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Implementing Gunshot Detection Technology

Recommendations for Law Enforcement and Municipal Partners

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In an effort to address the persistent and complex issue of violence in their communities, many law enforcement agencies have begun using technologies that hasten their responses to events involving gun violence and aid their investigations of such incidents. One such tool is gunshot detection technology (GDT), a system that uses a network of outdoor acoustic sensors to automatically detect gunfire and promptly alert law enforcement officers. With funding from the National Institute of Justice, the Urban Institute conducted a three-city evaluation of GDT to document how agencies implement and use the technology and assess its impacts on shooting notifications, response times, violent crime rates, and police-community relations. The cities that participated in this study are Denver, Colorado; Milwaukee, Wisconsin; and Richmond, California. Though several vendors produce and sell GDT, all three cities use ShotSpotter, Inc.'s GDT product.

Introduction

The Urban Institute conducted an evaluation with the Denver, Colorado; Milwaukee, Wisconsin; and Richmond, California police departments to document how agencies implement and use gunshot detection technology (GDT) and assess its impacts on shooting notifications, response times, violent crime rates, and police-community relations.

Throughout the evaluation, the Urban research team interviewed 46 law enforcement practitioners and 49 community members, and coded 174 firearm-related case files to examine how each city implemented GDT (Lawrence et al. 2019). The research team also analyzed GDT alerts, previously reported violent crime data, and calls-for-service data to assess GDT's impact on department notifications of shootings and officer response times to those notifications, firearm and violent crimes, and shooting- and violent crime–related calls for service. Findings indicated that on average, GDT generates a more comprehensive measure of shots fired than calls-for-service data, and in most cases GDT results in faster response times. Findings about GDT's impact on crime were mixed both within and across sites, but the technology yielded cost-beneficial impacts in some locations and contexts. Finally, our evaluation documented a wide range of implementation strategies, many of which provide insights on how agencies can implement GDT in a manner most likely to yield its intended impact.

The purpose of this guide is to outline the lessons learned from this evaluation to help law enforcement and their municipal partners make informed decisions about investing in GDT, and to offer guidance for maximizing its impact. We begin by defining GDT, focusing on ShotSpotter's specific technology. We then describe the various ways law enforcement use the technology and the data derived from it, followed by a list of seven key takeaways on best practices in training, policy development, deployment, alert response, use in investigations, and communication with community members. We hope this guide is a useful resource for informing law enforcement and government officials in decisions to invest in, continue, or expand GDT use to reduce rates of violent crime.

What Is Gunshot Detection Technology?

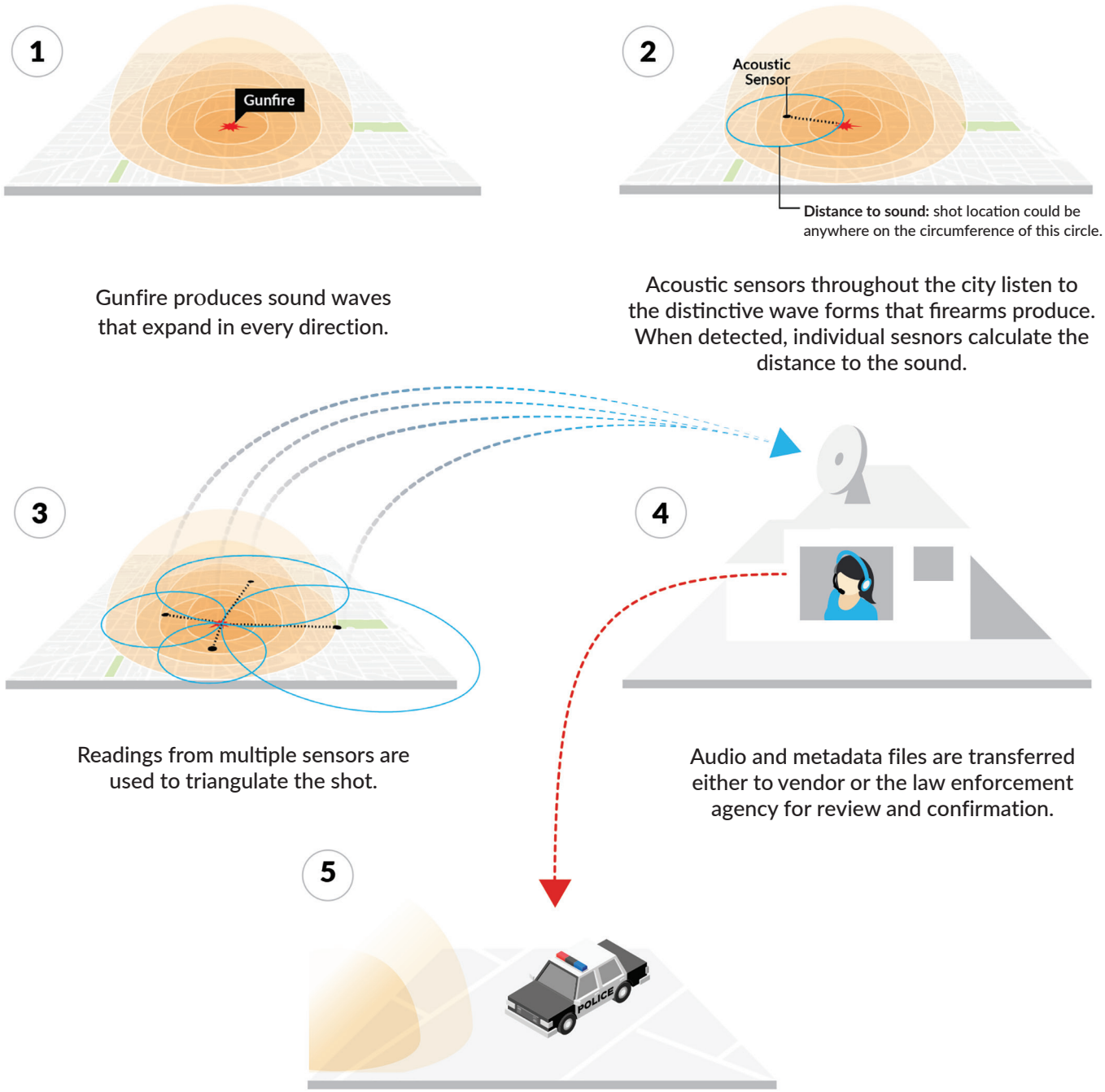
Gunshot detection technology is designed to automatically detect, verify, and rapidly notify police dispatchers and officers of the specific times and locations of firearm discharges. This is accomplished through a network of acoustic sensors mounted on high structures such as telephone poles, streetlights, and the roofs of public, commercial, and private buildings (with agreement from building owners). As outlined in figure 1, when a loud acoustic anomaly occurs within an area covered by GDT sensors (Step 1), the sensors triangulate the data to pinpoint the source of the sound (Steps 2 and 3).

The GDT collects information including the date and time the sound was recognized, audio clips that capture the duration of the shooting, the number of shots fired, and the geographic location (latitudinal and longitudinal metrics within 25 meters). Depending on the specific GDT product, this information is transferred either to the vendor or directly to the law enforcement agency, where the alert is reviewed and validated as a gunshot or rejected as a false positive (not gunfire) (Step 4). For example, ShotSpotter's GDT system has a two-phased review process where the sound and acoustic signature are initially analyzed by a AI-based machine classifier and if it is determined to be a probable gunshot it is sent to the company's Incident Review Center, where trained acoustic analysts then review the alert to verify it was gunfire and not some other noise, such as fireworks, a jackhammer, or a car backfire. Technicians in the Incident Review Center can also provide additional context about the alert, such as whether more than one type of firearm was fired or if the discharge came from a moving vehicle. Unlike ShotSpotter, if the law enforcement agency owns and maintains the GDT, the information is typically sent directly to the agency's communication division to be dispatched to patrol.

Once a ShopSpotter technician verifies an alert as gunfire, a "published" alert is created, whereupon dispatchers and officers can access the alert via the department's Computer-Aided Dispatch system, from their patrol car terminal computer using Computer-Aided Dispatch or the vendor's software, or through the vendor's smartphone app. After an acoustic anomaly is detected, it takes approximately 60 seconds or less for it to be published as a gunshot (Aguilar 2015; ShotSpotter 2018). Once the alert is made available to patrol officers or assigned to them by a dispatcher, officers are typically required to respond to the shooting following departmental standard operating procedures (Step 5).

FIGURE 1

Gunshot Detection Technology Data Flow



Source: Urban Institute.

Who Uses GDT and How?

Understanding the use and potential value of GDT requires an assessment of the technology from the perspectives of the various criminal justice practitioners who use it (or the data it generates). These include law enforcement executives and command staff, crime analysts, dispatchers, patrol officers and their supervisors, investigators, and prosecutors.

Law enforcement executives and command staff have a lead role in GDT acquisition and use: in addition to making decisions about whether to invest in the technology and about the size and location of coverage areas, they also lead policy development and training decisions on GDT use. They can also identify and capitalize on opportunities to integrate GDT data with other data and systems that can enhance its use. Denver, for example, has access to the Crime Gun Intelligence Center, a multi-agency task force led by the Federal Bureau of Alcohol, Tobacco, Firearms and Explosives. It has also leveraged resources from a Project Safe Neighborhoods grant to support analysis and integration of GDT alert data. Milwaukee's GDT program is situated in its Intelligence Fusion Center, which has a robust team of crime analysts and a full-time supervisor who manages the GDT program.

In addition, a law enforcement agency's leadership can set the tone regarding the technology's value and accuracy, as well as how they expect officers and civilian staff to use it. This includes dedicating sufficient resources to training, giving staff (particularly crime analysts) time to analyze GDT-generated data, and holding officers accountable to departmental policies.

Crime analysts have an early and ongoing role in GDT adoption and use. At the time of the initial GDT investment decision, they can produce maps of known areas of gun violence that depict patterns of reported gun-related crimes, homicides by firearm, and calls for service reporting shots fired. This information is useful for determining where to place GDT sensors to ensure the areas where the majority of gunfire incidents are likely to occur are covered. Because the cost of GDT depends on the number of sensors and the size of the coverage area, this is a critical first step that increases the likelihood that the investment is cost-effective.

Once GDT has been deployed, crime analysts analyze GDT data both independently and with other data. They analyze GDT data for trends and concentrations in firearm discharges (e.g., by time of day or day of the week) and map the data by location (e.g., city blocks, patrol areas, or neighborhoods). These analyses inform tactical decisions about how and where to deploy patrols and other resources. Moreover, by examining spatial patterns in combination with other intelligence, analysts can track feuds between local groups, crews, and gangs, and inform efforts to intervene and deescalate violence. This information can also support other crime-reduction strategies, such as Richmond, California's Operation Peacemaker program,

which recruits community members to conduct street outreach and address conflicts before they escalate.

Dispatchers are typically the first to be notified of a GDT alert. As such, they are responsible for notifying patrol officers of shots fired; in cases where patrol officers lack access to GDT technology, dispatchers can also provide context on how many shots were fired and any other calls for service that may be related to the incident. This information can help officers know whether they are approaching an active crime scene and anticipate the need for backup.

Patrol officers have a critical role in making GDT work. Officers reporting to the scene of a GDT alert should exit their patrol cars, identify signs of injury or homicide (and subsequently expedite medical care for those in need), search for shell casings, interview bystanders and potential witnesses, and canvas the neighborhood for additional intelligence or evidence. Because they are key to the GDT process, it is essential that officers be trained in GDT policies and protocols, have confidence in the technology, and are monitored by supervisors to ensure they are following leads generated from GDT alerts. This will ensure investigators have access to thoroughly collected and accurate information.

Patrol officers have also used GDT technology proactively to engage with community members. For example, in the days preceding holidays with large amounts of celebratory gunfire (e.g., the Fourth of July and New Year's Eve), officers in the Milwaukee, Wisconsin and Richmond, California police departments visited homes where alerts were detected in previous years to inform residents they should not be discharging firearms and alerting them to the dangers and legal ramifications of doing so.

Investigators may benefit most from GDT for two reasons: (1) the technology produces precise information about the timing and location of shots resulting in injuries or homicides, and (2) it can help patrol officers locate shell cases and collect other investigative intelligence from possible witnesses. Investigators can also integrate GDT-generated data with ballistics analyses, identifying whether shell casings are connected with guns used in other documented crimes. For example, the police departments in Denver, Colorado and Milwaukee, Wisconsin have in-house National Integrated Ballistic Information Network (NIBIN) programs that enable them to analyze bullet casings within 24 to 72 hours of gunfire incidents and link cases together. Both departments also require that all recovered casings be analyzed by a NIBIN specialist. In contrast, Richmond, California does not have an in-house NIBIN program and relies on the Contra Costa County Forensics Services Division to analyze recovered casings, and investigators decide whether bullets are sent for analysis.

Finally, **prosecutors** generally consider GDT useful; though the data alone does not make or break a case, it can be helpful in

demonstrating that the timing and location of the GDT alert coincides with the defendant's location. Gunshot detection data can also help prosecutors demonstrate that shots were fired from a moving vehicle as well as the timing and location of shots fired from multiple weapons, all of which can be instrumental in pinpointing who initiated a shooting. Gunshot detection technology has also been valuable for refuting claims of self-defense and proving intent. One prosecutor we interviewed used a four-second audio clip in court to demonstrate that a defendant had fired the first shot, disproving a claim of self-defense.

Although each of the above actors plays a specific role in GDT use, it is important that they work in partnership rather than in siloes. Training on GDT should therefore include representatives across all GDT roles. This can help trainees understand the technology's full potential and underscore the importance of coordination and collaboration across roles and responsibilities.

Recommendations

Although the structure of specific GDT programs can vary based on departments' resources, implementation strategies, and gun-violence programs, we gleaned several practices that any agency seeking to maximize GDT's benefits can apply. These practices, extracted from interviews with criminal justice stakeholders and community focus groups, are the basis for the recommendations that follow.

1. ***Install sensors in places with high concentrations of gun violence.*** Placing acoustic sensors in the right places is paramount to maximizing a GDT system's benefits while conserving resources. By analyzing data on calls for service and reported crimes and complementing them with agency intelligence and input from ShotSpotter staff, all three evaluation agencies were able to deploy GDT in the areas most heavily impacted by gun violence. Without understanding preexisting spatial concentrations of gun violence, agencies may overinvest in GDT or deploy it in places it is less likely to have an impact.

   Although installing sensors where gun violence is already happening may sound intuitive, it is more complicated than departments might assume. To work properly, GDT sensors need clear acoustic pathways unobstructed by tall buildings and must be near a power source, meaning the most ideal locations may not be feasible. In some cases, the most desirable and feasible locations also require consent and cooperation from private businesses or homeowners. Any law enforcement agency implementing or expanding GDT coverage should plan for these challenges and be prepared with necessary consent forms, reviewed by the agency's general counsel.

2. ***Communicate with community members early and often.*** Although GDT can provide law enforcement agencies accurate data

about the location and nature of gunfire incidents, the technology cannot replace information obtained directly from community members. When installing GDT systems, law enforcement should communicate with community members about what GDT is, what it is not, where it is deployed, and how it is being used. In focus groups with residents living in GDT coverage areas, it became evident that some people thought that departments could use GDT to constantly listen to and record the street activity in their neighborhoods. Clearly explaining how the technology works can dispel community members' misunderstandings and assuage concerns about privacy and surveillance.

In keeping with principles of community policing, it is also paramount that law enforcement explain that GDT is not a substitute for calls for service and that it is critical that residents continue reporting gunfire incidents they hear or observe. The Urban research team learned that some residents who were aware their city used GDT had stopped reporting shootings because they assumed the technology was automatically notifying their police department.

3. ***Develop clear policies and procedures before implementation.*** Gunshot detection technology's effectiveness rests on officers' response to alerts and their use of GDT-generated data and related intelligence. Before implementing GDT, agencies should develop clear policies and procedures for officers responding to alerts and arriving at alert locations. For example, though all three evaluation departments treated GDT alerts as Priority 1 dispatch, policies for canvassing neighborhoods, searching for and collecting shell casings, and locating witnesses and suspects varied considerably among agencies. The sooner agencies communicate policies and expectations of officers, the easier it is for supervisors to hold officers accountable for making the most of the technology.

4. ***Make training an ongoing priority.*** Departments should make officers aware of established GDT alert policies and procedures both in the police academy and through ongoing in-service trainings. These trainings should also emphasize GDT's purpose, accuracy, and limitations. In one evaluation site, the technology failed to issue an alert following a well-known shooting incident. Though such missed detection is uncommon, the fact that the GDT erred may have made some officers feel that responding to alerts is pointless. Training should include credible, vendor-specific research on GDT's accuracy to decrease doubts and increase compliance with departmental policies and procedures.

Several agencies that participated in this study consulted with agencies that have several years of experience using GDT. Leveraging the knowledge of law enforcement practitioners who have

worked with the technology can be a valuable opportunity to complement departmental training with peers' experiences.

5. ***Develop accountability mechanisms.*** Creating clearly stated policies and procedures and communicating them during ongoing trainings are critical foundations for using GDT, and developing and implementing accountability measures can help supervisors ensure compliance with these policies. One agency requires supervisors to conduct field checks after officers respond to an alert and report no evidence of or related to a shooting. The supervisor is required to return to the alert location within 24 hours to look for shell casings and conduct an additional canvass to unearth any additional intelligence and confirm the officer investigated the GDT alert thoroughly.

6. ***Assess departmental capacity for data integration and management before implementing GDT***. The data GDT generates can provide useful metrics of gun violence to incorporate into crime analysis, problem-solving, and tactical deployment decisions. To effectively use GDT data for these purposes, it is crucial that agencies integrate alert data with existing data systems (e.g., records management systems and Computer-Aided Dispatch). When possible, agencies should assess their systems' capacity for incorporating the data before implementing GDT so they can be ready to receive and process GDT data as soon as the system goes live.

7. ***Leverage complementary technologies.*** When agencies paired GDT data with data from other policing technologies, such as NIBIN or eTrace—a system that allows agencies to submit data to the Bureau of Alcohol, Tobacco, Firearms and Explosives' National Tracing Center—they experienced substantial benefits in GDT's investigative utility and impact. In particular, agencies with in-house NIBIN programs that allowed them to run rapid results on bullet casings enabled investigators to quickly link firearm cases within and across jurisdictions. An ideal shooting-investigation program would use GDT to get officers to the scene, NIBIN to analyze shell casings and connect weapons to other criminal events, and eTrace to investigate the owner(s) of the weapon, along with other traditional investigative practices such as next morning canvasses, canine searches for shell casings, and follow-up interviews.

Conclusion

Gunshot detection technology is a tool for addressing firearm violence that is most effective when law enforcement agencies thoroughly incorporate it into day-to-day procedures and operations. Although GDT's accuracy has been thoroughly documented, its impacts on crime depend squarely on its implementation. Its technological capabilities can make a "plug and play" approach tempting, but deploying it without attending to issues of policy development, training, and community engagement is unlikely to yield its intended impact. Gunshot detection technology requires intentionality in implementation and daily use to be valuable to the cities and agencies that use it. It is therefore crucial for agencies to assess their capacity for covering the hidden costs of implementing GDT—training, monitoring, analysis, and communication—before investing in it, and that they attend to those details before deploying it. Although GDT can be a powerful tool, it is also important to recognize that no one technology or program can fully address the underlying factors driving gun violence in the US. A combination of tools and responses is needed, along with authentic partnerships with the communities most likely to experience violent crime.

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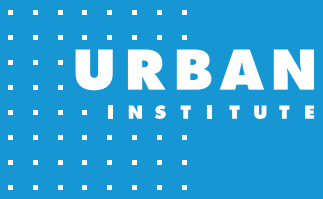

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