Altave's devices can be used for border surveillance and security for major events, among other applications

Balloons for ***internet*** *access*

Used as broadband signal relays, equipment can provide connectivity in remote locations

Yuri Vasconcelos

Living without internet access is common for about 3.9 billion people on the planet who do not yet have this service. The estimate is from the Sustainable Development Broadband Commission, an entity formed through a partnership between the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Telecommunication Union (ITU). Most of those without internet access live in rural areas of developing countries. Different initiatives have been implemented to make the planet more connected.

One of them is Project Loon, undertaken by X, Google's former research arm and now an independent company controlled by Alphabet, Google's holding company. Loon began in 2013 and is still in the experimental stage. The project consists of a network of unmanned balloons, inflated with helium, that fly in the stratosphere—from 7 kilometers (km) to 50 km above the Earth—carrying equipment that extends internet connectivity to isolated regions of the globe.

Facebook also has a project, named Aquila, which uses a solar-powered drone to provide internet access. In Brazil, Altave, in São José dos Campos, São Paulo State, uses balloons to extend broadband to farms and rural communities. The technology can also be used after natural disasters, when a region's infrastructure has been destroyed, and to monitor major events.

Project Loon balloons float at an altitude of 20 km, above the cruising altitude of commercial airplanes. Made of polyethylene, they were designed to withstand the hostile conditions of the stratosphere. The balloons are 15 meters (m) in diameter and 12 m in height, and are made to remain in space for more than 100 days.

Just below the envelope (the inflatable part of the balloon), the flight capsule is equipped with electronic devices that serve as a cell tower. The high-speed connection is made through the telecommunications operator closest to the balloon. That signal is picked up by on-board antennas and retransmitted to other project balloons, which communicate with each other to set up the communications network. The signal is then sent to users. Each balloon covers an area of 5,000 square kilometers (km^2).

"Loon balloons function as very low-orbit satellites. To achieve efficient connectivity, they have to assemble a network with several balloons that provides wide coverage and prevents blind spots—regions without an internet signal," explains electronics engineer Lúcio André de Castro Jorge of Embrapa Instrumentation of São Carlos (SP), an expert in field solutions using unmanned aerial vehicles (UAVs).

The Loon Project has already provided an internet signal to farms in New Zealand and to flood victims in Peru. In 2014, X demonstrated the technology in Brazil. Two balloons were launched in Piauí, one of the states with the lowest level of connectivity in the country. One of them provided a broadband signal to a school in the rural Campo Maior region in northern Piauí.

SOLAR DRONE

With a wingspan of 40 m (larger than that of a Boeing 737), Facebook's huge solar drone made its inaugural flight in July 2016. Aquila was designed to fly at an altitude ranging from 18 km to 27 km and send an internet signal to ground receivers using a laser transmission system, still under development.

The aircraft is made of carbon fiber and weighs 450 kilograms, half that of a small car. It was built to fly for up to 90 days straight, providing connectivity

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Positioned up to 200 meters above the ground, the balloons manufactured by Altave are 3 to 7 meters in diameter

2

to a region with a 60-km diameter. "The project will be under development for a few more years. Its biggest problem is flight autonomy. That is why its wings are so big and carry so many photovoltaic panels to capture energy for the batteries," says Castro Jorge.

TETHERED AEROSTATS

An essential difference between the technology of Altave, founded in 2011, and that used by the Loon and Aquila projects, is that the aerostats (lighter-than-air-aircraft, such as balloons and dirigibles) of the Brazilian company do not fly freely in the sky, but rather are tethered to a ground anchoring station via a cable. "Positioned from 50 to 200 m high, our balloons are like flexible towers for housing different technologies. The same platform can be used by monitoring cameras, communication radios or scientific equipment," explains aeronautical engineer Leonardo Mendes Nogueira, one of Altave's partners.

In the telecommunications industry, the operating principle is the same as that for Loon: the balloon receives the internet signal from a nearby ground station and retransmits it to users in remote locations. Since it is higher than a telephone tower, which has a height of 30 to 60 m, it manages to transmit the signal to more distant regions, overcoming obstacles on the ground.

In addition to providing connectivity, Altave's aerostats can be used for border surveillance, security at major events, environmental monitoring (deforestation, fire, and mines) and infrastructure monitoring (electric transmission networks and pipelines). To perform these missions, the balloons rely on a set of on-board cameras and communication equipment. "We designed and developed the entire aeronautical platform, which includes the envelope, the gondola and the anchoring device. The hardware that goes in the balloon is from other vendors. What we do is integrate it into the system," says aeronautical engineer Bruno Avena, the company's other partner.

SIMPLICITY AND CHALLENGES

Tethered balloons like Altave's are nothing new—they were used in the American civil war, and in the mid-19th century for air patrolling—but only about a dozen companies use them for commercial purposes. The main manufacturers are in the United States, France, Israel and Russia, and there are no Brazilian competitors.

A feature of the Altave balloons, which measure from 3 to 7 m in diameter, is simplicity. "They can be operated by just one person," says Avena. "One of the biggest operational challenges with tethered balloons was the complexity of ground handling, which required several

Laboratories in the stratosphere

Balloons have also been used as a platform for scientific studies

Extending internet access to remote regions of the planet is not the only mission of stratospheric balloons such as Project Loon. Since 1982, the U.S. space agency, NASA, has been using this type of equipment as a platform for scientific research. Around 10 to 15 balloons are launched each year to collect meteorological data, study solar storms, or monitor Earth's oceans and forests.

Recently, the scientific balloon market gained a new competitor, the company World View Enterprises. The first balloon made by the company, based in Tucson, Arizona, was launched in 2015, carrying on-board equipment developed by researchers at Montana State University to record the total solar eclipse that occurred in August 2015. Since then, it has flown 50 missions.

"We are seeing an increase in interest in something we did not even know existed a few years ago," company executive Taber MacCallum told *Science* magazine. According to the publication, companies like World View Enterprises can make balloons the allies of science. Their advantage is that their missions cost a few hundred thousand dollars, while NASA launches cost millions of dollars.

Project Loon equipment has already brought the internet to farmers in New Zealand, flood victims in Peru and students in Piauí, Brazil

operators when there was wind. We designed a platform that facilitates letting out and reeling in the balloon without the need for rope handling. The operator controls everything remotely. That solution gave us a patent." Altave also created an anchoring system that provides a longer life span for the cable securing the balloon.

"Producing balloons and an automatic winch to keep them tethered to a ground station is not an innovation in other countries, but Brazil did not have this technology. The development carried out by Altave is no small matter," says electrical engineer Geraldo José Adabo, professor at the Technological Institute of Aeronautics (ITA) and coordinator of autonomous systems projects at the institution.

In 2010, Adabo hired Altave to assist him on a project to inspect transmission lines. "At the time, I coordinated a program that used drones to do inspections. But there were communication failures between the aircraft and the control center, limited to 2 km," he explains. "Altave proposed a solution that increased the communication distance to 50 km."

Altave's balloons, whose final price ranges from a few tens of thousands of reais to millions of reais, depending on the application and the equipment on board, were also used during the Confederations Cup held in Brazil in 2013, and at the Olympic Games in Rio de Janeiro in 2016. In the former case, an aerostat monitored the perimeter of Maracanã Stadium, in Rio. The balloon was equipped with a high-sensitivity thermal camera with zoom capability. It was a free demonstration for the organizers.

Balloons were used to monitor competition sites during the Rio 2016 Olympic Games

At the Rio Olympic Games, the company won an international competition and four balloons, with 13 on-board cameras, were used to monitor the competition locations. According to Leonardo Nogueira, it was the first time that the technology was used during the Olympics. The company received R$24.5 million for providing the service.

With annual sales of R$13 million, Altave has plans to grow. The company has six balloons operating in Brazil and plans to export its products. To this end, in June 2017 it signed an agreement with Airstar Aerospace, the leader in the French stratospheric and tethered balloons market, to distribute its technology in Europe. With this, the Brazilian company intends to increase its presence in the global aerostat market, estimated today at US$5 billion, and expected to reach US$11 billion by 2021. ■

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Projects

1. Lighter-than-air platforms for multiple purposes (No. 13/50489-6); **Grant Mechanism**: Innovative Research in Small Businesses Program (PIPE); **Principal Investigator**: Bruno Avena de Azevedo (Altave); **Investment**: R$ 969,119.73.

2. Commercial and industrial development of multi-mission low-altitude tethered aerostats (No. 13/50782-5); **Grant Mechanism**: Innovative Research in Small Businesses Program (PIPE); **Principal Investigator**: Bruno Avena de Azevedo (Altave); **Investment**: R$ 506,463.60.