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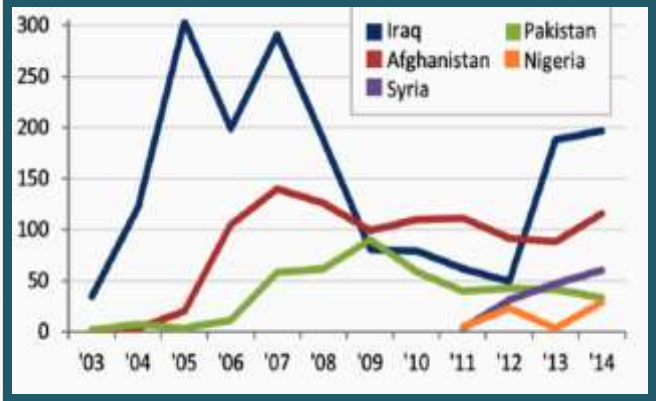
Introduction to Standoff IED, PBIED & VBIED Detection Technologies



Homeland Security Research Corp.

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Table of Contents

1 Standoff IED, PBIED & VBIED Detection Technologies 4

List of Figures

Table 1 - Standoff IED, PBIED & VDIED Detection Technologies 7

List of Figures

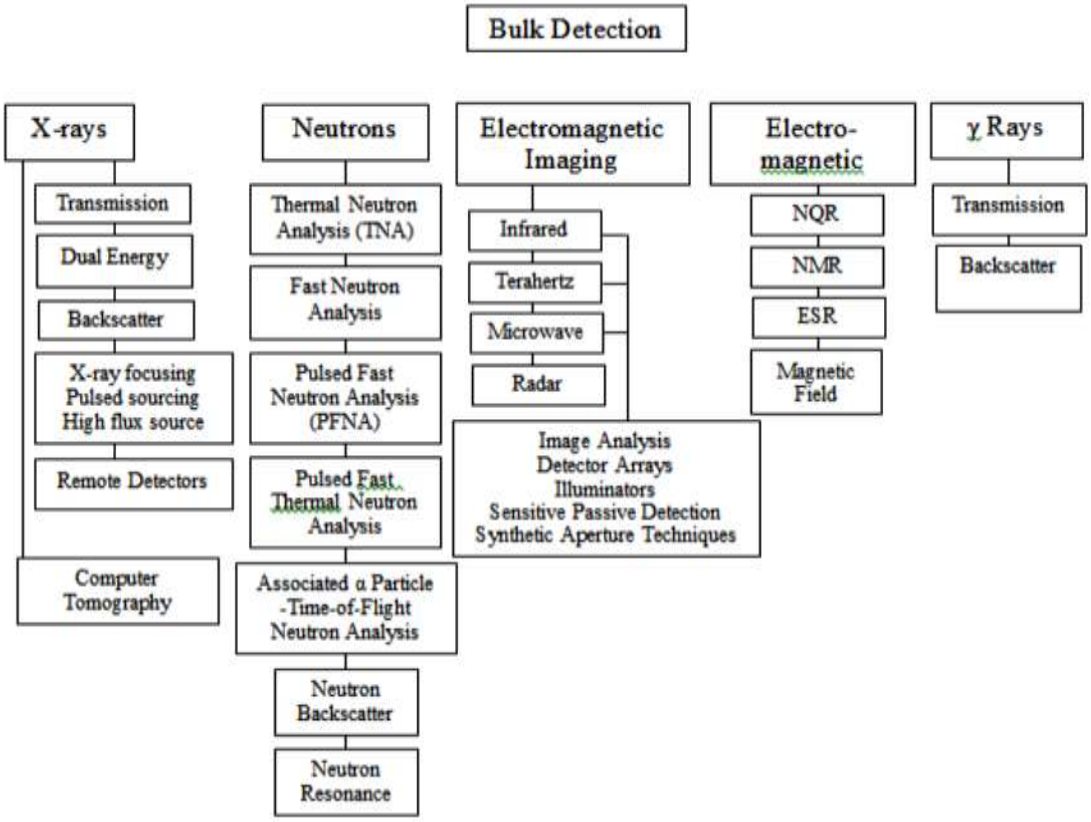
Figure 1 - Standoff & Non-Standoff IED Bulk Detection Technologies.....5
Figure 2 - Standoff IED Trace Detection Technologies.....6
Figure 3 - People Screening Portals - Threats and Associated Detection Technologies 9

1 Standoff IED, PBIED & VBIED Detection Technologies

- Improvised Explosive Devices (IEDs), PBIED & VBIED are persistent threats that manifest themselves in almost innumerable forms. Their detection and safe disposal is a formidable challenge.
- Over the past two decades, much progress has been made to address this challenge with the development of technologies with ever increasing levels of sophistication. These range from indirect methods to detect packaging, wiring, or fusing to more direct detection methods.
- Standoff detection methods are focused on detecting chemicals (including explosives and explosive devices) at a remote distance. In the case of substance detection on people or vital assets, this technique reduces the potential for severe damage. In addition, this technique enables detectors to collect signals transmitted over longer distances.
- In some modalities, it is possible to identify small concentrations of the threat chemicals: explosives, breakdown products, and/or precursors (trace detection), while other methodologies are based on the detection of suspicious packages, wires, fragmentation materials, and other physical attributes of IEDs (bulk detection).
- Key challenges in standoff detection include extending the distances at which effective PBIED, VBIED & IED Detection can be conducted, reducing the impact of various interferences and backgrounds (e.g., atmospheric and environmental) to increase sensitivity, effective PBIED, VBIED & IED Detection of multiple mobile potential threats, and increasing the speed at which the detection is made.

Bulk Detection Methodologies. Bulk explosive detection involves the detection of a macroscopic mass of explosive material (a visible amount of explosives), usually based on either imaging or on the molecular properties of the explosive. Techniques such as thermal infrared, x-ray, and millimeter-wave imaging are often used to detect the physical properties of suspicious objects (e.g., density, temperature). Equipment costs associated with bulk detection are often much higher, and some bulk detection techniques – especially those based on imaging, such as x-ray imaging – may have a lower degree of specificity than trace detection methods.

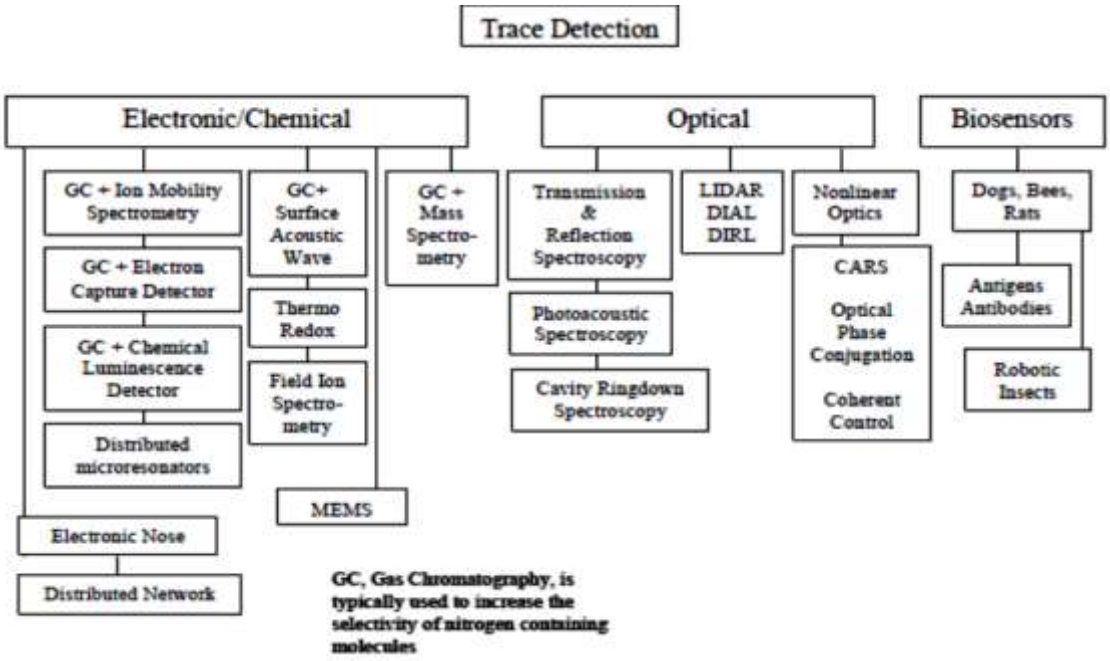
Figure 1 - Standoff & Non-Standoff IED Bulk Detection Technologies



(Source: S. A. Heider**)**

Trace Detection Methodologies. Trace detection techniques essentially detect the presence of a small amount of certain chemicals or explosives existing within an area or in a sample under investigation. Several different methodologies exist that perform trace detection using chemical sensors, and many are based upon optical techniques. In most cases, the detection process entails cross-referencing the wavelengths or wavenumbers measured to a spectroscopic database.

Figure 2 - Standoff IED Trace Detection Technologies



(Source: S. A. Heider**)**

- Standoff IED detection is a form of trace detection performed at a further distance from the sample or target. Standoff detection requires a certain level of energy per wavelength to exist in the backscattered light emitted from the sample and captured by the detector in order to interpret the received information.
- In techniques such as Laser Induced Breakdown Spectroscopy (LIBS), a spectrometer (device consisting of a diffraction grating and photo-detector) is often used to acquire the related information. The numerical aperture of spectrometers is often limited so only a certain amount of the backscattered light is actually captured for detection, which limits the obtained information. Since the spectrometer sends the light through a diffraction grating, acquiring a full spectrum of the sample light usually takes time and requires calibration to compensate for the loss of energy.
- The table below offers a side-by-side comparison of the present and pipeline Standoff IED, PBIED & VBIED Detection technologies.

Table 1 - Standoff IED, PBIED & VDIED Detection Technologies

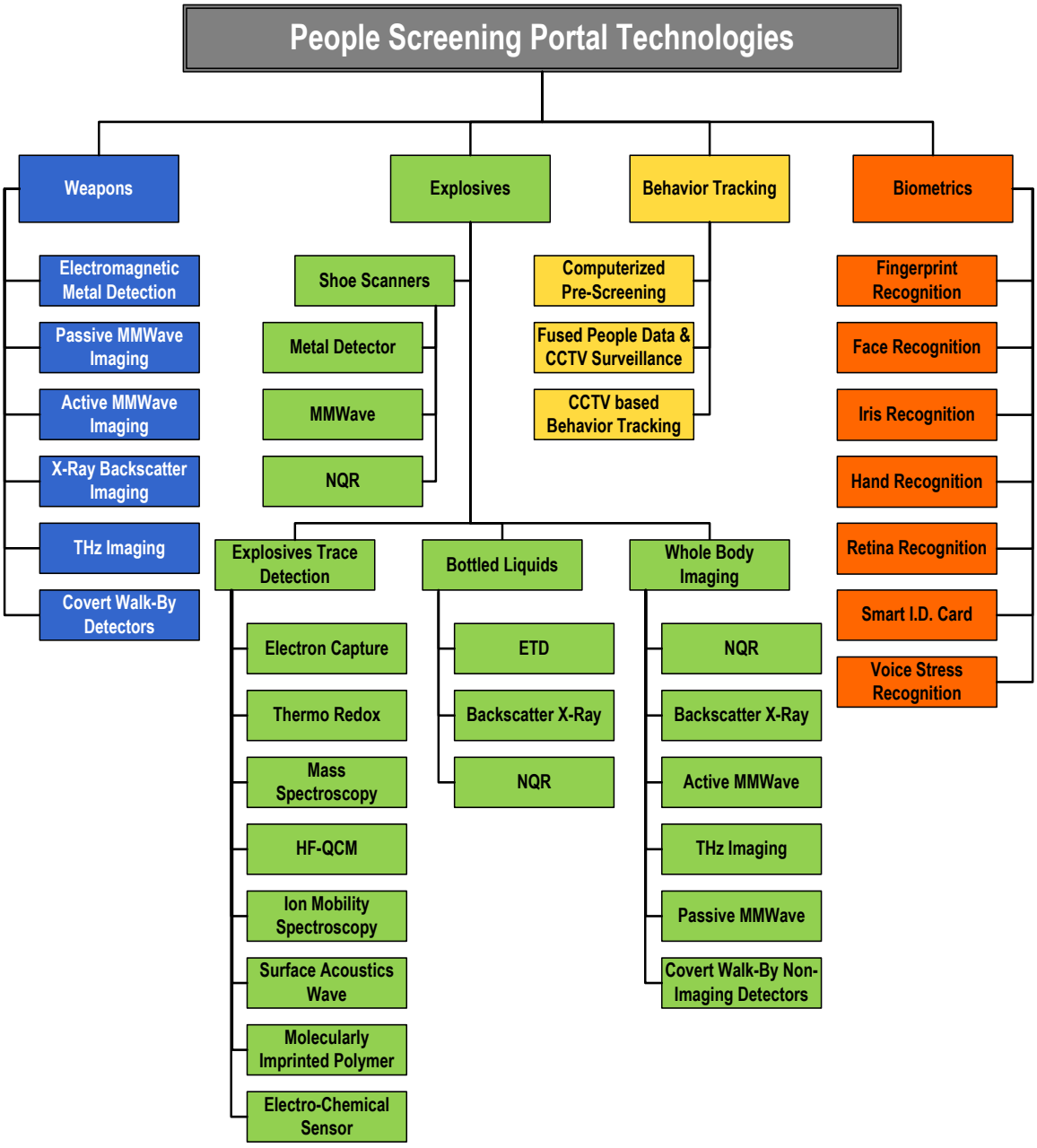
Technology Type	Technology Description	Tactical Purpose	Technology Decision Process
Passive MMW Imaging	Uses natural MMWave illumination emitted and reflected from a person and the surrounding environment	Detects the presence of concealed objects on a person's body	Not automated. Properly trained operators scan crowd looking for image anomalies indicative of concealed weapons (cannot identify a person from a MMW image)
Passive Terahertz imaging	Uses natural Terahertz illumination emitted and reflected from a person and the surrounding environment	Detects the presence of concealed objects on a person's body	Not automated. Properly trained operators scan crowd looking for image anomalies indicative of concealed weapons (cannot identify a person from a Terahertz image)
Passive and Active MMWave Sensors	A signal (no image) from the device can detect the presence of an anomaly in a person's MMWave signature	Detects the presence of concealed objects on a person's body	Can be automated or operated manually. Output is a temporal chart showing signals over the course of time the person is in a device's range
Infra-red Thermography (Passive)	Uses the IR energy naturally emitted and reflected by the human body	Concealed objects are observed with IR imaging systems	Not automated. Operators scan crowd looking for IR image anomalies indicative of concealed weapons
Intelligent Video Systems	Multiple fixes cover CCTV cameras coupled with image processing software compares images over time and identifies anomalies based on user -defined rules	Used to detect, locate and track leave-behind objects and individuals to identify anomalous behavior	Can be automated or operated manually. Software will process images and uses algorithms to detect anomalies
Standard CCTV Surveillance Camera	Commercial-off-the-shelf still and video surveillance systems	Used as an expanded view of the screening zone	Operated manually and uses data to compare other technology output for accuracy research
Standoff Biometric identification	CCTV-based standoff imaging applied to facial and/or iris biometric identification	Identify people on watch lists and identity theft	Automated
Standoff Laser based explosives detection	Adapted LIDAR-like chemical warfare technologies to detect airborne explosives traces	Detect explosives carried by a suicide bomber at safe distance	Automated
Active Standoff Terahertz Detection	Passive and active Terahertz radiation used to image and or spectroscopy identification of	Detect explosives carried by suicide bomber at safe distance Detect concealed	Both automated alarm and operator image and data interpretation

Technology Type	Technology Description	Tactical Purpose	Technology Decision Process
	weapons and explosives	weapons and explosive	
Standoff Behavioral Tracking	Off the shelf CCTV–based, behavioral tracking	Track and alarm for persons who demonstrate unusual behavior	Both automated alarm and operator image and data interpretation
Standoff Video Content Analysis	The use of feature detection algorithms to identify shapes of known threats		Semi-Automated
Stimuli Triggered Behavioral Surveillance	Covert Exposure of subjects to terror-related stimuli and tracking their response	Identify people with terrorist intentions	Automated

Note:

- Most standoff systems have an integrated CCTV camera which provides an auxiliary image of the people screened and the environment.
- Passive imaging technology uses only available atmospheric background "illumination" to create the image, while active imaging technology illuminates the subject to create the image.
- Technology image output is not identifiable; however, the device has a standard, on-board camera that will provide a still image alongside the unidentifiable image to identify which person to perform further screening on.

Figure 3 - People Screening Portals - Threats and Associated Detection Technologies



Note: This figure includes portal technologies that relate to people screening and are discussed in the people screening portals report.

More information can be found at:

Standoff IED, Person-Borne & Vehicle-Borne Explosives & Weapon Detection: Technologies & Global Market – 2015-2020