

Combatant or Collateral Damage?

New Technology Offers Urban Ops Advantage

By Ben Lagasca, Susan LeVine and Brian Long



U.S. Army/Spc. Margaret Taylor

Traffic to Pakistan approaches a customs checkpoint in Afghanistan's Nangarhar Province.

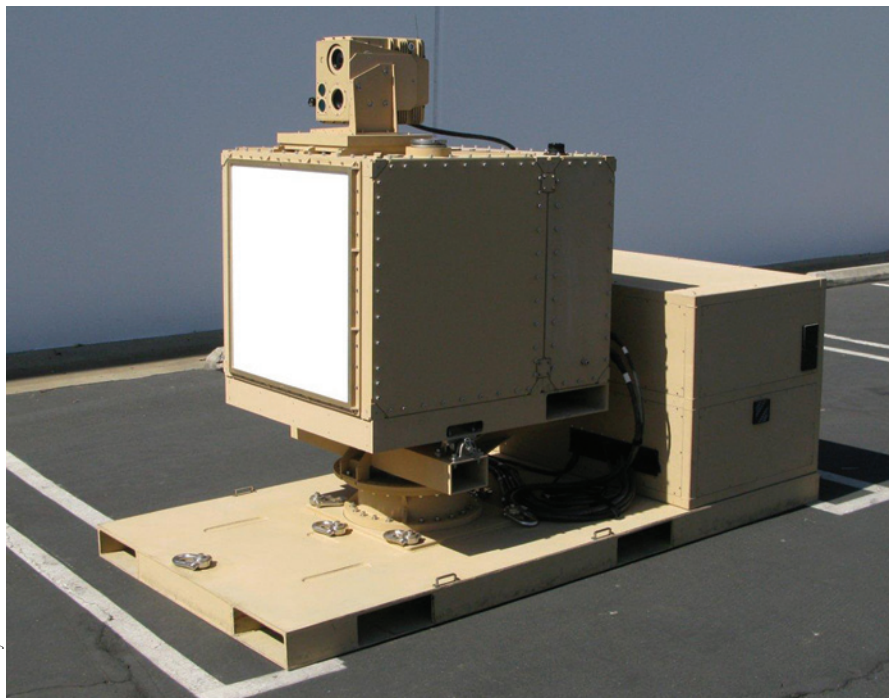
In Afghan cities like Kabul and Kandahar and on the open roads in between, U.S. military convoys couldn't tell if a rapidly approaching vehicle was an all-too-frequent car bomb, or the driver simply didn't understand signals to stay clear. In such cases, U.S. warfighters often had no good choice other than to kill or possibly be killed. Dismounted soldiers operating in Mosul, Iraq, and other cities faced similar situations. When armed threats appeared, it was sometimes hard to sort out combatant from civilian or child.

The U.S. Army likely faces more urban operations but on a grander scale. "Increasing urbanization throughout the world is making the megacity one of the key features of many potential operational theaters," U.S. Army Chief of Staff Gen. Raymond T. Odierno said in *Megacities and the United States Army: Preparing for a Complex and Uncertain Future*. In such environments, soldiers will need more than lethal force for ambiguous

threats and challenges; they will also need improved nonlethal weapons capabilities. The Army is developing this in the form of directed energy called Solid State Active Denial Technology.

Operating in the Midst of People

ARMY magazine's March article "Megacity Warfare: Taking Urban Combat to a Whole New Level" highlighted the challenges of urban operations. Numerous joint assessments have also noted them. "By the 2030s, 5 billion of the world's 8 billion people will live in cities," said *The Joint Operating Environment*, released in 2010 by U.S. Joint Forces Command. "Fully 2 billion of them will inhabit the great urban slums of the Middle East, Africa and Asia." Its conclusion was repeated in Joint Publication 3-06 *Joint Urban Operations*, published in November 2013: "Growing urbanization throughout the world raises the possibility of future military operations taking



The Army is developing an active denial system that will use radio frequency waves to deter trespass by delivering a heat sensation.

place in urban environments.” Soldiers are again likely to fight adversaries hiding among urban masses and help populations after destabilizing disasters, among other missions.

In urban operations, people are the center of gravity: They make the city, they are influenced by what soldiers do, and they pose the greatest challenges. They may impede maneuver, just as angry crowds blocked convoys in Kabul in 2006 or desperate people stormed relief trucks in Pakistan after the 2010 floods. They also constrain weapons fire, as occurred when militants in crowds initiated attacks on forces in Somalia, Iraq and Afghanistan. Consider another increasing terrorist tactic: the use of children to conduct attacks. Lethal force may be justified in such cases, but it can alienate populations and leave lingering psychological effects on U.S. warfighters.

Nonlethal capabilities provide options. They can support tactical maneuver in the urban environment by providing a means to warn, deter or repel personnel, such as people approaching convoys or standing on rooftops, exhibiting suspicious behavior. As noted in Joint Publication 3-06, “When civilians and hostile forces are intermingled, nonlethal weapons will provide the [joint force commander] a broader range of capabilities intended to significantly reduce undesired injuries to civilians and damage to infrastructure.”

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Millimeter Wave Directed Energy

In the 1980s, radars with certain frequencies were observed having a warming effect on nearby personnel. Air Force researchers subsequently believed this could be the basis for a nonlethal weapon. Preliminary analysis indicated that 95-gigahertz millimeter wave energy (so called because of the size of the energy’s wavelength) thermally stimulated nerve endings in the skin’s surface layers. Following federal regulations, researchers evaluated the energy on animals and then human volunteers, who consistently and rapidly avoided it. Researchers also determined that this avoidance behavior, and exposures limited to safe parameters, would minimize risk of significant injuries.

The response was dubbed the “repel effect” and led to development of active denial technology. In 2000, the Air Force assessed a containerized Active Denial System at Kirtland Air Force Base, N.M., which was capable of repelling volunteers

at distances up to 1,000 meters. Projecting the repel effect to a range of 1,000 meters was of interest to the Air Force for scenarios related to perimeter security and critical asset protection.

A second version of the technology was built to demonstrate the viability of integrating it into a mobile platform. This platform, a hybrid-electric variant of a Humvee, was evaluated in various venues and received high marks from warfighter assessments on the operational utility of the nonlethal repel effect. In one post-demonstration survey, 99 percent of respondents agreed that the active denial capability is an effective deterrent for crowd control. In 2008, an armored and self-contained system was mounted on a Heavy Expanded Mobility Tactical Truck to provide a robust, survivable and deployable capability. To date, more than 13,000 exposures have been made on volunteers in varying scenarios and environments.

Active denial technology development was called a “pathfinder” by the Defense Science Board. The systems developed from 2000 to 2008 helped determine the technology’s human effects and parameters for safe operations; informed reviews for legal and arms control compliance; demonstrated the technology to the DoD community; and helped the services define their needs for it.

Army Applications

The Army recognized the value of the repel effect but did not need a dedicated vehicle/system with a 1,000-meter range. Instead, the Army focused on applications in the urban environment, seeking a scaled-down version of the technology, interoperable with a range of tactical vehicles that could provide the same robust repel effect at shorter ranges and would allow for the development of an overall much smaller system.

Conceivably, a smaller-scaled, adjunct active denial system would be like a bumper for these vehicles, enhancing mobility

in urban areas. Such active denial technology-equipped vehicles also could support dismounted infantry moving through a city. Thus, if an individual or crowd attempts to block or come toward the vehicles and/or dismounted infantry, the system could repel and disperse potential adversaries. If some targeted individuals respond aggressively, lethal force could follow.

It is important to note that nonlethal capabilities, including active denial technology, are being developed to expand the range of options available to commanders. DoD policy on nonlethal weapons (NLW) is explicit that “the availability of NLW will not limit the commander’s inherent right or obligation to exercise unit self-defense” and “the presence of NLW will not constitute an obligation for their use.”

Smaller, Lighter System

“A culture of innovation is a part of the Army’s heritage,” wrote Army historian Jon T. Hoffman. That’s reflected in its pursuit of active denial technology. The Army is leading development of a much smaller and lighter active denial system, about the size of a mini-refrigerator, with a vision of its use on a wide range of mobile platforms. In doing so, the Army is leveraging the work of the Air Force and the DoD Non-Lethal Weapons Program.

The innovative aspect of this development is the Army’s use of solid-state technology. Previously developed active denial systems use a vacuum tube-based technology known as a gyrotron. Power is applied at one end of the tube, creating electrons that travel to the other end. As they do, magnets cause the electrons to spin; that converts them to millimeter wave, radio frequency energy. All this—power generation, gyrotron tubes, magnets—adds up to a lot of size and weight; considerable cooling is also required. A large antenna is needed to project this energy to as far as 1,000 meters.

Reducing the range requirement from 1,000 meters to approximately 100 meters allows the use of other 95-gigahertz-emitter technologies that are better suited for system size, weight and power reduction. Simply put, less range means less power is needed to generate and project energy. Compared to gyrotrons, a solid state active denial system is smaller and less costly, requires less power, and does not need a separate antenna because the millimeter wave energy is emitted directly from the solid state components.

The U.S. Army Research, Development and Engineering Command-Armament Research, Development and Engineering Center, in coordination with the Joint Non-Lethal Weapons Directorate, is leading the Army’s effort to develop a Solid State Active Denial Technology demonstrator. In 2016, a gimballed version of the full-scale demonstrator will be available for soldier assessment.

Advantage Soldiers Will Want

Today’s battlefield is complex. In the streets of Mosul, someone lobbed a grenade at an Army patrol that returned fire, killing a 12-year-old boy. Another soldier in Iraq engaged attacking insurgents who were using women and children as shields. Journalist David Brooks described the consequences to our warfighters: “Insurgents used women and children as shields, and soldiers and Marines feel a totalistic black stain on

themselves because of an innocent child’s face, killed in the firefight. The self-condemnation can be crippling.”

Solid State Active Denial Technology has the potential to provide soldiers advantages in countering ambiguous threats in complex environments and urban operations, including:

- Crowd control and dispersal: used to clear or deny areas and/or separate noncombatants from more determined armed threats.

- Convoy and checkpoint protection: used to warn, deter and/or assess the intent of approaching vehicles.

- Detering and/or degrading suspicious behavior: For example, this could be done to prevent noncombatant-appearing personnel from conducting surveillance and targeting, particularly from elevated structures.

- Perimeter and installation security: used to deny unauthorized personnel access to areas surrounding key facilities and infrastructure.

“On the modern battlefield, enemies will intentionally mix with the civilian population, making discrimination between friend and foe extremely difficult. The moral expectations of our citizens and allies require that civilian casualties and collateral damage be limited to the greatest possible extent,” Odierno wrote in “The Force of Tomorrow,” an article on ForeignPolicy.com. With an enduring need for a range of options beyond lethal force, and at the rate at which Solid State Active Denial Technology is advancing, it may soon become part of the force of today, providing soldiers an advantage in urban operations and other mission sets. ★



U.S. Army/Sgt. Ryan Hallock

Sgt. 1st Class Patricia Krumnauer, 593rd Sustainment Brigade, reacts to heat delivered by an active denial system during a training exercise at Joint Base Lewis-McChord, Wash.