Raspberry Pi

Customer story

Arribada technology for conservation
Raspberry Pi is key to Arribada's wildlife monitoring projects

The high cost of camera equipment presented a huge obstacle to conservationists monitoring species populations and behaviours. Arribada's affordable and robust Raspberry Pi-based kits are a game-changer.

Raspberry Pi solution	Raspberry Pi Zero, Raspberry Pi 4, Raspberry Pi cameras, Raspberry Pi Pico
Size of business	Small non-profit organisationss
Industry	Conservation

A Raspberry Pi Zero and Camera Module in a waterproof enclosure track sea turtles' journeys under the waves

Timelapse photography and remotely accessible monitoring tools are used routinely in conservation these days, but back in 2017, when Davies founded his non-profit organisation Arribada, they were groundbreaking. Keen to draw attention to threats to wildlife in different habitats and locations, he set about developing low-cost monitoring tools, reasoning that equipment costs should not be a barrier to helping critically endangered animals. He produced and designed multiple conservation observation tools, from a camera trap that would wake and detect an animal walking by, to a device that would send back an alert if a particular animal appeared.

Davies founded environmental organisation Arribada (the name, meaning "arrival", refers to the migration and birth cycles of sea turtles) with the aim of using technology to make a positive environmental contribution.

The challenge

Arribada needed a robust, low-cost kit that could be used in remote locations, often without human intervention. Its first project was a tag to monitor green sea turtles: this tool would show the impact that fishing and human activity were having, and open discussions about what protections might need to be introduced for the endangered species.

To track the turtles, Arribada's solution would need to be waterproof at the depths at which the creatures swim, as well as being able to operate reliably without the possibility of human intervention. It also needed to be both affordable and accessible to local research teams.

The solution

A Raspberry Pi Zero and a Raspberry Pi Camera Module were enclosed in a lightweight, waterproof enclosure. This could be attached, harmlessly, to the shell of a sea turtle, to track its journey under the waves. The device captures photos, video, and location data.

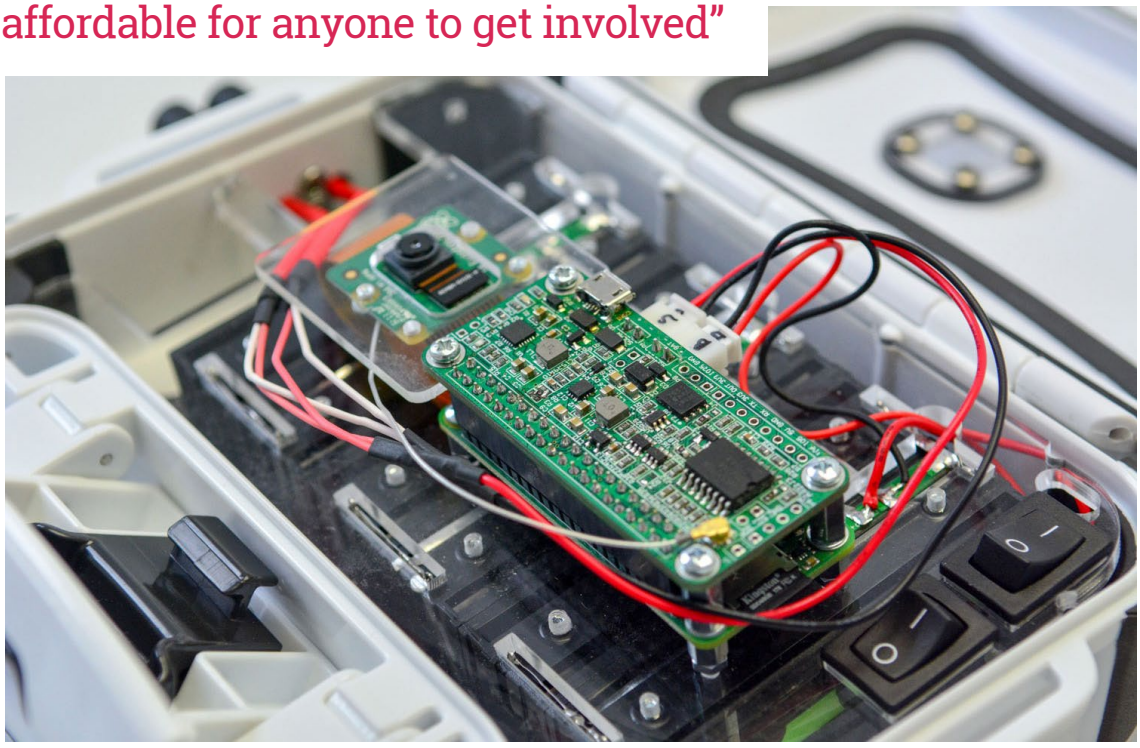
"Once the video has been recorded the tag is released from the shell of the turtle and is then recovered from the water's surface two weeks later. This lets us capture behaviour footage of both female and male turtles," Davies explains.

A challenge for turtle monitoring is that GPS location tags are only effective when the creature surfaces, which is often for less than two seconds. Waking up the monitoring devices to get a triangulation fix is not instantaneous, so Arribada developed its own Horizon Assisted-GPS tag as a key part of the Raspberry Pi Zero-based kit.

The kit means that turtles' behaviour, as well as their locations, can be discerned. The first turtle tags were developed when AI and machine learning were in their infancy, but, Davies says, we're in a very different space now. "You can imagine the benefit of running AI models on Raspberry Pi devices for the sea turtle: we can wake up [the device], capture a scene, process that scene, we can even [get the device to] make some intelligent decisions to say, is this worth recording? Is it worth going back to sleep or should I stay on?"

In addition to making decisions about continuing to monitor a site, perhaps going into a sleep cycle and awakening again an hour later to see what's changed, using Raspberry Pi offers machine learning advantages. "We can pull the models off, sit there and go through and train them a little bit more, tweak and review the video content. We can do it all at very little cost, because [Raspberry Pi] is so affordable."

"Raspberry Pi is so accessible and affordable for anyone to get involved"



It's an approach that has begun to mark out Arribada as a sophisticated research partner, with conservation organisations showing "a real interest in what Edge ML is going to do. We still use it on the Raspberry Pi. We don't just use it with sea turtles."

Some initiatives need bespoke solutions. This was the case in Cyprus where the Society for the Protection of Turtles (SPoT), one of the country's longest-established conservation charities, was keen to explore the use of LoRa radio communications to monitor fishing activity.

The boat-based LoRaWAN gateway that Arribada set up can provide a detailed overview of local fishing activity and report any potential encroachment on the five critical turtle breeding sites around the country's coast. Cypriot mobile phone regulations requiring SIM cards to be registered after four months made using them for cellular communications troublesome, hence the LoRaWAN setup using a Raspberry Pi 4 together with a Raspberry Pi Power-over-Ethernet HAT. This setup also meant there was no cost to the boat owners for having a tracking system onboard. An antenna on an eight-metre pole offered a clear view of any fishing vessels in a 15km radius, providing a robust and visible monitoring system.

Reducing the costs with widely available Raspberry Pi hardware was a game-changer

Why Raspberry Pi?

Raspberry Pi has become a keystone to almost all of Arribada's projects. Davies explains that it has always been one of the tools he uses "because it's so accessible and affordable for anyone to get involved." "You're always partnering with a researcher or a local community member who works with an NGO and has a specific challenge. We get called in to solve it with technology. They'll always say it has to be affordable, it has to be repairable and accessible."

Davies has used Raspberry Pi with various HATs to create whichever tool was needed, but after Raspberry Pi Pico became available in 2021, he found the low-cost microcontroller board often provided a solution.

The hardware was impressively resilient to temperature, saving daily photos for three Antarctic winters without maintenance

The results

The footage gathered by Arribada's Raspberry Pi-based turtle tags helped quantify the number of sea turtles as well as revealing their nesting locations, bolstering arguments for specific beaches and coastal areas to be off limits at specific times of the year — a crucial protection for this endangered species.

The low cost of Raspberry Pi hardware had a big impact too. Previously, many of the camera tools conservationists needed had such high price tags that research projects either became unviable or ended up severely limited in scope and impact. Often the quantity of kits a project really needed could not be funded, or the high cost of repair and replacement meant that monitoring could be undertaken only once rather than repeated to track changes over time.

Reducing the costs with off-the-shelf Raspberry Pi hardware — widely available and easily swapped out for replacement or upgrading — was a game-changer. Instead of a camera costing £500, a sub-£50 Raspberry Pi Camera Module with a Raspberry Pi Zero or Zero W could be used. The ability to deploy many of these much more affordable kits meant it was possible to cover significantly larger territories and provide more accurate population estimates. In most cases, a 3D-printed waterproof case became the most expensive element of each kit. And as new Raspberry Pi camera hardware became available, Arribada was able to make huge improvements to image and video capture capabilities.

Arribada also won over the Penguin Watch project, a wide-ranging research project monitoring penguin populations in different parts of the world. Arribada's Python-controlled Raspberry Pi camera setup came in at least three times cheaper than the commercial cameras the penguinologists had previously been using. The cost reduction meant the team had far fewer qualms about where monitoring kits were sited, and were more relaxed about leaving equipment in situ for remote monitoring, where some units would inevitably be subject to damage.

In fact, the hardware proved impressively resilient to temperature: the Penguin Watch camera units survived three Antarctic winters before the Arribada team made a maintenance visit. They were able to retrieve three years' worth of photos and found that the Raspberry Pi units had reliably woken to capture a photograph once a day every day, saving every single image. This photographic journal of the changing environment and its effect on penguin populations contributed directly to conversations about climate change and habitat loss.