in all directions are rapidly being replaced on Earth by more directional technologies that use less energy. The result is that, to someone on a distant world, Earth is fading away at radio wavelengths. ►

Is SETI worth doing?
What the experts think…

Duncan Forgan, University of Edinburgh

If the 'Rare Earth' hypothesis is correct, then the conditions leading to intelligent life on Earth are so finely tuned that they are unlikely to be reproduced elsewhere. In that case, the chance is very small that we will overlap with another communicating civilisation in our Galaxy. That doesn't make it completely impossible, just very, very difficult. Even if the Rare Earth hypothesis is false, a lot depends upon luck because you have to coincide not just in space, but also in time. Two civilisations might develop around stars that are next door to one another, but at completely different times in galactic history. Because they do not overlap in time, they will never know that the other existed. Even if we are able to make a complete census of all the stars and planets in the Galaxy at some point in the future, we will probably still require serendipity to find living beings – not just archaeological remains.

Ian Morison, Jodrell Bank Observatory, University of Manchester

I'm not convinced that the chance of success is high, but it would be very significant if we did make contact. It would tell us that civilisations can exist for long periods after the development of advanced technology. Although simple life is probably widespread throughout the Galaxy – it may even have existed elsewhere in our Solar System – evolution on Earth shows it takes a long time to get to intelligence, and very few planets remain stable for billions of years. At the moment, there are so many things we don't know, such as how many other solar systems are suitable for life. If we don't find anything after searching a long time, that is important too. Perhaps it will convince people that the human race really is something special and that we should do more to look after it. I don't think SETI is a waste of time, but I do think it's more likely we are the only advanced civilisation in the Galaxy than we are one of many.

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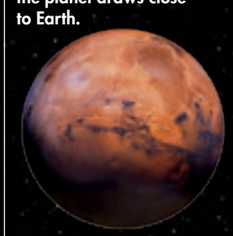
A LONG WAIT

The history of the Search for Extraterrestrial (ET) intelligence using radio waves stretches back over a century. In that time, the majority of the work has been performed by small groups of researchers, as you'll see below.

SUMMER 1899 – The US Navy conducts a three-day search of Mars for radio transmissions as the planet draws close to Earth.



AUGUST 1922 – Giuseppe Cocconi and Philip Morrison point out the quiet window of microwave radio frequencies that would be worth searching for signals.

SEPTEMBER 1959 – Frank Drake conducts his first search using the Green Bank radio telescope. He watched two Sun-like stars for 150 hours.

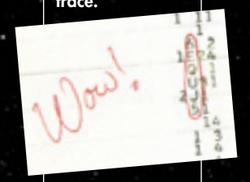
APRIL 1960 – Radio pioneer Nikola Tesla is convinced that he has detected faint, artificial radio signals coming from space.

NOVEMBER 1967 – Strange pulsations detected by a radio telescope at Cambridge are shown to be tiny spinning stars called pulsars, not messages from ET.

SEPTEMBER 1971 – NASA publishes Project Cyclops, a proposed array of 1,500 dishes for a price of $10 billion! Unsurprisingly, it was not built.

NOVEMBER 1974 – A radio message is beamed into space from the Arecibo telescope, Puerto Rico, to alert ETs to our presence.

AUGUST 1977 – A single powerful blast of radio is captured by Delaware's Big Ear telescope. Astronomer Jerry Ehman writes 'Wow!' on the trace.



JUNE 1983 – Search for ET space probes around Earth performed from Hat Creek Radio Observatory using the 26m radio dish. Nothing found.

NOVEMBER 1984 – The SETI Institute, a private non-profit organisation, is founded in California to pursue the search for extraterrestrial intelligence.

OCTOBER 1992 – US Government funds a NASA SETI programme, consisting of an all-sky search and a targeted search. It was cancelled months later.

OCTOBER 1998 – Oak Ridge Observatory, Massachusetts, begins to search for pulsed laser beams, which aliens might be using instead of radio waves for signalling.

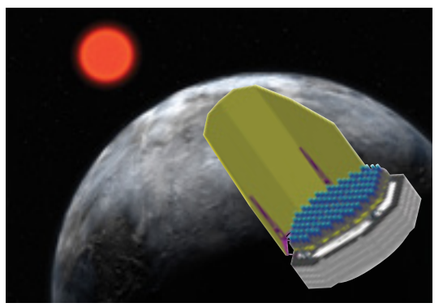
MAY 1999 – SETI@home launches. The screensaver computer program searches packets of radio astronomy data for suspicious signals.

OCTOBER 2007 – The first phase of construction of the Allen Telescope Array is completed at Hat Creek Radio Observatory, California.

SETI equipment

ALLEN TELESCOPE ARRAY
The 42 antennae (the number surely inspired by Douglas Adams) of the Allen Telescope Array (ATA) have been operating since 11 October 2007. It aims to survey 1,000,000 stars for SETI signals. The ATA is a joint venture between the SETI Institute and the Radio Astronomy Lab of the University of California, Berkeley.

HARVARD OSETI 72-INCH
Situated at Harvard-Smithsonian's Oak Ridge Observatory, 40 miles west of Boston, Massachusetts, the 72-inch telescope is the latest addition to the Harvard Optical SETI programme. Since 19 October 1998, the observatory has been searching for pulsed laser beams from selected Sun-like stars.



PLATO
A mission concept from the European Space Agency, PLATO (Planetary Transits and Oscillations of Stars) will search 500,000 stars for planets, especially those within habitable zones. The idea is to find habitable planets first, allowing traditional SETI projects to be targeted at them.

RAL BERKELEY.EDU/ATA, ESO, ESO/L. CALCADA

► Then there is the use of more efficient data compression techniques. These days, any repeating pattern is compressed and encoded. Therefore any SETI searches that look for repetition as a distinguishing feature of an artificial signal might be doomed to failure. It's worth remembering that the first pulsar discovered was initially referred to as LGM-1 for Little Green Men. Its repeating pattern was produced by a rapidly spinning stellar remnant, but if it had genuinely been a message from ET, it would have been unusual. More advanced civilisations would probably use compression.

Although this one turned out to be a false alarm, it may suggest a good strategy, according to Richard Carrigan of Fermilab, Illinois. He believes that an alternate approach to SETI is to look for the evidence of giant engineering projects throughout the Universe. For example, the proposed 'Dyson Spheres' are giant spherical solar panels used by alien civilisations to enclose their home star in order to intercept every last photon of starlight. Such a vast construction would radiate waste heat as infrared radiation different in appearance from that given out by stars.

A detection would likely be viewed by many people as a confirmation, rather than a revelation

Last year, Carrigan searched the catalogue of 250,000 infrared sources produced by the IRAS satellite, applying stringent rules about what was and wasn't a star in the search for the telltale signs of a Dyson Sphere. In the end he came up empty handed. "There is no compelling Dyson Sphere within 100-1,000 lightyears of the Earth," he told *Sky at Night Magazine*.

Others have suggested that identifying extraterrestrial space probes makes more sense than looking for radio communications. They've searched the space near Earth for signs of strange-looking asteroids that might actually be spacecraft. Again, nothing suspicious has been spotted. And again, it's not very encouraging if you're an advocate of SETI.

But for now, let's forget the disappointment and assume that at some point in the future, a detection is made. What then? Some people have said it will precipitate the most profound change in human history. But Albert Harrison of the University of California at Davis disagrees. "There have been a number of occasions when

An artist's impression of a planet orbiting the red dwarf star Gliese 667 C, part of a triple star system. Could worlds like this host a civilisation?

people have thought ET intelligence has been found," he told the Royal Society. "The impact was minimal."

Harrison could be right. In 1835, newspapers printed pictures purporting to be winged men and other strange creatures on the Moon. It was weeks before the hoax was admitted. Today, in an era when most people assume that extraterrestrials exist (either as UFOs or "out there" in the Universe), a detection would likely be viewed by many as a confirmation rather than a revelation. Of course, there's the manner of detection to take into account. A radio signal of obviously alien origin would have significantly less impact than a spacecraft materialising in Parliament Square.

The fact of the matter is that without direct contact, mere knowledge of the existence of extraterrestrials may not change anything at all.

So are they out there or not? And can 50 or more years of silence be construed as evidence that they simply do not exist? Seth Shostak of the SETI Institute once attacked such thinking by looking out into the parking lot beyond his office and concluding that there were no elephants in the world because he could not see any among the cars. Given the limited volume of space that we have searched, he argued, the same might be true of extraterrestrials. When it comes to the question of whether or not aliens exist, we have to admit we don't know... yet. The search goes on.

How you can help

How do you fancy joining in the search for ET? Well, you can indeed get involved and you don't need a radio telescope, thanks to SETI@home software. First released in May 1999, it's been a hugely popular download ever since. The idea is simple: the software harnesses the downtime of computers across the world to analyse radio astronomy data, searching for suspicious radio signals. The software does this by being a screensaver that kicks in whenever your computer is inactive.

It automatically requests a data packet from across the internet and then sets about looking for anything that stands out from the norm. In particular, it looks for signals that use a narrow band of frequencies. That's because there are no natural sources of such narrowband signals. Anything found would be flagged and passed back across the internet but, at the time of going to print, nothing had been...

A recent addition to the software is Astropulse. This is code that allows the software to look for pulsed broadband signals. These are the signals given out by rapidly rotating neutron stars. They're also expected to be given out by exploding black holes and, in addition, may come from as-yet-unanticipated celestial phenomena.

STEP 1: Go to the SETI@home website: http://setiathome.berkeley.edu/. The left-hand panel is called Get Started. Read the rules and policies to understand how the software will use your computer.

STEP 2: If you agree with the rules click the button to download the software platform called BOINC. This is an essential component of SETI@home. Follow the installation instructions.

STEP 3: BOINC can run many different analysis programs. To run SETI@home, wait until prompted and then type in http://setiathome.berkeley.edu to get your computer sifting data from space.