National Protective Security Authority

An Introduction and Overview to
Gunshot Detection Systems (GDS)

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Introduction

This document presents an overview of the principles behind a GDS, the different technologies available and considerations regarding the environments they operate in.

This document does not cover Military or Police use of GDS.

This document is primarily focussed on indoor GDS's as part of NPSA's wider Marauding Terrorist Attack programme of work.

This document should be considered in conjunction with NPSA's guidance on Marauding Terrorist Attacks.

Background

Marauding Terrorist Firearms Attacks (MTFA's) in indoor/crowded space locations have been witnessed across the world. While within the UK, firearms regulation and laws are strict, an attack utilising a firearm is still a realistic possibility. Limiting the duration of an attack and consequently its severity, will depend on rapid, reliable and accurate detection along with an appropriate response from emergency services.

Detection is vital if Security Control Room (SCR) Operators are to respond to an incident in a timely manner. In the case of an MTFA, it is highly unlikely that an operator will be looking at a particular CCTV camera view at that exact time a weapon is fired. During a firearm attack it can be assumed that those witnessing the attack will not be able to call the Police or the SCR in the early stages. Therefore, a technological solution significantly speeds up response times.

GDS significantly improves speed of awareness of an attack and clarity of a situation, without it, it can be extremely confusing and also slow to establish what has happened.   The clarity and speed provided by a GDS is essential to the deciding and implementing of a response.

Gunshot Detection System (GDS) are no longer military only technology and are now available commercially for the protection of company buildings and employees. The technology has been driven forward in recent years by manufacturers in the United States as an attempt to assist in the response to "active shooter" situations and the deployment of gunshot detection technology is increasing every year.

A poorly planned GDS deployment, like any other security system, can be expensive and may not meet all requirements of a site. Therefore, before committing to a technological solution, organisations must assess the risks they face and determine if they justify its deployment. This is achieved by carrying out an Operational Requirement (OR).

Procedural measures and deterrence communications should first be considered and developed as a means of mitigation. It is when an organisation feels that these do not reduce the risks to an acceptable level that they may wish to deploy technical measures, such as GDS.

Introduction

A GDS is typically made up from a number of sensors, along with a central control unit. The sensors are positioned to cover a defined area, they are the "eyes and ears" of the system. The control unit provides the interface to the system and may allow for further integration into other physical security systems e.g. Automated Access Control Systems (AACS) and Video Management Systems (VMS).

A GDS' primary purpose is to detect the presence of a gunshot and communicate its location, thereby allowing a response to be initiated either:

⇒ Automatically by integrated systems

⇒ Manually by a guard force

Key elements that form a response, be it by a person or by a system, include confirmation of an incident, deciding what action to take on the basis of that confirmation and then communication of that action.
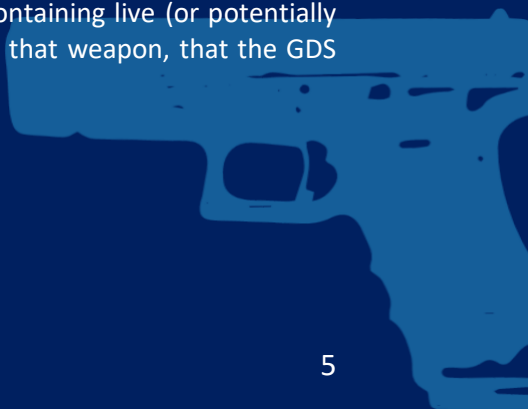
On receipt of a GDS alert, guard force response is critical in determining how the incident will progress. A delay in response or an unconsidered response could extend the incident duration or have significant consequences. Immediate notification of emergency services is critical, but so is immediate organisational response such as public address announcements, lockdown and communications. For further information on organisational response to an MTFA please see CPNI's suite of guidance on Marauding Terrorist Attack. (https://www.gov.uk/government/publications/marauding-terrorist-attacks)

In the event of any firearms incident, a fast response time by emergency services is critical to bringing the incident under control. The overall response time to an incident will comprise of a combination of detection (and reporting) time plus Police travel time:

> **response time = detection (and reporting) time + Police travel time**

It therefore follows, that a decreased detection and reporting time will reduce the overall response time to an incident by emergency services capable of dealing with the incident.

A GDS should not be confused with weapon detection by the use of video analytics or search and screening technologies. It is the physical act of discharging a weapon containing live (or potentially blank) ammunition, and the characteristics displayed whilst discharging that weapon, that the GDS captures, classifies and acts upon.

Principles

The main principles that define a GDS are:

⇒ A GDS detects a gunshot and alerts an operator

⇒ It detects the discharge of ammunition by looking for a unique signature i.e. the sound (acoustic) and / or infrared light (optical) associated with firing a weapon

⇒ It consists of one or more sensors.

⇒ It may have a user visual and/or textual interface that displays gunshot alerts

⇒ It will detect all relevant threat ammunition – It must be able to clearly differentiate between live gunfire and simulated gunfire or sounds similar to gunfire. A low false alarm rate is essential.

⇒ It must be able to detect (with high confidence) gunshot of all calibres.

⇒ GDS that are accurate will significantly increase MTFA detection. For a human, a single shot is the hardest to detect and recognise. A capable GDS will alert on single shots.

⇒ Implemented correctly, a GDS will reduce the response time to accurately identify a firearms discharge

Principles

Technologies

The technology behind a GDS is designed to detect the characteristics associated with gunfire. The 3 main **characteristics** of a gunshot are as follows:

⇒ Muzzle Flash – this is the "flash of light" coming from the barrel when the weapon is fired. It consists of visible and infra-red (IR) light. (GDS sensors specifically detect in the IR spectrum).

⇒ Muzzle Blast – the noise produced by the explosion/rapid burning of the propellant and its exit from the barrel of a firearm.

⇒ Projectile Shockwave – a separate shockwave produced by a bullet passing through the air at supersonic velocity. This does not apply in all situations - certain ammunition and firearm combinations yield lower velocity bullets and bullet velocity rapidly reduces with distance.

> **A GDS that detects muzzle flash is often called "optical sensor" technology**

> **A GDS that detects muzzle blast and/or projectile shockwave is often called "acoustic sensor" technology**

GDS can either use a single sensor technology type or a combination of sensor technology types.

Current combinations that have been seen are:

⇒ Acoustic Only (muzzle blast)

⇒ Acoustic Only (muzzle blast **and** shockwave)

⇒ Optical and Acoustic (muzzle flash **and** muzzle blast)

⇒ Optical and Acoustic (muzzle flash, muzzle blast **and** projectile shockwave)

> **GDS that use a combination of optical and acoustic sensors to form a single device are often called "Dual Technology Sensors"**

Dual technology sensors can be set up in one of two ways;

1) The alert is generated when **either** of the individual sensors is activated called an "**OR**" configuration. If the optical **OR** acoustic sensors detect gunshot, they create an alert.

2) The alert is generated when **both** of the individual sensors is activated called an "**AND**" configuration. If the optical **AND** acoustic sensors detect gunshot, they create an alert.

The most common setup for a GDS is the "**AND**" configuration. Firearms attacks are loud and easy to detect, the technology however needs to filter out false alarms and the "AND" configuration assists with this.

Environment

GDS can theoretically be used in both indoor and outdoor environments; however, conditions within these environments can affect the ability of any system to accurately detect a gunshot, this primarily depends on which of the 3 characteristics of a gunshot the GDS aims to detect. There are some principles that can act as a guide as to how each system will perform in a given environment.

Outdoor

Typically, outdoor environments are more suited to acoustic sensor types, using muzzle blast or shockwave characteristics to detect gunfire.

GDS that use **muzzle flash sensors** outdoors find the environment challenging to detect in, due to the high levels of ambient Sun light as the Sun emits over 50% of its light as IR radiation.

GDS that use **acoustic only sensors** can also struggle with the background sound level in busy and built up environments.

Example Outdoor Locations

⇒ Parks
⇒ Outdoor markets e.g. Christmas markets
⇒ Large public events e.g. sporting/entertainment events
⇒ Parts of, or whole cities
⇒ Outdoor critical national infrastructure sites (water, electric etc)

Indoor

Typically, indoor environments are more suited to muzzle flash sensor types either as a single characteristic or in combination with a secondary, acoustic, characteristic.

GDS that use **acoustic only sensors** indoors could find industrial or loud environments challenging.

Example Indoor Locations

⇒ A CNI or high profile building
⇒ An office location
⇒ A school
⇒ A shopping centre

There is a third environment, **covered areas**, this may be an area such as a train station concourse that typically is fully **covered** with a roof but is not a fully **enclosed** space. As these areas tend to sit between indoor and outdoor environments, shots tend to be easier to detect than in outdoor environments but could be more prone to false alarms than completely indoor environments.

Example Covered Areas

⇒ Train stations
⇒ Airport Terminals

The general principle is:
the more external light and / or background sound in an area, the harder it is for a GDS to operate correctly

It is essential that sites considering implementation of a GDS work closely with manufacturers to establish the environments that their systems are designed to operate