National Aeronautics and Space Administration

Higher Ground, LLC's UAV technology, developed under NASA SBIR/STTR Awards, will allow UAVs to go beyond visual line of sight.

Advanced Unmanned Aerial Vehicles for Improved Communications

Challenge

Reestablishing communication channels is one of the most important yet time-consuming procedures to carry out following a natural disaster. After Hurricane Katrina impacted Louisiana in 2005, more than 60% of networks were still down 3 weeks after the event.[1] In 2017, when Hurricane María devastated Puerto Rico, 95% of cellular sites failed island-wide, leaving many civilians disconnected for months.[2] One viable approach to this challenge is increasing the capabilities of Unmanned Aerial Vehicles (UAVs), commonly known as drones, which could provide sustained communication outlets in hard-to-access areas while emergency response efforts are underway.

Solution

NASA sought to advance UAV technology as part of their Aeronautics Research Mission Directorate, which is dedicated to developing safe and transformative aviation, by engaging with Higher Ground LLC, a small business located in Palo Alto, California. Higher Ground received Phase I, Phase II, and Phase II-X SBIR awards from NASA and also caught the attention of the Department of Homeland Security (DHS), which saw the UAV's potential to bring communications to network-deficient areas. Both DHS and NASA awarded Phase III funds to Higher Ground for up to $6.9M.

[1]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1550804/
[2]https://www.fema.gov/hurricane-maria

Project

Enhancements to Unmanned Aerial Vehicles (UAVs)

Mission Directorate

Aeronautics Research

Phase III Success

Funding from NASA and DHS up to $6.9M

Snapshot

Higher Ground, LLC is expanding the reach of UAVs to fly beyond visual line of sight. Their major developments include UAV tracking, even in network-deficient areas, and enabling UAVs to detect and avoid oncoming traffic. Higher Ground's work with the NASA SBIR program resulted in additional work with DHS to enhance emergency response functions of UAVs.

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Under several NASA SBIR awards, Higher Ground proposed to develop solutions to address two key limitations on UAVs:

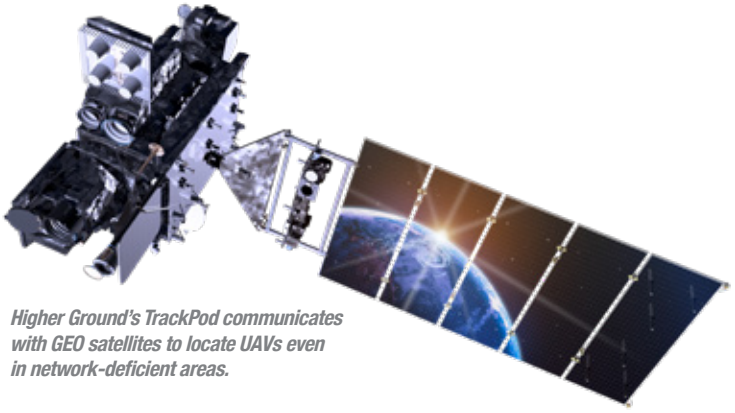
- **Track and locate –** users need to be able to track UAVs even in locations outside of cellular networks
- **Detect and avoid –** UAVs need to be able to detect and avoid oncoming air traffic automatically

UAVs are just one part of an Unmanned Aircraft System (UAS), comprised of the flying component (the UAV), the control center, and the communications between the two. Current UAVs can only fly within visual line of sight (VLOS)—1000 feet away from and 400 feet above the control center. Together with NASA, Higher Ground is working to fly beyond VLOS (BVLOS). To do so, the control center needs to track and locate the UAV at all times; however, in areas where communications have broken down, or in mountainous and rural spans lacking reception towers, no existing control center has this capability.

Instead of sending communication signals to towers on the ground, Higher Ground looks to the sky for a solution. "We suggested sending the signal up to geostationary satellites," explains Rob Reis, CEO and President of Higher Ground. "GEO satellites don't move, and there's nothing in between the UAV and the satellite.

If you send the signal up, you can always report in your location." In contrast to low-Earth orbit (LEO) satellites—which move around the Earth at extremely high speeds and are not fixed in space relative to Earth—geosynchronous equatorial orbit (GEO) satellites follow the direction and pace of the Earth's rotation. Because they are fixed, they are reliable points of communication for tracking and locating UAVs.

> "The SBIR program is wonderful and NASA should get credit for what they're doing here. NASA being innovative and taking some risks has helped us come up with some remarkable solutions.
>
> – Rob Reis
> CEO and President of Higher Ground, LLC



Higher Ground's TrackPod communicates with GEO satellites to locate UAVs even in network-deficient areas.

Higher Ground developed a lightweight, credit card-sized device to communicate with GEO satellites. Their TrackPod technology is being tested at NASA, along with a second solution to allow UAVs to detect and avoid aerial obstacles. Although UAVs are one vehicle among many in air traffic, they are responsible for their own safety.

"You can't hit anything, and we're referring to other airplanes," says Reis. "You have to detect them soon enough to get out of the way. Keep in mind the UAV might be stationary or traveling at 40mph, but the aircraft is going at 150mph, so you don't have a lot of time to detect it and move."

Military aircraft use radar to detect objects in the air from thousands of feet above the ground, but radars on UAVs, which fly only hundreds of feet above ground, must contend with the most obtrusive reflector of radar: Earth. Higher Ground is testing an onboard radar to combat the "ground clutter" caused by flights close to the Earth's surface. When Higher Ground's radar detects a threat, it directs the UAV to get out of the way by descending. This capability (which has never been accomplished before), along with the TrackPod technology, will expand the BVLOS reach of UAVs.

Along with their current improvements to UAV safety, one of the next objectives Higher Ground is pursuing with DHS is Wi-Fi on demand provided by UAVs. This capability will allow UAVs to facilitate communications in areas where networks have been cut and in places where networks have never reached before.

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