The Best Radio Antenna Is One That's a Tank

University of Wisconsin engineers have done it, devising a new and better way for military vehicles to communicate.

U.S. Army

By Eric Tegler Apr 27, 2016

"Whip" antennas—those long metal rods that used to extend from our cars—look pretty cool in a *Smokey and the Bandit* kind of way. But for military vehicles, they're not such a great solution.

Troops in the field communicate using relatively low frequency radio signals. The

upside is that they don't require much power and can travel long distances. But to operate efficiently, antennas need to be at least one-quarter the length of the radio waves they transmit. Since military comms use the HF band where radio waves can range from 10 to 100 yards in length, big antennas are better. But putting huge antennas on a Humvee or an armored personnel carrier or a tank just isn't practical. Short antennas, meanwhile, are inefficient, operating in a narrow bandwidth and dissipating as much as 90 percent of input power as useless heat instead of useful broadcast radio signals.

"IF A LARGE METALLIC STRUCTURE IS THERE, WHY NOT TAKE ADVANTAGE OF IT?"

But what if you could effectively enlarge antenna size by using the vehicle itself as an antenna? That's what University of Wisconsin–Madison engineers are seeking to do as part of a project supported by the Office of Naval Research (ONR). "We're basically looking at using the 'antennas' traditionally mounted on military vehicles as a means of exciting the platform itself," says Nader Behdad, associate professor of electrical and computer engineering at UW–Madison. "If a large metallic structure is there, why not take advantage of it?"

The team aims to design "coupling structures" that, when strategically placed on a vehicle, allow it to transmit or receive signals at low frequencies. The structures act as electric or magnetic dipoles "exciting" the main structure—that is, making it resonate at frequencies comparable to its size and shape. They can "tune" the vehicle to work as an antenna across a range of frequencies.

"Think of an armored personnel carrier for example," Behdad says. "The dimensions are generally about 10 meters long. Some natural resonate modes of the structure resonate very efficiently at HF frequencies with different [stimulative] current distributions and radiation patterns. With the scale model we used, we showed that this works."

The scale model they made was merely a simple metal box paired with rudimentary loops as coupling structures. The project is only two months old, but over the course of the next two years the researchers wantto scale up to a full-size vehicle. Behdad says they've found that the shapes of the coupling structures matter less than their placement, but that if energy is efficiently coupled to the platform, wide band antenna operation at low frequencies around 10 MHz is possible. Conveniently, the process doesn't require changing the vehicle structures themselves. "We're not going to cut or alter the platform, we're just going to put coupling structures on," Behdad emphasizes.

"YOU COULD HEAR SIGNALS FROM THE OTHER SIDE OF THE WORLD."

Bandwidth is important. Current military vehicles use separate transmitters handle

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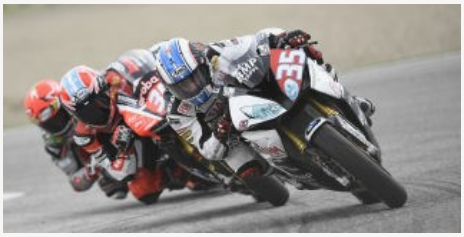

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internet data, Bluetooth connections, and cellphone calls because each signal uses a particular bandwidth. If a truck-as-antenna has enough bandwidth can capability to send and receive multiple types of information, it can dispense with multiple antennas, becoming more stealthy and less prone to damage. "If you increase the volume over which your radiating current is distributed, you have increased bandwidth. Because the platform is the antenna, you get more bandwidth than with a whip antenna mounted on it and tuned to the same frequency," Behdad says.

The team's goal is to achieve a bandwidth of 25 KHz at 2 MHz and a larger range at 10 MHz. Such bandwidth could allow for data transmission rates up to 100 Kbps, sufficient for voice and text data if not video or images.

In this era of high-speed, high-frequency broadband technology, it's an oddly simple solution. "When I was younger, I used to listen to short-wave radio stations using a small transistor radio. You could hear signals from the other side of the world. That was amazing to me. I tell my students that if our infrastructure breaks down for some reason, HF radio is going to be the only reliable means of long range communication."

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