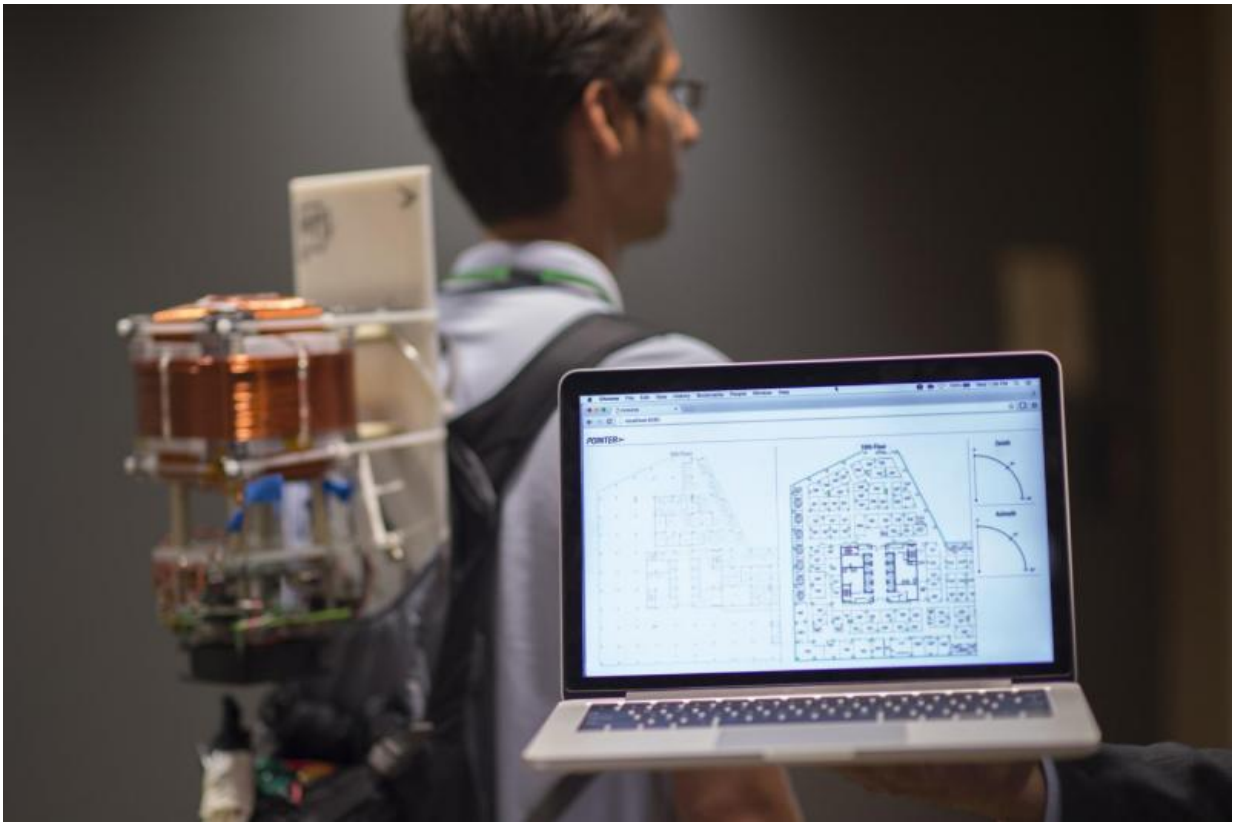
New technology could help track firefighters for safety

December 20 2016, by Andrew Good



A test of a new tracking technology, which can be followed on a computer map. JPL may have solved a longstanding technology problem for firefighters: how do you track them inside of buildings, which often block radio signals? Credit: Paul Wedig/DHS-Science and Technology Directorate

In 1999, six career firefighters lost their lives responding to a five-alarm

fire. They were part of a group of 73 dispatched to a smoke-filled warehouse in Worcester, Massachusetts. Lost inside the building's tight corners, they were unable to find an exit before running out of oxygen.

Avoiding a tragedy like that has been a technical challenge for decades. In the outdoors, firefighters can use GPS to track one another, and radios to stay in communication. But when they move into a steel and concrete building, these technologies suddenly become unreliable.

A research team at NASA's Jet Propulsion Laboratory in Pasadena, California, has developed a tracking system that could be a game-changer for firefighter safety. The team has been demonstrating the system, called POINTER (Precision Outdoor and Indoor Navigation and Tracking for Emergency Responders), for national and regional leaders in the first-responder community. The tracking technology could also benefit search-and-rescue teams in industrial or military contexts.

In August, POINTER was successfully demonstrated for top leadership at the Department of Homeland Security (DHS) Science and Technology Directorate, which has funded its development.

"To this day, the ability to track and locate first responders is a number one priority for disaster agencies across the country," said Greg Price, DHS First Responder Technologies Division director. "It's truly a Holy Grail capability that doesn't exist today. If the POINTER project continues along its current path of success, first responders will be safer in the future." Price observed the demo, along with DHS Under Secretary for Science and Technology Reginald Brothers and Deputy Under Secretary Robert Griffin. In September, representatives from fire departments across the U.S. visited JPL for a demonstration of POINTER. The tracking challenge was top of mind for Andrew Wordin, a battalion chief with the Los Angeles Fire Department: just weeks before, a firefighter became lost in a building after a roof gave way

under him.

"They immediately declared a mayday," Wordin said. "As soon as that happens, everything stops. All radio traffic stops. All incident management stops."

Everyone's job becomes finding that lost firefighter and ensuring his safety. Wordin called the POINTER demo "very exciting," saying it showed promise for addressing the tracking problem inside of buildings.

New technology developed at NASA's Jet Propulsion Laboratory can locate firefighters wearing a backpack-sized device. Engineers are working to shrink the device to fit in a pocket. Credit: Paul Wedig/DHS-Science and Technology Directorate

The science of waves and fields

POINTER is both a technological and a mathematical breakthrough. JPL's Darmindra Arumugam solved a problem researchers had been looking at since the 1970s.

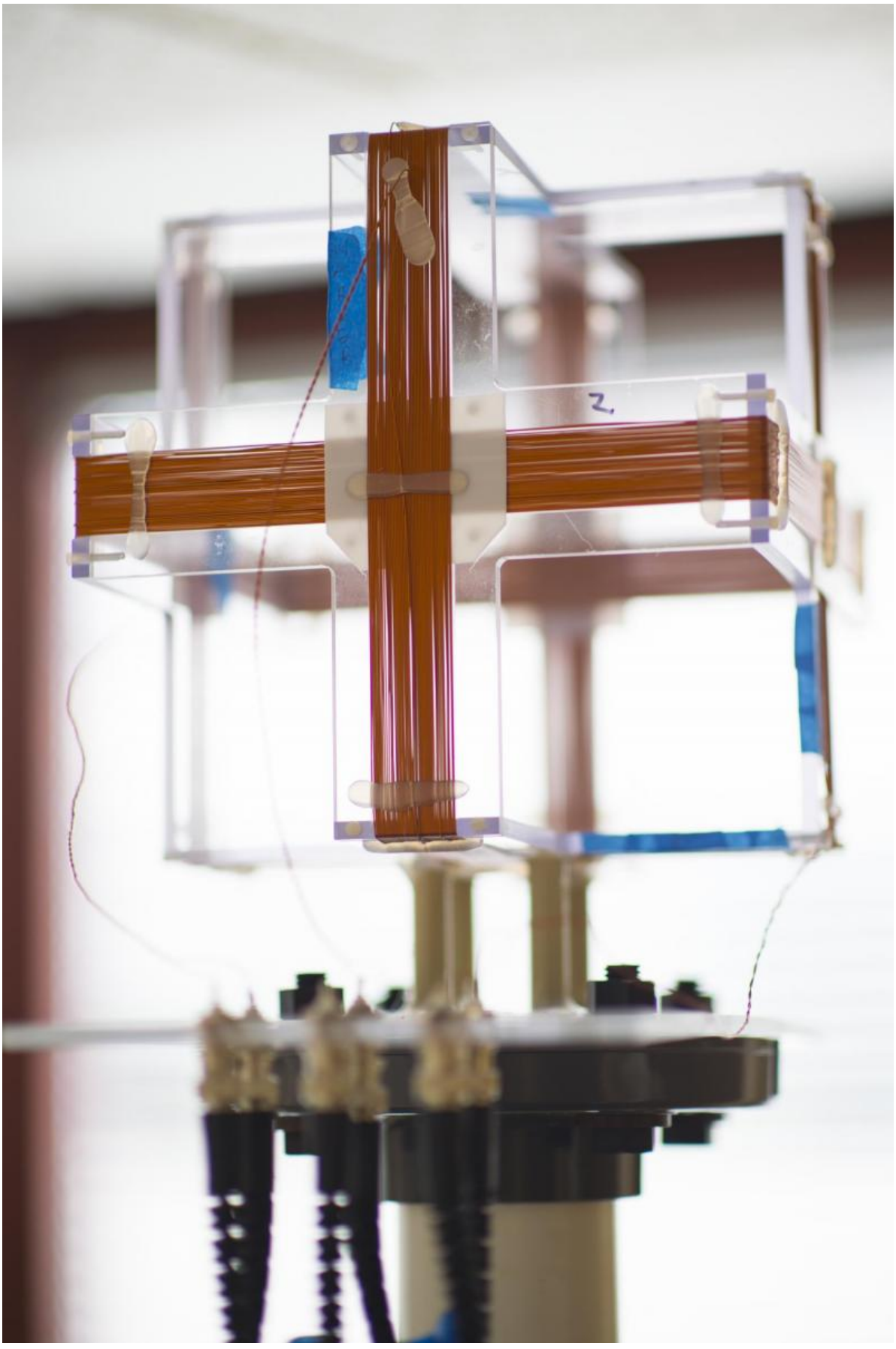
Most of that research has focused on radio waves, which have the advantage of propagating energy over long distances. That's made them ideal for communications and sensory technologies like radar. But they're also notoriously unpredictable indoors: they ricochet off walls and won't penetrate far underground. This is why you might lose your phone signal when you enter a steel-reinforced building or walk down to a basement.

Instead, Arumugam started looking at electromagnetic fields—quasistatic fields, to be exact. These fields have been largely overlooked by researchers because they have short ranges. They're limited to just a few hundred yards, or meters, but they don't behave like waves. They can get around walls, offering increased non-line-of-sight capabilities.

The fields can also be tweaked to different sizes and wavelengths. Whereas waves represent energy in constant motion over time, fields can be stationary, or can change so slowly that they appear stationary (known as quasi-stationary or quasi-static). They can even be used to sense the different orientations of devices.

That last part is important. A tracking device emitting a quasi-static field would tell a receiver where it was in space, plus which way it was facing. It could tell a team commander whether a firefighter is crawling along the ground or is stationary, facing down on the floor—suggesting that person may have stopped moving.

All of this involves complicated mathematics. Arumugam developed the theory, technique and algorithms that can analyze both the electrical and the magnetic components of quasistatic fields. These algorithms are the key to being able to interpret the quasistatic fields and their signaling.



A close-up of a receiver used outside a building to test a new firefighting tracking technology. Credit: Paul Wedig/DHS-Science and Technology Directorate

A pocket-sized lifesaver

The technology is now being developed further so that it can be miniaturized and prepared for commercialization. Besides first responders, the need for this technology spans industrial, military and space applications.

Arumugam and his team put together a field transmitter that fits on a backpack, and they've shown it can be shrunk down to a device that weighs 0.4 ounces (11.7 grams). Over the next few years, JPL will be working to shrink POINTER even further, until a transmitter is small enough to fit into a pocket or on a belt buckle.

Arumugam said a device of this type could be a lifesaver for future search-and-rescue teams, but has wide potential application beyond that.

"POINTER could be used in space robotics," he said. "It could be used for tracking robots in underground tunnels, caves or under ice. They need to be able to navigate themselves, and we don't have sensors today that would be able to track them. For us, this is a great opportunity to develop a technology for NASA and non-NASA uses."

Ed Chow, manager of JPL's Civil Program Office and POINTER program manager, said a cellphone-sized tracker would integrate well with another first responder technology called AUDREY. This artificial

intelligence system would distribute real-time data across a team of first responders, but distributing relevant information depends on knowing each member's exact location in the field.

"AUDREY is trying to provide suggested directions for firefighters lost in smoke," Chow said. "But without knowing each member's exact position and orientation, you can't make those kinds of suggestions."

Provided by NASA